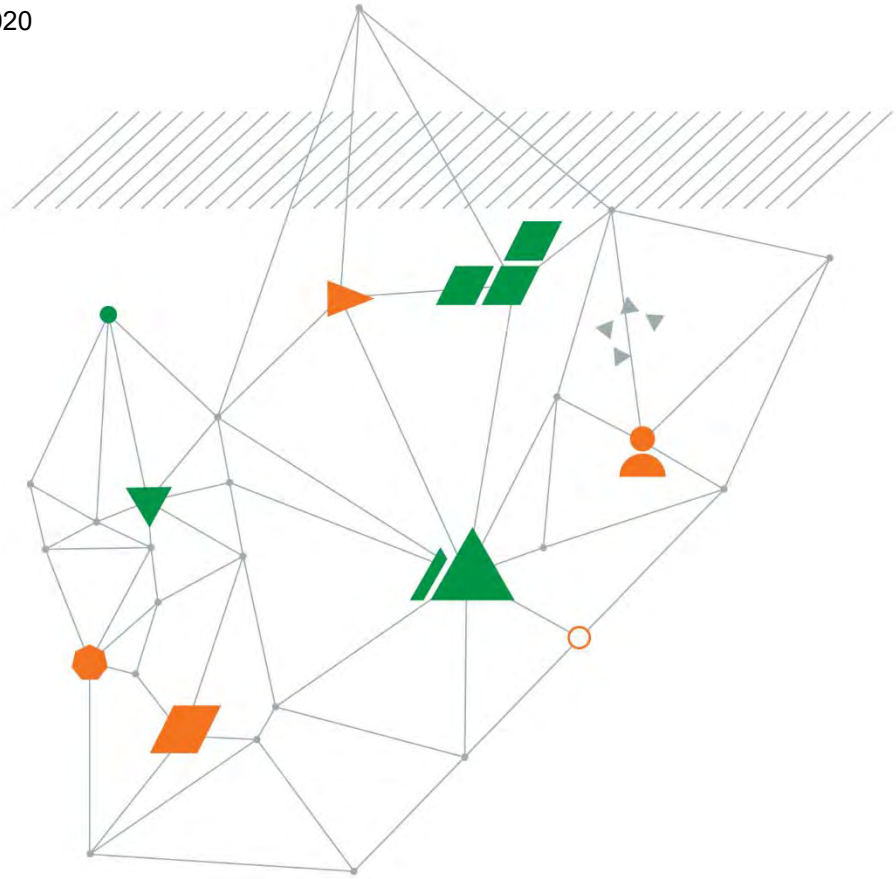
Creo Consultants Pty Ltd
Merrimu Precinct
Additional Geotechnical Investigation
Soil Sodicity and Dispersiveness Assessment

754-MELGE233440AE_Rev03

30 November 2020



Real
potential
is uncovered
only when
you scratch
beneath
the surface

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Merrimu Precinct
Additional Geotechnical Investigation Soil Sodicity and Dispersiveness Assessment

Prepared for
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This report presents the results of a geotechnical investigation undertaken for the above project.

Should you have any queries related to this report, or require further assistance, please contact the undersigned.

For and on behalf of Coffey

Farid Khayyer
Senior Geotechnical Engineer

Quality information

Revision history

Revision	Description	Date	Originator	Reviewer	Signatory
V0	Geotechnical investigation report	15 September 2020	S Seetharaman	G Manivannan	F Khayyer
V1	Executive summary added	10 October 2020	S Seetharaman	G Manivannan	F Khayyer
V2	Updated following additional sampling	6 November 2020	M Jamieson	H Mulder	F Khayyer
V3	Updated following comments	30 November 2020	M Jamieson	H Mulder	F Khayyer

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Executive summary

Coffey have previously issued two reports for the proposed Merrimu Precinct Structure Plan (PSP) site in Bacchus Marsh comprising:

1. A geotechnical investigation report which provides geotechnical recommendations regarding footings and pavements for the development area.
2. A desktop assessment with regards to the geology and erosion potential within the Merrimu PSP site, based on information provided by the Victorian Planning Authority (VPA) and publicly available information.

The findings of the desktop assessment included:

- The soils across the PSP site has been classified as Sodosols in accordance with Australian Soil Classification. Sodosols include subsoils that are sodic and prone to dispersion (and erosion) when they come into contact with water;
- Sodosols of the Werribee Formation are highly dispersive and are present along the escarpment of the plateau;
- Given that highly erodible soils are present along the escarpment of the plateau, the key issue would be managing the surface water run-off from the future development.

Following the desktop study, the current geotechnical investigation was undertaken to provide a better understanding on the potential sodicity and dispersiveness of the soil within the PSP, which are considered the main causes of the observed soil erosion in the Merrimu PSP. This report also provides comments and recommendations to reduce the potential for and manage soil erosion.

The geological units in the Merrimu PSP site comprise Quaternary age Newer Volcanics, located on the plateau, and Tertiary age Werribee formation, located on the mid and lower slopes below the plateau.

The chemical laboratory tests undertaken provided an indication of the sodicity and dispersiveness of the soils. The geotechnical laboratory tests allow prediction and qualitative measurement of the dispersibility and consequent erodibility when the soils come into to contact with water during or after developmental activities.

The chemical laboratory tests on soils of the Newer Volcanics indicated that out of 14 samples tested, 9 samples returned Exchangeable Sodium Percentage (ESP) of >15% indicating the soils are highly sodic and may be dispersive. The remaining samples returned ESP of <6% indicating that the soil samples are non-sodic.

The geotechnical laboratory testing on soils of the Newer Volcanics (Emerson Class Number and Pinhole Dispersion testing) indicated that remoulding of the soil at a moisture content near the optimum for compaction does not cause dispersive behaviour.

However further breakdown of the soil may occur by water turbulence or concentrated rapid water flow.

The chemical laboratory tests on soils of the Werribee Formation indicated that out of 10 samples tested, 3 samples returned Exchangeable Sodium Percentage (ESP) of >15% indicating the soils are sodic and dispersive. One sample returned ESP between 10% and 15% indicating that the soil is moderately sodic and a further 5 samples returned ESP between 6% and 10% indicating that the soils are slightly sodic. One sample returned ESP of <6% indicating that the sample is non-sodic.

The Emerson Class Number (ECN) testing on soils of the Werribee Formation returned ECN of 2 and 3, indicating that these soils are classed as dispersive.

The testing on soils of the Newer Volcanics indicates that the soils are moderately to highly sodic and dispersion may be variable. These results indicate that there is potential for erosion, and care should

be taken to reduce this potential. The erosion potential of the Newer Volcanics soils needs to be considered in the preparation of the surface water / stormwater management plan.

The testing on soils of the Werribee Formation indicates that the soils are slightly to highly sodic and dispersive. The laboratory results are consistent with the observations of erosion in the gully.

Any development should ensure that appropriate plans are put in place to ensure that no additional runoff is discharged from the development to areas where Werribee Formation soils are exposed (such as gullies) to mitigate the potential of any increased erosion as a result of the development.

Prevention and management of erosion can be achieved using a combination of methods including:

- Identification and avoid disturbing or exposing dispersive soils.
- Precise re-compaction of soils to decrease the soil permeability, which restricts the movement of water and dispersed clay through the soil matrix.
- Chemical amelioration including the use of gypsum or lime to change the chemical concentration of the soil.
- Topsoil / cover and revegetation which provides several benefits by providing a physical and chemical barrier to dispersive soils.

The information contained in this report must be read together with other specific details pertinent to geotechnical considerations provided in the reports outlined in Section 1 of this report.

1. Introduction

This report presents the results of two supplementary geotechnical investigations undertaken by Coffey Services Australia Pty Ltd (Coffey) for the proposed Merrimu Precinct Structure Plan (PSP) site in Bacchus Marsh, Victoria.

The initial supplementary investigation was commissioned by Tass Palios of Creo Consultants Pty Ltd (Creo) via email dated 2 July 2020 and was performed in general accordance with Coffey proposal 754-MELGE233440.1AA _Rev02 dated 1 June 2020.

A further investigation was completed in October 2020 and was performed in general accordance with Coffey proposal 754-MELGE233440.1AF dated 31 August 2020.

2. Background information

This report should be read in conjunction with the following previous reports submitted by Coffey for the site:

1- Merrimu Precinct – Geotechnical investigation. Coffey report 754-MELGE233440AB dated 6 December 2019.

2- Merrimu Precinct – Desktop assessment. Coffey report 754-MELGE233440AC_Rev01 dated 7 July 2020.

The initial geotechnical investigation (Reference 1 above) provided geotechnical recommendations regarding footings and pavements for the development area.

Following the direction from Victorian Planning Authority (VPA), a desktop assessment was undertaken (Reference 2 above) by reviewing the following documents:

- Merrimu PSP Final Geomorphology and Vegetation Assessment, undertaken by Alluvium, on behalf of Melbourne Water (provided by VPA).
- Geological Survey Victoria, Bacchus Marsh map sheet (1:50,000 scale).
- A draft plan comparing the developable areas.

The findings of the desktop assessment included:

- The soils across the site has been classified as Sodosols in accordance with Australian Soil Classification.
- Sodosols are soils having a strong texture contrast between surface (A) horizons and subsoil (B) horizons and the subsoil horizons are sodic. A sodic soil is defined as a soil with an exchangeable sodium of greater than 6% of the cation exchange capacity Sodic soils are prone to dispersion (and erosion) when comes into contact with water;
- Sodosols of the Werribee Formation are highly dispersive and are present along the escarpment of the plateau;
- Geomorphic sensitivity to change is a key driver of biological and vegetation sensitivity to change; and
- The geomorphology sensitivity of the precinct is mainly associated with the change in the hydrology across the precinct;
- Given that highly erodible soils are present along the escarpment of the plateau, the key issue would be managing the surface water run-off from the future development.

Following the desktop study a geotechnical investigation was planned to sample the soils within the Merrimu PSP site to provide comment of the sodicity and dispersiveness of the subsurface soils within the site. The findings of this investigation are the subject of this report.

3. Aims

The aims of this geotechnical investigation were to provide comments and recommendations on the following items:

- Subsurface and groundwater conditions at the Merrimu PSP site;
- Depth to and thickness of Werribee Formation soils (if encountered) at test locations;
- Presence of rock (if encountered);
- Dispersiveness nature of the soils within the Merrimu PSP site and provide mitigating or preventive measures;
- Re-use potential of site won soil as clay liner material and advise on alternate material if found not suitable;
- Excavatability, as well as temporary and permanent batter slopes for wetland area;
- Suitability of excavated material for use as engineered fill, and provide recommendations on the construction of engineered fill, including subgrade preparation, layer thickness, moisture conditioning and compaction.

This assessment has been undertaken based on the results of the laboratory tests together with the test pit engineering logs.

4. Outline of investigation

4.1. August 2020 – test pit investigation

The August field investigation was undertaken between 4 and 6 August 2020 and comprised excavation of 25 test pits (denoted as TP101 to TP125) to depths ranging from 0.4 m refusal to 3.1 m (target depth) below ground level (bgl) at locations shown on Figure 1. Refusal on shallow rock was encountered in 18 of the test pits.

The test pit locations were chosen considering the location of the previous test pits. Some of the test pits in this assessment were nominated targeting mainly the geomorphologically sensitive areas and near waterways located close to the boundary of the proposed development area (denoted as Target test pits in Figure 1). It is noted that no test pits were nominated in the flood plains or further down towards the bottom of the slope.

A summary of the test pit depths including depths to refusal is presented in Table 1.

Table 1 - Summary of fieldwork

Test pit	TP101	TP102	TP103	TP104	TP105	TP106	TP107	TP108	TP109	TP110
Depth (m)	1.5	2	2.5	1	2.5	0.8	1.4	3	1.9	1.6
Comment	-	-	-	R	R	R	R		R	R
Test pit	TP111	TP112	TP113	TP114	TP115	TP116	TP117	TP118	TP119	TP120
Depth (m)	1.1	1.1	0.4	3.1	2	1.6	1.1	0.8	1.3	2.1
Comment	R	R	R	-	-	R	R	R	R	-
Test pit	TP121	TP122	TP123	TP124	TP125					
Depth (m)	0.8	1.4	1.7	1.4	2.6					
Comment	R	R	R	R	R					
Where: R = Refusal; TP101 – denotes targeted test pit										

The test pits were excavated using a 15 tonne tracked excavator supplied and operated by Kingston Plant Hire. Disturbed and undisturbed, and bulk samples were recovered at selected depths from the test pits for visual assessment and laboratory testing.

Upon completion, the test pits were photographed, backfilled with the excavated spoil and tamped with the excavator bucket. Excess spoil was mounded over the test pits to accommodate future settlement.

Dynamic Cone Penetrometer (DCP) tests were carried out adjacent to each test pits.

The fieldwork was carried out in the presence of a geotechnical engineer from Coffey who located the test pits, conducted DCP testing, nominated sampling depths and prepared engineering logs.

The soil profile encountered in the test pits is described in the engineering logs presented in Appendix A including relevant photographs. The logs are preceded by an explanation sheets that outline the terms and symbols used in the log preparation. The results of DCP testing are presented graphically in the engineering logs provided in Appendix A.

4.2. October 2020 – borehole and hand auger investigation

The October field investigation was undertaken between 5 and 7 October 2020 and comprised the drilling of two boreholes (designated BH-1 and BH-4) and 10 shallow sample locations (designated HA-1A to HA-1C, HA-2A to HA-2C and HA-3A to HA-3D).

The boreholes were drilled to depths of between 11.10m to 11.95m bgl at the locations shown on Figure 1. The boreholes were drilled using a track mounted drilling rig supplied and operated by Urban Drilling Pty Ltd. The boreholes were advanced using augering and washboring techniques in soil and coring techniques in rock.

Standard Penetration Tests (SPTs) were carried out at nominal 1.5m intervals in soils to assist in estimating soil strength. Recovered rock core was boxed, photographed on site and returned to Coffey's warehouse for laboratory testing and storage.

The conditions encountered in the boreholes are presented in the engineering logs presented in Appendix A along with core photographs.

The shallow sample locations were advanced using hand tools and were excavated to depths of between 0.2m and 0.4m bgl and the locations are presented in Figure 1. Disturbed samples were recovered from the boreholes for laboratory testing.

The materials encountered in the shallow sample locations are summarised in Table 2 in Section 6.2. Photographs of select shallow sample locations are shown in Photographs 1 to 4 in Appendix A.

4.3. Laboratory testing

4.3.1. August 2020 investigation

The following geotechnical laboratory tests were carried out at a NATA registered laboratory on selected soil samples collected from the test pits:

- 17 Emerson Class Number tests;
- 14 Exchangeable Sodium Percentage (ESP) tests;
- 5 Pinhole Dispersion tests on samples remoulded to 95% Standard Compaction or from undisturbed U63 tubes; and
- 4 Falling head permeability testing on samples remoulded to a target dry density ratio of 95% Standard compaction;

- 4 particle size distribution tests;
- 14 pH value tests; and
- 14 Electrical Conductivity (EC) tests.

The results of the geotechnical laboratory tests are presented in Section 6.4 and the certificates are provided in Appendix B.

4.3.2. October 2020 investigation

The following geotechnical laboratory tests were carried out at a NATA registered laboratory on selected soil samples collected from the boreholes and hand auger locations:

- 10 Emerson Class Number tests;
- 10 Exchangeable Sodium Percentage (ESP) tests;
- 10 pH value tests; and
- 10 Electrical Conductivity (EC) tests
- 22 Point Load Strength Index tests (Non-NATA).

The results of the geotechnical laboratory tests are presented in Section 6.2 and the certificates are provided in Appendix B.

5. Regional geology and geological setting

The geology of Merrimu is outlined in the Geological Survey of Victoria, Bacchus Marsh map sheet (1:50, 000 scale). The plan of the proposed Merrimu site superimposed on the geological map sheet of Bacchus Marsh is presented in Figure 1.

The geological map sheet indicates the site is located on a plateau underlain mainly by Newer Volcanics (Bullengarook Flow) comprising residual basaltic clay overlying weathered basalt rock.

The geological map also indicates presence of soils of Werribee Formation along the escarpment of the plateau. The Werribee Formation comprises sand and silty sand and minor clay and are assessed to be highly dispersible.

The Bacchus Marsh map sheet presents a geological cross section “A-B-C” that runs through the site. The section indicates that, over the plateau, the Newer Volcanics is underlain at depth by soils of Werribee Formation which in turn is underlain by shale, slate, siltstone and sandstone. Over the plateau, based on the scale provided in the cross section “A-B-C”, the Newer Volcanics is estimated to extent to depths ranging from 10 m to 20 m and in places up to 30 m.

The cross section “A-B-C” also indicates that soils of Werribee Formation would be encountered at or near the surface along the escarpment of the plateau. The applicable section of the cross section is presented in Figure A.

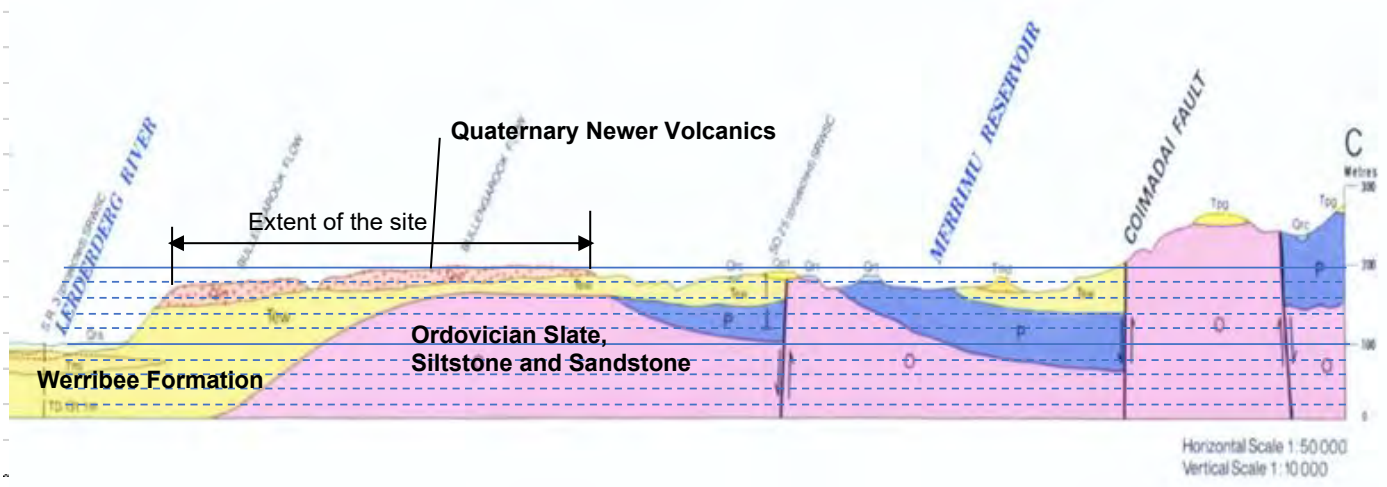

Figure A - cross section A-B-C

6. Results of the investigation

6.1. Surface conditions

The majority of the Merrimu PSP site is located on a plateau and is relatively flat with a slight downhill slope from north to south. However, there is a drop in the site elevation nearby O'Connell Road. Pyrites Creek runs from north to south to the east of the Merrimu PSP site.

A gully is present at the southern end of the Merrimu PSP site which falls to Flanagans Drive. The slopes steepen towards the gully. Burrowing is evident around the gully. Erosion features are also present, predominantly comprising channel, rill and gully erosion. Several large erosion features (>5m deep) were observed. Photographs 5 to 10 in Appendix A show some of the erosion features in the gully.

The ground surface over the plateau was covered with thick grass. Basalt outcrops and loose basalt boulders were noted in places.

The ground surface of the slopes are generally covered by grass and vegetation although parts are bare.

Old mature trees between 5m and 20m high are scattered in the gully.

At the time of the August 2020 investigation, the site was very dry with no surface water present and easily trafficable by a 4WD.

The October 2020 investigation was carried out following rain. Parts of the site were inaccessible for 4WD vehicles due to surface water and basalt boulders at the surface. Surface water was present over Bences Road limiting access in parts.

6.2. Subsurface conditions

The subsurface conditions encountered during the investigations were generally consistent with the regional geology described in Section 5.

The subsurface profile at the plateau typically comprised a thin layer of topsoil (up to 0.2 m thick) overlying residual soils underlain by extremely or less weathered basalt. Werribee Formation soils were encountered beneath the basalt at a depth of 8.95m to 9.6m (RL 132.9 to 151.8m)

The topsoil comprised clayey silt and was of friable consistency.

The residual soils were generally dark brown, grey and red brown clays of high plasticity and of very stiff to hard consistency. The clays contained variable proportions of calcareous pockets and calcareous mottling. Basalt cobbles and boulders were encountered at depth in places. It should be noted that cobbles and boulders in a clay matrix is a common soil profile in the Newer Volcanics.

Extremely weathered basalt comprised gravel/clayey gravel and was assessed to be in dense to very dense condition.

Refusal to excavation of the test pits was encountered on what was assessed to be weathered basalt rock/boulders. Our experience in Newer Volcanics has shown that the depth to bed rock can vary significantly over very short horizontal distances.

The shallow sample locations were excavated on the upper and mid slopes of the gully to the south of the site and were extended to depths up to 0.4m below existing surface level to collect samples for laboratory testing.

The subsurface conditions encountered on the upper slopes comprised soils of the Newer Volcanics similar as described above. The subsurface conditions on the mid slopes included soils of the Werribee Formation, comprising red and brown fine to medium grained sands and clayey sands.

For details on subsurface conditions, reference should be made to the engineering logs presented in Appendix A (boreholes and test pits) and Table 2 (shallow sample locations).

Table 2 – Materials in shallow sample locations

Location	Depth (m)	Geological Unit	Material	Description
HA-1A	0.15	Newer Volcanics	Clay (CH)	high plasticity, brown, with sand, with basalt cobbles and boulders
HA-1B	0.2	Werribee Formation / Subsoil?	Sand (SP)	fine to medium grained, brown, with clay
HA-1C	0.3	Werribee Formation / Subsoil?	Sand (SP)	fine to medium grained, brown
HA-2A	0.3	Newer Volcanics	Clay (CH)	high plasticity, brown, trace of fine-grained sand
HA-2B	0.3	Newer Volcanics	Clay (CH)	high plasticity, brown mottled red and grey, fine to coarse grained gravel and cobbles at surface
HA-2C	0.3	Werribee Formation	Clayey Sand (SC)	fine to medium grained, brown mottled orange and white
HA-3A	0.4	Werribee Formation / Subsoil?	Sand (SP)	fine grained, brown, with clay, trace coarse grained gravel, rounded
HA-3B	0.4	Werribee Formation / Subsoil?	Sand (SP)	fine to medium grained, pale brown
HA-3C	0.3	Werribee Formation	Clayey Sand (SC)	fine to medium grained, brown
HA-3D	0.3	Werribee Formation	Sandy Clay (CH)	high plasticity, brown mottled white

6.3. Groundwater

Groundwater inflow was not observed in any of the test pits over the depth range of investigation at the time of the fieldwork. Perched groundwater could be anticipated in wetter months, particularly in calcareous layers underlain by impermeable clays. Seasonal variations in groundwater should be anticipated.

6.4. Laboratory test results

The results of the laboratory testing on the selected samples are provided in Table 3 and Table 4. The laboratory test certificates are presented in Appendix B.

Table 3 - Summary of laboratory test results

Location	Depth (mbgl)	Sample number	Particle Size Distribution (%)			Coefficient of permeability *(m/s)	Emerson Class Number	Pinhole dispersion test - Designation
			Gravel	Sand	Fines			
TP103	1 to 1.5	349	-	-	-	-[1]	4	D1
TP105	1 to 1.5	351	7	32	61	$2x10^{-9}$	4	ND2
TP118	0 to 0.5	352	-	-	-	-	6	ND2
TP122	1 to 1.5	350	-	-	-	$3x10^{-9}$	4	ND2
TP123	1.1 to 1.5	353	-	-	-	$5x10^{-9}$	4	ND2

Where: * Remoulded at 95% maximum dry density and optimum moisture content; mbgl = metres below ground level;
D1 – highly dispersive ND2 = completely erosion resistant
Notes:
[1]. Sample could not be saturated. Considered to be impermeable.

Table 4 - Summary of laboratory test results (Emerson, ESP, pH and EC)

Location	Depth (mbgl)	Unit	Material	Sample number	Emerson Class Number	ESP (%)	pH	EC (µS/cm)	Particle Size Distribution (%)		
									Gravel	Sand	Fines
BH-1	10.5	Werribee Fm		M20-Oc24632	2	32	9.4	67	-	-	-
BH-1	11.5	Werribee Fm		M20-Oc24631	2	22	9.4	47	-	-	-
BH-4	9.7	Werribee Fm		M20-Oc24634	2	11	9.4	370	-	-	-
BH-4	10.7	Werribee Fm		M20-Oc24633	2	23	8.6	360	-	-	-
HA-1B	0.2	Werribee Fm	SP Sand	M20-Oc24625	2	6.1	7.9	29	-	-	-
HA-1C	0.3	Werribee Fm	SP Sand	M20-Oc24626	3	7.2	7.4	10	-	-	-
HA-2C	0.3	Werribee Fm	SC Clayey Sand	M20-Oc24627	2	6.5	9.4	730	-	-	-
HA-3B	0.4	Werribee Fm	SP Sand	M20-Oc24628	2	6.6	7.3	17	-	-	-
HA-3C	0.3	Werribee Fm	SC Clayey Sand	M20-Oc24629	3	9.6	9.3	270	-	-	-
HA-3D	0.3	Werribee Fm	CH Shandy Clay	M20-Oc24630	2	4.9	9.5	110	-	-	-

Location	Depth (mbgl)	Unit	Material	Sample number	Emerson Class Number	ESP (%)	pH	EC (µS/cm)	Particle Size Distribution (%)		
									Gravel	Sand	Fines
TP101	1.15 to 1.5	Newer Volcanics	CH	354	4	18	9.3	1000	-	-	-
TP103	1 to 1.5	Newer Volcanics	CH	349	4	23	9.2	1600	-	-	-
TP104	0 to 0.5	Newer Volcanics	CH	367	4	2.8	8.6	210	1	4	95
TP105	0.4 to 0.5	Newer Volcanics	CH Sandy clay	355	4	2	9.1	96	-	-	-
TP105	1 to 1.5	Newer Volcanics	SP Sand	351	4	5	9.2	280	7	32	61
TP108	0.5	Newer Volcanics	CH	365	4	19	8.8	1300	0	8	92
TP108	2.5	Newer Volcanics	CH	356	5	32	8.2	1700	-	-	-
TP109	1.5	Newer Volcanics	CH	357	4	16	9.2	1200	-	-	-
TP110	0.5	Newer Volcanics	CH	358	3	-	-	-	-	-	-
TP114	2.5	Newer Volcanics	CH	359	4	26	9	2000	-	-	-
TP115	1.5 to 1.6	Newer Volcanics	CH	360	4	26	8.7	2300	-	-	-
TP116	0.5	Newer Volcanics	CH	361	3	-	-	-	-	-	-
TP118	0 to 0.5	Newer Volcanics	CH	352	6	21	7.4	55	-	-	-
TP120	1.5	Newer Volcanics	CH	362	4	24	9	2400	0	8	92
TP122	1 to 1.4	Newer Volcanics	GC	363	-	4.7	8.8	290	-	-	-
TP122	1 to 1.5	Newer Volcanics	GC	350	4	-	-	-	-	-	-
TP123	1.1 to 1.5	Newer Volcanics	CH	353	4	3.3	9.1	79	-	-	-
TP125	1.2 to 1.5	Newer Volcanics	CH	364	6	-	-	-	-	-	-
Where: ESP = Exchangeable Sodium Percentage; EC=Electrical conductivity (1:5 aqueous extract)											

7. Soil dispersiveness

7.1. Assessment of dispersive soils and dispersiveness

The following laboratory tests were carried out in our current assessment to identify the dispersiveness of the soils at the site:

- Exchangeable Sodium Percentage (ESP);
- Emerson Class Number (EC No.); and
- Pinhole dispersion test

7.1.1. Exchangeable Sodium Percentage (ESP)

The Exchangeable Sodium Percent (ESP) is the most common analytical technique used to identify sodic or potentially dispersive soils. The ESP is determined from the ratio of exchangeable cations.

The ESP measures the proportion of cation exchange sites occupied by sodium. Soils are considered sodic when the ESP is greater than 6, and highly sodic when the ESP is greater than 15 (Table 5).

Table 5 - Relationship between degree of dispersion and exchangeable sodium percentage

Rating	ESP (%)	Soil dispersion test
Non-sodic	<6	No dispersion evident after 24 hours. Aggregates slaked but not dispersed (milky) clay.
Slightly sodic	6–10	Dispersion (milky halo) evident after 24 hours. Soil aggregates slightly disperse.
Moderately sodic	10–15	Dispersion (milky halo) evident after several hours. Soil aggregates partially disperse.
Highly sodic	>15	Dispersion (milky halo) evident in less than 30 minutes. Soil aggregates completely disperse.

When a sodic soil comes into contact with non-saline water, water molecules are drawn in-between the clay platelets causing the clay to swell to such an extent that individual clay platelets are separated from the aggregates, this process is known as dispersion. In slightly saline water, or water with a moderate electrolyte (salt) concentration, sodic soils swell, but generally don't disperse.

While sodic soils are generally dispersive, it is important to acknowledge that not all sodic soils disperse, and that not all dispersive soils are sodic (Sumner 1993). Factors such as silt and high magnesium content may induce non-sodic soils (ESP <6%) to disperse, while organic matter, clay mineralogy, acidity, and high iron content may prevent sodic soils (ESP> 6%) from dispersing (Raine and Loch 2003, Rengasamy 2002).

The pH values of the samples tested ranged from 7.3 to 9.5 indicating the soils are moderately to highly alkaline.

7.1.2. Emerson Class Number

The Emerson soil crumb test (AS 1289.3.8.1-1997) is an Australian Standard for the prediction of dispersive behaviour of clay soils. The Emerson test is quick and simple and can be used to assist in the rapid identification of dispersive soils. The test has three levels:

i. Spontaneous dispersion of an air dried aggregate in deionised water,

ii. Remoulding at near maximum field capacity and re-immersion in deionised water,

iii. Remoulded soil is shaken in deionised water.

The Emerson Class Numbers are described in Table 6.

Table 6 – Emerson Class Number classification

Emerson Class Number	Level	Description
Class 1	i	Complete dispersion of immersed air dried aggregate
Class 2	i	Some dispersion of immersed air dried aggregate
Class 3	ii	Dispersion of remoulded sample
Class 4	ii	No dispersion of remoulded sample – calcite or gypsum present
Class 5	iii	Dispersion following shaking
Class 6	iii	Flocculation following shaking
Class 7	i	No dispersion, swelling of immersed air dried aggregate
Class 8	i	No dispersion, no swelling of immersed air dried aggregate

7.1.3. Pinhole Dispersion Test

The Pinhole Dispersion Test presents a qualitative measurement of the dispersibility and consequent erodibility of clay soils. The test is undertaken by causing water to flow through a small hole punched in a sample of the material. The pinhole is measured, and the shape of the pinhole inspected for erosion. The soils are classified based on the pinhole dispersion test results as given in Table 7.

Table 7 - Pinhole dispersion classification

Designation	Classification
D1	Highly dispersive
D2	Dispersive
PD1	Potentially dispersive
PD2	Potentially dispersive (intermediate)
ND1	Non-dispersive
ND2	Completely non-dispersive

7.1.4. Discussion of laboratory test results

Soils of the Newer Volcanics were encountered within the Merrimu PSP site on the plateau and upper slopes. Soils of the Werribee Formation were encountered and sampled from the boreholes at depth or near surface from the escarpments and in the gully. For the purposes of this discussion we will address these units separately.

Newer Volcanics

Laboratory testing with regards to soil dispersiveness was completed on 17 samples from the Newer Volcanics soils.

The ESP results (Table 4) indicated that out of 14 samples tested, 9 samples returned ESP of >15% indicating the soil samples are highly sodic and may be dispersive. The remaining samples returned ESP of <6% indicating that the soil samples are non-sodic.

It can be noted from Table 4 that the results of Emerson Class Number (ECN) of 14 out of 16 samples tested returned ECN of 4 or more indicating the soils are non-dispersive and contain calcite or gypsum. During the field investigation, the residual soils were observed to comprise variable proportion of calcareous content which is reflected in the ECN test results. The ECN result of 4 indicate that remoulding of the soil at a moisture content near the optimum for compaction (simulating the use of these soils in a filling and compaction operation) does not increase the potential for

dispersive behaviour, however further breakdown of the soil may occur, by water turbulence or concentrated rapid water flow which needs to be considered in the preparation of the surface water / stormwater management plan.

Pinhole dispersion test results presented in Table 3 indicate 4 out of 5 samples tested can be classified as “Completely non-dispersive”. This indicates that when the remoulded soil comes into contact with water the soils do not disperse.

Werribee Formation

Laboratory testing with regards to soil dispersiveness was completed on 10 samples from the Werribee Formation soils.

The ESP results (Table 4) indicated that out of 10 samples tested:

- 3 samples returned ESP of >15% indicating the soils are highly sodic and dispersive;
- 1 sample returned ESP between 10% and 15% indicating the soils are moderately sodic;
- 5 samples returned ESP between 6% and 10% indicating that the soils are slightly sodic; and,
- 1 sample returned ESP of less than 6% indicating the soil is non sodic.

The Emerson Class Number test results returned ECN of 2 for eight samples indicating that these soils are dispersive. The remaining two samples returned ECN of 3 indicating that these soils are dispersive upon remoulding.

It is worth noting that the ESP laboratory test results on Werribee Formation soils from depth (>0.5m bgl) were predominately highly sodic with three of the four samples greater than 20%. The ESP results on the upper Werribee Formation soils (<0.5m bgl) were typically moderately sodic with 5 of the 6 samples returning results between 6% and 10%.

7.2. Potential for erosion

The geology of the plateau within the Merrimu PSP site comprises Newer Volcanics. The laboratory testing indicates that the soils are moderately to highly sodic and dispersion is variable. With these results in consideration there is potential for erosion, and care should be taken to reduce the potential for erosion in these materials. Sections 7.3 to 7.5 provide discussion on activities increasing risk of erosion, reducing the risk of erosion and prevention and management measures for erosion with respect to the anticipated development activities.

The surface geology of the gully at the southern end of the Merrimu PSP site comprises Newer Volcanics on the upper slopes and Werribee Formation along the mid and lower slopes. Laboratory testing indicates that the soils of the Werribee Formation are slightly to highly sodic and dispersive. The laboratory results are consistent with the observations of erosion in the gully. The potential for further erosion in the gully is high.

We understand that it is likely that the development will be predominately located on the plateau. The gully is not located within this area but is within the Merrimu PSP site. It is necessary that the development does not negatively affect the condition of the gully.

Any development should ensure that appropriate plans are put in place to ensure that no additional runoff is discharged from the development to areas where Werribee Formation soils are exposed (such as the gully) so as to mitigate the potential of any increased erosion as a result of the development.

7.3. Activities increasing risk of erosion

Following are some potential activities that are considered to increase the risk of erosion/tunnel erosion:

- Removal of topsoil;
- Soil excavation or expose of subsoils to rainfall;
- Supply of services via trenches;
- Construction of roads and culverts in dispersive subsoils;
- Installation of sewage and grey water disposal systems in dispersive subsoils; and
- Dam construction from dispersive soils.

7.4. Options for reducing the risk of erosion

Options for reducing the risk of erosion during construction and development works on dispersive soils include:

- Where possible do not remove or disturb topsoil or vegetation.
- Ensure that dispersive subsoils are covered with an adequate layer of topsoil.
- Avoid construction techniques that result in exposure of dispersive subsoils.
- Use alternatives to ‘cut and fill’ construction such as pier and post foundations.
- Where possible avoid the use of trenches for the supply of services i.e. water and power.
- If trenches must be used, ensure that repacked spoil is properly compacted, treated with gypsum and topsoiled.
- Consider alternative trenching techniques that do not expose dispersive subsoils.
- Ensure runoff from hard areas is not discharged into areas with dispersive soils. If necessary, create safe areas for discharge of runoff.
- If possible do not excavate culverts and drains in dispersive soils.
- Consider importing non-sodic soil to create appropriate road surfaces and drains without the need for excavation.
- Ensure that culverts and drains excavated into dispersive subsoils are capped with non-dispersive clays mixed with gypsum, topsoiled and vegetated.
- Avoid use of septic trench waste disposal systems; consult your local council about the use of alternative above ground treatment systems.
- Construction of dams from dispersive soils is usually possible, using one or a combination of: precise compaction, chemical amelioration, capping with non-dispersive clays, sand filters and adequate topsoiling.

7.5. Prevention and management of erosion

Prevention of erosion in urban and peri-urban environments is best achieved using a combination of,

- Identification and avoidance of dispersive soils.
- Precise re-compaction.
- Chemical amelioration.
- Sand blocks and barriers.
- Topsoil / cover and revegetation.

7.5.1. Precise re-compaction

A high degree of compaction reduces soil permeability, restricting the movement of water and dispersed clay through the soil matrix, which decreases the severity of dispersion and restricts tunnel development.

Normal earth moving machinery including bulldozers, excavators and graders do not provide sufficient compactive force to reduce void spaces or achieve adequate compaction in dispersive soils. A sheepsfoot roller of appropriate weight is usually required to compact dispersive soils.

7.5.2. Chemical amelioration

Gypsum and lime can be used to treat sodic soils. Gypsum (calcium sulphate) is more effective than lime (calcium carbonate) for the treatment of dispersive soils as it increases the electrolyte concentration in the soil solution as well as displacing sodium with calcium within the clay structure. Gypsum is less commonly used than hydrated lime in dam construction and other works due to its lower solubility, and higher cost. In alkaline (pH >7.0) soils the effectiveness of hydrated lime is reduced by the formation of insoluble calcium carbonate, such that gypsum is preferred to hydrated lime.

7.5.3. Topsoil and vegetation

Topsoil or covering of exposed dispersive soils reduces the likelihood of subsoil dispersion and initiation of erosion by;

- Providing a source of salt to increase the electrolyte content of infiltration water.
- Preventing desiccation and subsoil cracking.
- Promoting even infiltration.
- Providing a protective cover from raindrop impact.
- Providing a suitable medium for revegetation.

Topsoil minimises the interaction between water and dispersive clays by providing both a physical and chemical barrier. Topsoil also reduces soil desiccation and development of surface cracks. It is suggested that exposed dispersive subsoils be covered with at least 150mm of nondispersive topsoil and sown with an appropriate mix of grass species. In some cases, it will be necessary to protect the topsoil from erosion with ‘jute’ cloth or similar product.

8. Construction considerations

8.1. Excavation

Soil strength materials (topsoil, residual and extremely weathered rock) at the site may be excavated using conventional mechanical equipment such as backhoes and tracked excavators. Low production rates may be anticipated in extremely weathered rock and where boulders are encountered.

The excavatability of the basalt is based on the strength of the rock and the frequency of the defects. No information is available on these characteristics as the geotechnical investigation terminated on basalt rock with refusal of the 15-tonne excavator. Based on previous experience in basalt of the Newer Volcanics, we would expect that heavy use of rock breakers would be required and possibly blasting in locations.

8.2. Batter slopes

Open excavation may be suitable for the construction of the wetlands assuming that a suitably graded batter is provided for both temporary and permanent conditions. Personnel should not enter any excavation in excess of 1.5m depth, unless trench shoring support is provided, or the excavation is appropriately battered. Regardless of the depth of excavation or batter slope, extreme care should be exercised regarding the presence of debris in the sides of the excavation. Batter slopes are likely to be subject to fretting and local loss of material, particularly if exposed to weather for extended periods. Drainage should be provided at the top of batter slopes to divert runoff away from the slope face.

The batters of the wetlands may comprise soil and rock; or may be entirely located within soil. It is recommended that temporary batter slopes excavated in soils should be formed at not steeper than 1V:1H. Permanent batter slopes should not be steeper than 1V:2H in either the natural clays, engineered fill or extremely weathered basalt. Pond facing batters should not exceed 1V:3H in soils/engineered fill and 1V:2H in rock.

Flatter slopes may be required for the following:

- Groundwater ingress, particularly if encountered in granular soil layers;
- Maintenance;
- Landscaping; and
- Access.

8.3. Earthwork Materials

Select fill may comprise material such as crushed rock, clayey sand, sandy clay or weathered rock. Imported fill materials should be of low reactivity to reduce the potential for shrink-swell movements. It is recommended that imported fill materials be required to have a maximum particle size after compaction of 50mm and have a liquid limit not exceeding 50%. Alternative materials may be considered but samples should be submitted for approval prior to use.

Topsoil is suitable for landscaping purposes only.

Subject to an assessment of their condition at the time of construction the natural clays and extremely weathered rock (clayey gravel) on site may be used for the construction of engineered fill. Removal of oversized particle (>75mm) from extremely weathered rock may be required.

The on-site natural clays of the Newer Volcanics are of high plasticity with occasional cobbles and boulders which would need to be removed depending on the particle size. This natural clay can be considered for use as engineered fill although separation of the larger particles will be required. The high plasticity clays can be difficult to place and compact and is likely to require moisture conditioning. Workability of the material can be improved by soil mixing or the addition of gypsum/lime. The performance of the soil mixing/additives would need to be verified with laboratory testing. The shrink-swell characteristics of this material will need to be considered when placed under/near retaining walls and civil structures such as drainage/pavements/culverts/footings.

8.4. Subgrade preparation

It is recommended that the following procedures be adopted for the preparation of engineered fill and subgrade beneath pavements:

- Excavate to design subgrade level. Remove any uncontrolled fill and vegetation to expose the natural clay subgrade and grub out any major roots. Also remove topsoil containing significant organic matter and any silty subsoils. An assessment of the subsoil may be undertaken by a suitably experienced geotechnical professional at the time of construction to confirm the extent of removal required.

- It should be noted that the subgrade would need to be over excavated to place the required subgrade improvement layer.
- The exposed subgrade should then be proof rolled using a heavy vibrating pad foot roller to identify any soft or week spots any soft, wet or weak areas which may require remedial works. The proof rolling should be observed by a suitably experienced Engineer.
- Should extensive soft or weak areas be encountered, a bridging layer is likely to be required, in which case further geotechnical advice should be sought.
- Following proof rolling the subgrade improvement layer should be placed in and compacted to achieve a dry density ratio of at least 98% Standard compaction and within ± 2% of Standard Optimum Moisture Content (SOMC) in accordance with AS1289.5.1.1, 5.4.1 or 5.7.1. The loose layer thickness of the material would need to be decided based on type of material and equipment used.
- Pavement materials (e.g. base and sub-base materials) should be placed in layers not exceeding 200mm loose thickness and compacted to achieve a dry density ratio of 98% Modified (base) and 95% Modified (subbase) in accordance with AS1289 5.2.1 and, 5.4.1., or in compliance with the specific design requirements. The moisture content of the material should be maintained within ± 2% of Standard OMC.

Where engineered fill is required to raise the subgrade level, it should be placed and compacted as described above. Select fill may comprise material such as crushed rock, clayey sand, sandy clay or weathered sedimentary rock. It is recommended that imported fill materials be required to have a maximum particle size after compaction of 50mm and have a liquid limit not exceeding 50%. Alternative materials may be considered but samples should be submitted for approval before use.

It is recommended that subgrade preparation, fill placement and compaction be performed in the presence of a suitably experienced geotechnical practitioner and the level of compaction checked by field density testing. Subgrade preparation should be carried out during dry weather conditions where possible. Provision should be made for effective diversion and removal of all surface water from the prepared subgrade from any source, particularly for sand subgrade preparation.

9. Wetland construction

The results of the permeability tests on remoulded samples compacted to 95% Standard has a permeability ranging between 2 x 10^{-9} m/s and 5 x 10^{-9} m/s and are considered to be suitable for reuse as clay liners.

The in-situ (field) permeability of the soil horizons encountered during the excavation of the wetlands is likely to be influenced by structure and fissures and calcareous pockets within the soils and to improve the performance of the wetlands we recommend that the wetlands construction procedures discussed in Section 9.2 are adopted.

9.1. Liners

Highly or less weathered rock or granular soils are not likely to be suitable materials to form a retarding basin of a wetlands, as defects within the rock mass or the high permeability of granular soils may allow excessive water loss from the wetlands. Some form of liner should be placed over exposed rock or granular materials encountered in the base and batters of the wetlands. The subgrade to the liner should be suitably prepared (i.e. provision of a protective bridging layer) to reduce the risk of damage to the liner by sharp rock edges.

9.1.1. Clay Liner

Based on the results of the laboratory testing, the site won residual clay soils compacted to 98% Standard in accordance with Section 9.2, are expected to have a permeability less than 1 x 10^{-9}m/s,

which is commonly adopted for low permeability clay liners. The dispersion tests indicate these soils are not dispersive but contains calcite or gypsum.

Care should be taken to ensure that the liner does not dry out and crack during or following construction. Where clay liners may be subjected to wetting and drying, the clay liner should be covered by topsoil cover with grass, hard edge systems or other synthetic surface protection.

9.1.2. Geosynthetic Clay Liner (GCL)

An alternative lining system is Geosynthetic Clay Liner (GCL). The GCL about 10mm thick with a layer of sodium bentonite, between cross-linked needle punched geotextiles. In addition, the liner needs to be covered with 300mm of soil, to provide additional protection and to confine the GCL and overlapping joints between the rolls. The top of the liner is located in an anchored trench.

9.1.3. HDPE Liner

High Density Polyethylene (HDPE) liner may also be considered. Again, the subgrade to the liner should be suitably prepared to reduce the risk of damage to the liner. We note that HDPE liners become very slippery when wet and this should be considered as part of the site safety plan if used.

9.1.4. Geocomposite Liner

A new development in lining systems comprises a combined geotextile and geomembrane, such as “Canal”. The geomembrane provides a robust liner while the geotextile provides protection and a non slip surface. The geomembrane has to be welded together. The subgrade to the liner should be suitably prepared to reduce the risk of damage to the liner. The material is susceptible to UV light and where exposed should be covered by topsoil and grass or other hard edge systems.

9.2. Clay liner construction

Where sand/gravel or highly of less weathered rock are encountered in the batters or base of the wetlands, we recommend the placement of a liner to prevent excessive water loss from the wetlands due to high permeability within these layers. Liner options are discussed in Section 9.1.

Where appropriate materials for a clay liner are identified, our recommended construction procedures are as follows:

- Excavate to the design base level
- If the exposed subgrade comprises natural clays it should be scarified to a minimum depth of 300mm. Particles larger than 200mm should be removed, the clay should be moisture conditioned to within 0% to +3% of Standard optimum moisture content and then compacted to a minimum dry density ratio of 98% Standard in accordance with AS1289 5.1.1, 5.4.1 or 5.7.1. Soil treating, if proposed, should be included at this stage. Depending on proposed compaction plant, it may be necessary to place the 300mm compacted layer, in two or more layers.
- If the exposed subgrade comprises rock, sand or gravel lenses, silts or fill materials these should be removed to a depth of 300mm and replaced with a suitable clay material and compacted as described above.
- Where walls are proposed to retain the pond, as opposed to a batter, the clay liner should be placed up against the base of the wall.

It is important that the compacted clay liner be kept moist following compaction to avoid the formation of desiccation cracks prior to commissioning. The desiccation cracks would result in a more permeable clay liner and higher seepage losses. The placement of a sacrificial layer of topsoil over the clay liner would help to reduce drying.

It is recommended that Level 1 inspection and testing requirements be adopted for earthworks, as defined in AS3798-2007 “Guidelines on earthworks for commercial and residential developments”.

9.3. Anticipated construction difficulties

9.3.1. Soft site conditions

Ponded water and soft surface conditions may affect plant accessing the site. The extent is generally depending on the time of year the construction work is undertaken. Drains and working platforms may be required to get plant into the site. In addition, the high plasticity clay soils beneath the soft surface layers may soften if exposed to surface run-off. We recommend that site stripping is undertaken in stages.

9.3.2. Dispersive soils

The dispersive nature of the residual soils means that where soils are in contact with water, in particular fresh water, they have the potential to erode/disperse potentially resulting in unsightly erosion and/or destabilisation of the wetlands batters. We therefore recommend that:

- The wetlands be constructed such that runoff water is not allowed to pond;
- Water runoff is directed into properly constructed and appropriately lined channels;
- Vegetation regrowth is assisted in areas of exposed soil, such as the wetlands batters. This may include the use of geotextile matting, such as Jute.
- Areas that suffer excessive erosion, rilling or piping may benefit from treatment with gypsum, which can reduce the dispersion potential for long enough for re-vegetation to occur.

If the clay liner is constructed out of dispersive soils, there is potential for excessive erosion and or piping to occur, particularly on the water line, if preventative action is not taken. The following preventative action is therefore recommended:

- The clay liner should be well compacted, as noted in Section 9.2 of this report
- A non-dispersive soil cover or some form of surface protection may be placed over the dispersive soils. The options include a non-dispersive clay which could provide half the clay liner thickness, non-dispersive topsoil or a 100mm thick compacted layer of fine crushed rock.

Where a non–dispersive soil cover is proposed (site won or imported), it is recommended that the soils have a minimum Emerson Dispersion Class of at least 6.

10. Limitations

This investigation report has been prepared based on the results of geotechnical investigation carried out at the site and the data included in this report should not be used for any other purpose without our prior review and agreement.

To the best of our knowledge, the presented data in our geotechnical report represents a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these finding represent the actual state of the site at all points.

Your attention is drawn to the attached document entitled "*Important Information about your Coffey Report*".

References

1. Dispersive soils and their management. Technical Reference Manual. Department of Primary Industries and Water, Tasmania
2. Identifying dispersive soils. Government of Western Australia. Department of Agriculture and Food. Note 386 (November 2009)

Figures

Appendix A - Results of field investigation

Appendix B – Results of laboratory testing

Appendix C – Results of laboratory testing (chemical)

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Merrimu Precinct
Additional Geotechnical Investigation Soil Sodicity and Dispersiveness Assessment

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30 November 2020

754-MELGE233440AE_Rev03

This report presents the results of a geotechnical investigation undertaken for the above project.

Should you have any queries related to this report, or require further assistance, please contact the undersigned.

For and on behalf of Coffey

Farid Khayyer
Senior Geotechnical Engineer

Quality information

Revision history

Revision	Description	Date	Originator	Reviewer	Signatory
V0	Geotechnical investigation report	15 September 2020	S Seetharaman	G Manivannan	F Khayyer
V1	Executive summary added	10 October 2020	S Seetharaman	G Manivannan	F Khayyer
V2	Updated following additional sampling	6 November 2020	M Jamieson	H Mulder	F Khayyer
V3	Updated following comments	30 November 2020	M Jamieson	H Mulder	F Khayyer

Distribution

Report Status	No. of copies	Format	Distributed to	Date
Rev0	1	PDF	Creo Consultants	15 September 2020
Rev01	1	PDF	Creo Consultants	10 October 2020
Rev02	1	PDF	Creo Consultants	5 November 2020
Rev03	1	PDF	Creo Consultants	30 November 2020

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Appendices

Executive summary

Coffey have previously issued two reports for the proposed Merrimu Precinct Structure Plan (PSP) site in Bacchus Marsh comprising:

1. A geotechnical investigation report which provides geotechnical recommendations regarding footings and pavements for the development area.
2. A desktop assessment with regards to the geology and erosion potential within the Merrimu PSP site, based on information provided by the Victorian Planning Authority (VPA) and publicly available information.

The findings of the desktop assessment included:

- The soils across the PSP site has been classified as Sodosols in accordance with Australian Soil Classification. Sodosols include subsoils that are sodic and prone to dispersion (and erosion) when they come into contact with water;
- Sodosols of the Werribee Formation are highly dispersive and are present along the escarpment of the plateau;
- Given that highly erodible soils are present along the escarpment of the plateau, the key issue would be managing the surface water run-off from the future development.

Following the desktop study, the current geotechnical investigation was undertaken to provide a better understanding on the potential sodicity and dispersiveness of the soil within the PSP, which are considered the main causes of the observed soil erosion in the Merrimu PSP. This report also provides comments and recommendations to reduce the potential for and manage soil erosion.

The geological units in the Merrimu PSP site comprise Quaternary age Newer Volcanics, located on the plateau, and Tertiary age Werribee formation, located on the mid and lower slopes below the plateau.

The chemical laboratory tests undertaken provided an indication of the sodicity and dispersiveness of the soils. The geotechnical laboratory tests allow prediction and qualitative measurement of the dispersibility and consequent erodibility when the soils come into to contact with water during or after developmental activities.

The chemical laboratory tests on soils of the Newer Volcanics indicated that out of 14 samples tested, 9 samples returned Exchangeable Sodium Percentage (ESP) of >15% indicating the soils are highly sodic and may be dispersive. The remaining samples returned ESP of <6% indicating that the soil samples are non-sodic.

The geotechnical laboratory testing on soils of the Newer Volcanics (Emerson Class Number and Pinhole Dispersion testing) indicated that remoulding of the soil at a moisture content near the optimum for compaction does not cause dispersive behaviour.

However further breakdown of the soil may occur by water turbulence or concentrated rapid water flow.

The chemical laboratory tests on soils of the Werribee Formation indicated that out of 10 samples tested, 3 samples returned Exchangeable Sodium Percentage (ESP) of >15% indicating the soils are sodic and dispersive. One sample returned ESP between 10% and 15% indicating that the soil is moderately sodic and a further 5 samples returned ESP between 6% and 10% indicating that the soils are slightly sodic. One sample returned ESP of <6% indicating that the sample is non-sodic.

The Emerson Class Number (ECN) testing on soils of the Werribee Formation returned ECN of 2 and 3, indicating that these soils are classed as dispersive.

The testing on soils of the Newer Volcanics indicates that the soils are moderately to highly sodic and dispersion may be variable. These results indicate that there is potential for erosion, and care should

be taken to reduce this potential. The erosion potential of the Newer Volcanics soils needs to be considered in the preparation of the surface water / stormwater management plan.

The testing on soils of the Werribee Formation indicates that the soils are slightly to highly sodic and dispersive. The laboratory results are consistent with the observations of erosion in the gully.

Any development should ensure that appropriate plans are put in place to ensure that no additional runoff is discharged from the development to areas where Werribee Formation soils are exposed (such as gullies) to mitigate the potential of any increased erosion as a result of the development.

Prevention and management of erosion can be achieved using a combination of methods including:

- Identification and avoid disturbing or exposing dispersive soils.
- Precise re-compaction of soils to decrease the soil permeability, which restricts the movement of water and dispersed clay through the soil matrix.
- Chemical amelioration including the use of gypsum or lime to change the chemical concentration of the soil.
- Topsoil / cover and revegetation which provides several benefits by providing a physical and chemical barrier to dispersive soils.

The information contained in this report must be read together with other specific details pertinent to geotechnical considerations provided in the reports outlined in Section 1 of this report.

1. Introduction

This report presents the results of two supplementary geotechnical investigations undertaken by Coffey Services Australia Pty Ltd (Coffey) for the proposed Merrimu Precinct Structure Plan (PSP) site in Bacchus Marsh, Victoria.

The initial supplementary investigation was commissioned by Tass Palios of Creo Consultants Pty Ltd (Creo) via email dated 2 July 2020 and was performed in general accordance with Coffey proposal 754-MELGE233440.1AA _Rev02 dated 1 June 2020.

A further investigation was completed in October 2020 and was performed in general accordance with Coffey proposal 754-MELGE233440.1AF dated 31 August 2020.

2. Background information

This report should be read in conjunction with the following previous reports submitted by Coffey for the site:

1- Merrimu Precinct – Geotechnical investigation. Coffey report 754-MELGE233440AB dated 6 December 2019.

2- Merrimu Precinct – Desktop assessment. Coffey report 754-MELGE233440AC_Rev01 dated 7 July 2020.

The initial geotechnical investigation (Reference 1 above) provided geotechnical recommendations regarding footings and pavements for the development area.

Following the direction from Victorian Planning Authority (VPA), a desktop assessment was undertaken (Reference 2 above) by reviewing the following documents:

- Merrimu PSP Final Geomorphology and Vegetation Assessment, undertaken by Alluvium, on behalf of Melbourne Water (provided by VPA).
- Geological Survey Victoria, Bacchus Marsh map sheet (1:50,000 scale).
- A draft plan comparing the developable areas.

The findings of the desktop assessment included:

- The soils across the site has been classified as Sodosols in accordance with Australian Soil Classification.
- Sodosols are soils having a strong texture contrast between surface (A) horizons and subsoil (B) horizons and the subsoil horizons are sodic. A sodic soil is defined as a soil with an exchangeable sodium of greater than 6% of the cation exchange capacity Sodic soils are prone to dispersion (and erosion) when comes into contact with water;
- Sodosols of the Werribee Formation are highly dispersive and are present along the escarpment of the plateau;
- Geomorphic sensitivity to change is a key driver of biological and vegetation sensitivity to change; and
- The geomorphology sensitivity of the precinct is mainly associated with the change in the hydrology across the precinct;
- Given that highly erodible soils are present along the escarpment of the plateau, the key issue would be managing the surface water run-off from the future development.

Following the desktop study a geotechnical investigation was planned to sample the soils within the Merrimu PSP site to provide comment of the sodicity and dispersiveness of the subsurface soils within the site. The findings of this investigation are the subject of this report.

3. Aims

The aims of this geotechnical investigation were to provide comments and recommendations on the following items:

- Subsurface and groundwater conditions at the Merrimu PSP site;
- Depth to and thickness of Werribee Formation soils (if encountered) at test locations;
- Presence of rock (if encountered);
- Dispersiveness nature of the soils within the Merrimu PSP site and provide mitigating or preventive measures;
- Re-use potential of site won soil as clay liner material and advise on alternate material if found not suitable;
- Excavatability, as well as temporary and permanent batter slopes for wetland area;
- Suitability of excavated material for use as engineered fill, and provide recommendations on the construction of engineered fill, including subgrade preparation, layer thickness, moisture conditioning and compaction.

This assessment has been undertaken based on the results of the laboratory tests together with the test pit engineering logs.

4. Outline of investigation

4.1. August 2020 – test pit investigation

The August field investigation was undertaken between 4 and 6 August 2020 and comprised excavation of 25 test pits (denoted as TP101 to TP125) to depths ranging from 0.4 m refusal to 3.1 m (target depth) below ground level (bgl) at locations shown on Figure 1. Refusal on shallow rock was encountered in 18 of the test pits.

The test pit locations were chosen considering the location of the previous test pits. Some of the test pits in this assessment were nominated targeting mainly the geomorphologically sensitive areas and near waterways located close to the boundary of the proposed development area (denoted as Target test pits in Figure 1). It is noted that no test pits were nominated in the flood plains or further down towards the bottom of the slope.

A summary of the test pit depths including depths to refusal is presented in Table 1.

Table 1 - Summary of fieldwork

Test pit	TP101	TP102	TP103	TP104	TP105	TP106	TP107	TP108	TP109	TP110
Depth (m)	1.5	2	2.5	1	2.5	0.8	1.4	3	1.9	1.6
Comment	-	-	-	R	R	R	R		R	R
Test pit	TP111	TP112	TP113	TP114	TP115	TP116	TP117	TP118	TP119	TP120
Depth (m)	1.1	1.1	0.4	3.1	2	1.6	1.1	0.8	1.3	2.1
Comment	R	R	R	-	-	R	R	R	R	-
Test pit	TP121	TP122	TP123	TP124	TP125					
Depth (m)	0.8	1.4	1.7	1.4	2.6					
Comment	R	R	R	R	R					
Where: R = Refusal; TP101 – denotes targeted test pit										

The test pits were excavated using a 15 tonne tracked excavator supplied and operated by Kingston Plant Hire. Disturbed and undisturbed, and bulk samples were recovered at selected depths from the test pits for visual assessment and laboratory testing.

Upon completion, the test pits were photographed, backfilled with the excavated spoil and tamped with the excavator bucket. Excess spoil was mounded over the test pits to accommodate future settlement.

Dynamic Cone Penetrometer (DCP) tests were carried out adjacent to each test pits.

The fieldwork was carried out in the presence of a geotechnical engineer from Coffey who located the test pits, conducted DCP testing, nominated sampling depths and prepared engineering logs.

The soil profile encountered in the test pits is described in the engineering logs presented in Appendix A including relevant photographs. The logs are preceded by an explanation sheets that outline the terms and symbols used in the log preparation. The results of DCP testing are presented graphically in the engineering logs provided in Appendix A.

4.2. October 2020 – borehole and hand auger investigation

The October field investigation was undertaken between 5 and 7 October 2020 and comprised the drilling of two boreholes (designated BH-1 and BH-4) and 10 shallow sample locations (designated HA-1A to HA-1C, HA-2A to HA-2C and HA-3A to HA-3D).

The boreholes were drilled to depths of between 11.10m to 11.95m bgl at the locations shown on Figure 1. The boreholes were drilled using a track mounted drilling rig supplied and operated by Urban Drilling Pty Ltd. The boreholes were advanced using augering and washboring techniques in soil and coring techniques in rock.

Standard Penetration Tests (SPTs) were carried out at nominal 1.5m intervals in soils to assist in estimating soil strength. Recovered rock core was boxed, photographed on site and returned to Coffey's warehouse for laboratory testing and storage.

The conditions encountered in the boreholes are presented in the engineering logs presented in Appendix A along with core photographs.

The shallow sample locations were advanced using hand tools and were excavated to depths of between 0.2m and 0.4m bgl and the locations are presented in Figure 1. Disturbed samples were recovered from the boreholes for laboratory testing.

The materials encountered in the shallow sample locations are summarised in Table 2 in Section 6.2. Photographs of select shallow sample locations are shown in Photographs 1 to 4 in Appendix A.

4.3. Laboratory testing

4.3.1. August 2020 investigation

The following geotechnical laboratory tests were carried out at a NATA registered laboratory on selected soil samples collected from the test pits:

- 17 Emerson Class Number tests;
- 14 Exchangeable Sodium Percentage (ESP) tests;
- 5 Pinhole Dispersion tests on samples remoulded to 95% Standard Compaction or from undisturbed U63 tubes; and
- 4 Falling head permeability testing on samples remoulded to a target dry density ratio of 95% Standard compaction;

- 4 particle size distribution tests;
- 14 pH value tests; and
- 14 Electrical Conductivity (EC) tests.

The results of the geotechnical laboratory tests are presented in Section 6.4 and the certificates are provided in Appendix B.

4.3.2. October 2020 investigation

The following geotechnical laboratory tests were carried out at a NATA registered laboratory on selected soil samples collected from the boreholes and hand auger locations:

- 10 Emerson Class Number tests;
- 10 Exchangeable Sodium Percentage (ESP) tests;
- 10 pH value tests; and
- 10 Electrical Conductivity (EC) tests
- 22 Point Load Strength Index tests (Non-NATA).

The results of the geotechnical laboratory tests are presented in Section 6.2 and the certificates are provided in Appendix B.

5. Regional geology and geological setting

The geology of Merrimu is outlined in the Geological Survey of Victoria, Bacchus Marsh map sheet (1:50, 000 scale). The plan of the proposed Merrimu site superimposed on the geological map sheet of Bacchus Marsh is presented in Figure 1.

The geological map sheet indicates the site is located on a plateau underlain mainly by Newer Volcanics (Bullengarook Flow) comprising residual basaltic clay overlying weathered basalt rock.

The geological map also indicates presence of soils of Werribee Formation along the escarpment of the plateau. The Werribee Formation comprises sand and silty sand and minor clay and are assessed to be highly dispersible.

The Bacchus Marsh map sheet presents a geological cross section “A-B-C” that runs through the site. The section indicates that, over the plateau, the Newer Volcanics is underlain at depth by soils of Werribee Formation which in turn is underlain by shale, slate, siltstone and sandstone. Over the plateau, based on the scale provided in the cross section “A-B-C”, the Newer Volcanics is estimated to extent to depths ranging from 10 m to 20 m and in places up to 30 m.

The cross section “A-B-C” also indicates that soils of Werribee Formation would be encountered at or near the surface along the escarpment of the plateau. The applicable section of the cross section is presented in Figure A.

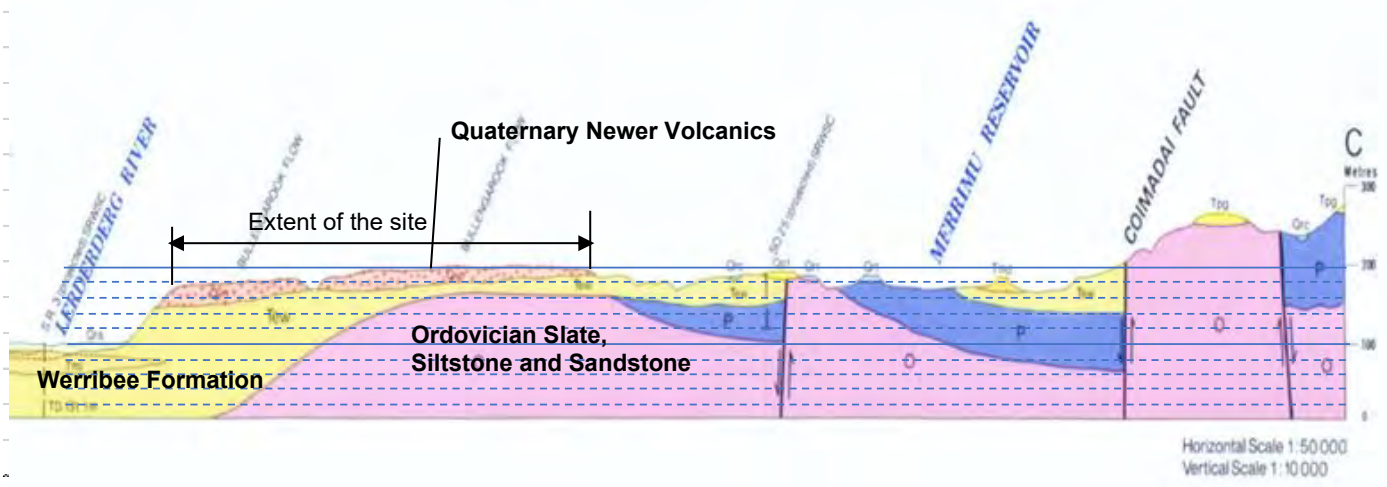


Figure A - cross section A-B-C

6. Results of the investigation

6.1. Surface conditions

The majority of the Merrimu PSP site is located on a plateau and is relatively flat with a slight downhill slope from north to south. However, there is a drop in the site elevation nearby O'Connell Road. Pyrites Creek runs from north to south to the east of the Merrimu PSP site.

A gully is present at the southern end of the Merrimu PSP site which falls to Flanagans Drive. The slopes steepen towards the gully. Burrowing is evident around the gully. Erosion features are also present, predominantly comprising channel, rill and gully erosion. Several large erosion features (>5m deep) were observed. Photographs 5 to 10 in Appendix A show some of the erosion features in the gully.

The ground surface over the plateau was covered with thick grass. Basalt outcrops and loose basalt boulders were noted in places.

The ground surface of the slopes are generally covered by grass and vegetation although parts are bare.

Old mature trees between 5m and 20m high are scattered in the gully.

At the time of the August 2020 investigation, the site was very dry with no surface water present and easily trafficable by a 4WD.

The October 2020 investigation was carried out following rain. Parts of the site were inaccessible for 4WD vehicles due to surface water and basalt boulders at the surface. Surface water was present over Bences Road limiting access in parts.

6.2. Subsurface conditions

The subsurface conditions encountered during the investigations were generally consistent with the regional geology described in Section 5.

The subsurface profile at the plateau typically comprised a thin layer of topsoil (up to 0.2 m thick) overlying residual soils underlain by extremely or less weathered basalt. Werribee Formation soils were encountered beneath the basalt at a depth of 8.95m to 9.6m (RL 132.9 to 151.8m)

The topsoil comprised clayey silt and was of friable consistency.

The residual soils were generally dark brown, grey and red brown clays of high plasticity and of very stiff to hard consistency. The clays contained variable proportions of calcareous pockets and calcareous mottling. Basalt cobbles and boulders were encountered at depth in places. It should be noted that cobbles and boulders in a clay matrix is a common soil profile in the Newer Volcanics.

Extremely weathered basalt comprised gravel/clayey gravel and was assessed to be in dense to very dense condition.

Refusal to excavation of the test pits was encountered on what was assessed to be weathered basalt rock/boulders. Our experience in Newer Volcanics has shown that the depth to bed rock can vary significantly over very short horizontal distances.

The shallow sample locations were excavated on the upper and mid slopes of the gully to the south of the site and were extended to depths up to 0.4m below existing surface level to collect samples for laboratory testing.

The subsurface conditions encountered on the upper slopes comprised soils of the Newer Volcanics similar as described above. The subsurface conditions on the mid slopes included soils of the Werribee Formation, comprising red and brown fine to medium grained sands and clayey sands.

For details on subsurface conditions, reference should be made to the engineering logs presented in Appendix A (boreholes and test pits) and Table 2 (shallow sample locations).

Table 2 – Materials in shallow sample locations

Location	Depth (m)	Geological Unit	Material	Description
HA-1A	0.15	Newer Volcanics	Clay (CH)	high plasticity, brown, with sand, with basalt cobbles and boulders
HA-1B	0.2	Werribee Formation / Subsoil?	Sand (SP)	fine to medium grained, brown, with clay
HA-1C	0.3	Werribee Formation / Subsoil?	Sand (SP)	fine to medium grained, brown
HA-2A	0.3	Newer Volcanics	Clay (CH)	high plasticity, brown, trace of fine-grained sand
HA-2B	0.3	Newer Volcanics	Clay (CH)	high plasticity, brown mottled red and grey, fine to coarse grained gravel and cobbles at surface
HA-2C	0.3	Werribee Formation	Clayey Sand (SC)	fine to medium grained, brown mottled orange and white
HA-3A	0.4	Werribee Formation / Subsoil?	Sand (SP)	fine grained, brown, with clay, trace coarse grained gravel, rounded
HA-3B	0.4	Werribee Formation / Subsoil?	Sand (SP)	fine to medium grained, pale brown
HA-3C	0.3	Werribee Formation	Clayey Sand (SC)	fine to medium grained, brown
HA-3D	0.3	Werribee Formation	Sandy Clay (CH)	high plasticity, brown mottled white

6.3. Groundwater

Groundwater inflow was not observed in any of the test pits over the depth range of investigation at the time of the fieldwork. Perched groundwater could be anticipated in wetter months, particularly in calcareous layers underlain by impermeable clays. Seasonal variations in groundwater should be anticipated.

6.4. Laboratory test results

The results of the laboratory testing on the selected samples are provided in Table 3 and Table 4. The laboratory test certificates are presented in Appendix B.

Table 3 - Summary of laboratory test results

Location	Depth (mbgl)	Sample number	Particle Size Distribution (%)			Coefficient of permeability *(m/s)	Emerson Class Number	Pinhole dispersion test - Designation
			Gravel	Sand	Fines			
TP103	1 to 1.5	349	-	-	-	-[1]	4	D1
TP105	1 to 1.5	351	7	32	61	$2x10^{-9}$	4	ND2
TP118	0 to 0.5	352	-	-	-	-	6	ND2
TP122	1 to 1.5	350	-	-	-	$3x10^{-9}$	4	ND2
TP123	1.1 to 1.5	353	-	-	-	$5x10^{-9}$	4	ND2

Where: * Remoulded at 95% maximum dry density and optimum moisture content; mbgl = metres below ground level;
D1 – highly dispersive ND2 = completely erosion resistant
Notes:
[1]. Sample could not be saturated. Considered to be impermeable.

Table 4 - Summary of laboratory test results (Emerson, ESP, pH and EC)

Location	Depth (mbgl)	Unit	Material	Sample number	Emerson Class Number	ESP (%)	pH	EC (µS/cm)	Particle Size Distribution (%)		
									Gravel	Sand	Fines
BH-1	10.5	Werribee Fm		M20-Oc24632	2	32	9.4	67	-	-	-
BH-1	11.5	Werribee Fm		M20-Oc24631	2	22	9.4	47	-	-	-
BH-4	9.7	Werribee Fm		M20-Oc24634	2	11	9.4	370	-	-	-
BH-4	10.7	Werribee Fm		M20-Oc24633	2	23	8.6	360	-	-	-
HA-1B	0.2	Werribee Fm	SP Sand	M20-Oc24625	2	6.1	7.9	29	-	-	-
HA-1C	0.3	Werribee Fm	SP Sand	M20-Oc24626	3	7.2	7.4	10	-	-	-
HA-2C	0.3	Werribee Fm	SC Clayey Sand	M20-Oc24627	2	6.5	9.4	730	-	-	-
HA-3B	0.4	Werribee Fm	SP Sand	M20-Oc24628	2	6.6	7.3	17	-	-	-
HA-3C	0.3	Werribee Fm	SC Clayey Sand	M20-Oc24629	3	9.6	9.3	270	-	-	-
HA-3D	0.3	Werribee Fm	CH Shandy Clay	M20-Oc24630	2	4.9	9.5	110	-	-	-

Location	Depth (mbgl)	Unit	Material	Sample number	Emerson Class Number	ESP (%)	pH	EC (µS/cm)	Particle Size Distribution (%)		
									Gravel	Sand	Fines
TP101	1.15 to 1.5	Newer Volcanics	CH	354	4	18	9.3	1000	-	-	-
TP103	1 to 1.5	Newer Volcanics	CH	349	4	23	9.2	1600	-	-	-
TP104	0 to 0.5	Newer Volcanics	CH	367	4	2.8	8.6	210	1	4	95
TP105	0.4 to 0.5	Newer Volcanics	CH Sandy clay	355	4	2	9.1	96	-	-	-
TP105	1 to 1.5	Newer Volcanics	SP Sand	351	4	5	9.2	280	7	32	61
TP108	0.5	Newer Volcanics	CH	365	4	19	8.8	1300	0	8	92
TP108	2.5	Newer Volcanics	CH	356	5	32	8.2	1700	-	-	-
TP109	1.5	Newer Volcanics	CH	357	4	16	9.2	1200	-	-	-
TP110	0.5	Newer Volcanics	CH	358	3	-	-	-	-	-	-
TP114	2.5	Newer Volcanics	CH	359	4	26	9	2000	-	-	-
TP115	1.5 to 1.6	Newer Volcanics	CH	360	4	26	8.7	2300	-	-	-
TP116	0.5	Newer Volcanics	CH	361	3	-	-	-	-	-	-
TP118	0 to 0.5	Newer Volcanics	CH	352	6	21	7.4	55	-	-	-
TP120	1.5	Newer Volcanics	CH	362	4	24	9	2400	0	8	92
TP122	1 to 1.4	Newer Volcanics	GC	363	-	4.7	8.8	290	-	-	-
TP122	1 to 1.5	Newer Volcanics	GC	350	4	-	-	-	-	-	-
TP123	1.1 to 1.5	Newer Volcanics	CH	353	4	3.3	9.1	79	-	-	-
TP125	1.2 to 1.5	Newer Volcanics	CH	364	6	-	-	-	-	-	-
Where: ESP = Exchangeable Sodium Percentage; EC=Electrical conductivity (1:5 aqueous extract)											

7. Soil dispersiveness

7.1. Assessment of dispersive soils and dispersiveness

The following laboratory tests were carried out in our current assessment to identify the dispersiveness of the soils at the site:

- Exchangeable Sodium Percentage (ESP);
- Emerson Class Number (EC No.); and
- Pinhole dispersion test

7.1.1. Exchangeable Sodium Percentage (ESP)

The Exchangeable Sodium Percent (ESP) is the most common analytical technique used to identify sodic or potentially dispersive soils. The ESP is determined from the ratio of exchangeable cations.

The ESP measures the proportion of cation exchange sites occupied by sodium. Soils are considered sodic when the ESP is greater than 6, and highly sodic when the ESP is greater than 15 (Table 5).

Table 5 - Relationship between degree of dispersion and exchangeable sodium percentage

Rating	ESP (%)	Soil dispersion test
Non-sodic	<6	No dispersion evident after 24 hours. Aggregates slaked but not dispersed (milky) clay.
Slightly sodic	6–10	Dispersion (milky halo) evident after 24 hours. Soil aggregates slightly disperse.
Moderately sodic	10–15	Dispersion (milky halo) evident after several hours. Soil aggregates partially disperse.
Highly sodic	>15	Dispersion (milky halo) evident in less than 30 minutes. Soil aggregates completely disperse.

When a sodic soil comes into contact with non-saline water, water molecules are drawn in-between the clay platelets causing the clay to swell to such an extent that individual clay platelets are separated from the aggregates, this process is known as dispersion. In slightly saline water, or water with a moderate electrolyte (salt) concentration, sodic soils swell, but generally don't disperse.

While sodic soils are generally dispersive, it is important to acknowledge that not all sodic soils disperse, and that not all dispersive soils are sodic (Sumner 1993). Factors such as silt and high magnesium content may induce non-sodic soils (ESP <6%) to disperse, while organic matter, clay mineralogy, acidity, and high iron content may prevent sodic soils (ESP> 6%) from dispersing (Raine and Loch 2003, Rengasamy 2002).

The pH values of the samples tested ranged from 7.3 to 9.5 indicating the soils are moderately to highly alkaline.

7.1.2. Emerson Class Number

The Emerson soil crumb test (AS 1289.3.8.1-1997) is an Australian Standard for the prediction of dispersive behaviour of clay soils. The Emerson test is quick and simple and can be used to assist in the rapid identification of dispersive soils. The test has three levels:

i. Spontaneous dispersion of an air dried aggregate in deionised water,

ii. Remoulding at near maximum field capacity and re-immersion in deionised water,

iii. Remoulded soil is shaken in deionised water.

The Emerson Class Numbers are described in Table 6.

Table 6 – Emerson Class Number classification

Emerson Class Number	Level	Description
Class 1	i	Complete dispersion of immersed air dried aggregate
Class 2	i	Some dispersion of immersed air dried aggregate
Class 3	ii	Dispersion of remoulded sample
Class 4	ii	No dispersion of remoulded sample – calcite or gypsum present
Class 5	iii	Dispersion following shaking
Class 6	iii	Flocculation following shaking
Class 7	i	No dispersion, swelling of immersed air dried aggregate
Class 8	i	No dispersion, no swelling of immersed air dried aggregate

7.1.3. Pinhole Dispersion Test

The Pinhole Dispersion Test presents a qualitative measurement of the dispersibility and consequent erodibility of clay soils. The test is undertaken by causing water to flow through a small hole punched in a sample of the material. The pinhole is measured, and the shape of the pinhole inspected for erosion. The soils are classified based on the pinhole dispersion test results as given in Table 7.

Table 7 - Pinhole dispersion classification

Designation	Classification
D1	Highly dispersive
D2	Dispersive
PD1	Potentially dispersive
PD2	Potentially dispersive (intermediate)
ND1	Non-dispersive
ND2	Completely non-dispersive

7.1.4. Discussion of laboratory test results

Soils of the Newer Volcanics were encountered within the Merrimu PSP site on the plateau and upper slopes. Soils of the Werribee Formation were encountered and sampled from the boreholes at depth or near surface from the escarpments and in the gully. For the purposes of this discussion we will address these units separately.

Newer Volcanics

Laboratory testing with regards to soil dispersiveness was completed on 17 samples from the Newer Volcanics soils.

The ESP results (Table 4) indicated that out of 14 samples tested, 9 samples returned ESP of >15% indicating the soil samples are highly sodic and may be dispersive. The remaining samples returned ESP of <6% indicating that the soil samples are non-sodic.

It can be noted from Table 4 that the results of Emerson Class Number (ECN) of 14 out of 16 samples tested returned ECN of 4 or more indicating the soils are non-dispersive and contain calcite or gypsum. During the field investigation, the residual soils were observed to comprise variable proportion of calcareous content which is reflected in the ECN test results. The ECN result of 4 indicate that remoulding of the soil at a moisture content near the optimum for compaction (simulating the use of these soils in a filling and compaction operation) does not increase the potential for

dispersive behaviour, however further breakdown of the soil may occur, by water turbulence or concentrated rapid water flow which needs to be considered in the preparation of the surface water / stormwater management plan.

Pinhole dispersion test results presented in Table 3 indicate 4 out of 5 samples tested can be classified as “Completely non-dispersive”. This indicates that when the remoulded soil comes into contact with water the soils do not disperse.

Werribee Formation

Laboratory testing with regards to soil dispersiveness was completed on 10 samples from the Werribee Formation soils.

The ESP results (Table 4) indicated that out of 10 samples tested:

- 3 samples returned ESP of >15% indicating the soils are highly sodic and dispersive;
- 1 sample returned ESP between 10% and 15% indicating the soils are moderately sodic;
- 5 samples returned ESP between 6% and 10% indicating that the soils are slightly sodic; and,
- 1 sample returned ESP of less than 6% indicating the soil is non sodic.

The Emerson Class Number test results returned ECN of 2 for eight samples indicating that these soils are dispersive. The remaining two samples returned ECN of 3 indicating that these soils are dispersive upon remoulding.

It is worth noting that the ESP laboratory test results on Werribee Formation soils from depth (>0.5m bgl) were predominately highly sodic with three of the four samples greater than 20%. The ESP results on the upper Werribee Formation soils (<0.5m bgl) were typically moderately sodic with 5 of the 6 samples returning results between 6% and 10%.

7.2. Potential for erosion

The geology of the plateau within the Merrimu PSP site comprises Newer Volcanics. The laboratory testing indicates that the soils are moderately to highly sodic and dispersion is variable. With these results in consideration there is potential for erosion, and care should be taken to reduce the potential for erosion in these materials. Sections 7.3 to 7.5 provide discussion on activities increasing risk of erosion, reducing the risk of erosion and prevention and management measures for erosion with respect to the anticipated development activities.

The surface geology of the gully at the southern end of the Merrimu PSP site comprises Newer Volcanics on the upper slopes and Werribee Formation along the mid and lower slopes. Laboratory testing indicates that the soils of the Werribee Formation are slightly to highly sodic and dispersive. The laboratory results are consistent with the observations of erosion in the gully. The potential for further erosion in the gully is high.

We understand that it is likely that the development will be predominately located on the plateau. The gully is not located within this area but is within the Merrimu PSP site. It is necessary that the development does not negatively affect the condition of the gully.

Any development should ensure that appropriate plans are put in place to ensure that no additional runoff is discharged from the development to areas where Werribee Formation soils are exposed (such as the gully) so as to mitigate the potential of any increased erosion as a result of the development.

7.3. Activities increasing risk of erosion

Following are some potential activities that are considered to increase the risk of erosion/tunnel erosion:

- Removal of topsoil;
- Soil excavation or expose of subsoils to rainfall;
- Supply of services via trenches;
- Construction of roads and culverts in dispersive subsoils;
- Installation of sewage and grey water disposal systems in dispersive subsoils; and
- Dam construction from dispersive soils.

7.4. Options for reducing the risk of erosion

Options for reducing the risk of erosion during construction and development works on dispersive soils include:

- Where possible do not remove or disturb topsoil or vegetation.
- Ensure that dispersive subsoils are covered with an adequate layer of topsoil.
- Avoid construction techniques that result in exposure of dispersive subsoils.
- Use alternatives to ‘cut and fill’ construction such as pier and post foundations.
- Where possible avoid the use of trenches for the supply of services i.e. water and power.
- If trenches must be used, ensure that repacked spoil is properly compacted, treated with gypsum and topsoiled.
- Consider alternative trenching techniques that do not expose dispersive subsoils.
- Ensure runoff from hard areas is not discharged into areas with dispersive soils. If necessary, create safe areas for discharge of runoff.
- If possible do not excavate culverts and drains in dispersive soils.
- Consider importing non-sodic soil to create appropriate road surfaces and drains without the need for excavation.
- Ensure that culverts and drains excavated into dispersive subsoils are capped with non-dispersive clays mixed with gypsum, topsoiled and vegetated.
- Avoid use of septic trench waste disposal systems; consult your local council about the use of alternative above ground treatment systems.
- Construction of dams from dispersive soils is usually possible, using one or a combination of: precise compaction, chemical amelioration, capping with non-dispersive clays, sand filters and adequate topsoiling.

7.5. Prevention and management of erosion

Prevention of erosion in urban and peri-urban environments is best achieved using a combination of,

- Identification and avoidance of dispersive soils.
- Precise re-compaction.
- Chemical amelioration.
- Sand blocks and barriers.
- Topsoil / cover and revegetation.

7.5.1. Precise re-compaction

A high degree of compaction reduces soil permeability, restricting the movement of water and dispersed clay through the soil matrix, which decreases the severity of dispersion and restricts tunnel development.

Normal earth moving machinery including bulldozers, excavators and graders do not provide sufficient compactive force to reduce void spaces or achieve adequate compaction in dispersive soils. A sheepsfoot roller of appropriate weight is usually required to compact dispersive soils.

7.5.2. Chemical amelioration

Gypsum and lime can be used to treat sodic soils. Gypsum (calcium sulphate) is more effective than lime (calcium carbonate) for the treatment of dispersive soils as it increases the electrolyte concentration in the soil solution as well as displacing sodium with calcium within the clay structure. Gypsum is less commonly used than hydrated lime in dam construction and other works due to its lower solubility, and higher cost. In alkaline (pH >7.0) soils the effectiveness of hydrated lime is reduced by the formation of insoluble calcium carbonate, such that gypsum is preferred to hydrated lime.

7.5.3. Topsoil and vegetation

Topsoil or covering of exposed dispersive soils reduces the likelihood of subsoil dispersion and initiation of erosion by;

- Providing a source of salt to increase the electrolyte content of infiltration water.
- Preventing desiccation and subsoil cracking.
- Promoting even infiltration.
- Providing a protective cover from raindrop impact.
- Providing a suitable medium for revegetation.

Topsoil minimises the interaction between water and dispersive clays by providing both a physical and chemical barrier. Topsoil also reduces soil desiccation and development of surface cracks. It is suggested that exposed dispersive subsoils be covered with at least 150mm of nondispersive topsoil and sown with an appropriate mix of grass species. In some cases, it will be necessary to protect the topsoil from erosion with ‘jute’ cloth or similar product.

8. Construction considerations

8.1. Excavation

Soil strength materials (topsoil, residual and extremely weathered rock) at the site may be excavated using conventional mechanical equipment such as backhoes and tracked excavators. Low production rates may be anticipated in extremely weathered rock and where boulders are encountered.

The excavatability of the basalt is based on the strength of the rock and the frequency of the defects. No information is available on these characteristics as the geotechnical investigation terminated on basalt rock with refusal of the 15-tonne excavator. Based on previous experience in basalt of the Newer Volcanics, we would expect that heavy use of rock breakers would be required and possibly blasting in locations.

8.2. Batter slopes

Open excavation may be suitable for the construction of the wetlands assuming that a suitably graded batter is provided for both temporary and permanent conditions. Personnel should not enter any excavation in excess of 1.5m depth, unless trench shoring support is provided, or the excavation is appropriately battered. Regardless of the depth of excavation or batter slope, extreme care should be exercised regarding the presence of debris in the sides of the excavation. Batter slopes are likely to be subject to fretting and local loss of material, particularly if exposed to weather for extended periods. Drainage should be provided at the top of batter slopes to divert runoff away from the slope face.

The batters of the wetlands may comprise soil and rock; or may be entirely located within soil. It is recommended that temporary batter slopes excavated in soils should be formed at not steeper than 1V:1H. Permanent batter slopes should not be steeper than 1V:2H in either the natural clays, engineered fill or extremely weathered basalt. Pond facing batters should not exceed 1V:3H in soils/engineered fill and 1V:2H in rock.

Flatter slopes may be required for the following:

- Groundwater ingress, particularly if encountered in granular soil layers;
- Maintenance;
- Landscaping; and
- Access.

8.3. Earthwork Materials

Select fill may comprise material such as crushed rock, clayey sand, sandy clay or weathered rock. Imported fill materials should be of low reactivity to reduce the potential for shrink-swell movements. It is recommended that imported fill materials be required to have a maximum particle size after compaction of 50mm and have a liquid limit not exceeding 50%. Alternative materials may be considered but samples should be submitted for approval prior to use.

Topsoil is suitable for landscaping purposes only.

Subject to an assessment of their condition at the time of construction the natural clays and extremely weathered rock (clayey gravel) on site may be used for the construction of engineered fill. Removal of oversized particle (>75mm) from extremely weathered rock may be required.

The on-site natural clays of the Newer Volcanics are of high plasticity with occasional cobbles and boulders which would need to be removed depending on the particle size. This natural clay can be considered for use as engineered fill although separation of the larger particles will be required. The high plasticity clays can be difficult to place and compact and is likely to require moisture conditioning. Workability of the material can be improved by soil mixing or the addition of gypsum/lime. The performance of the soil mixing/additives would need to be verified with laboratory testing. The shrink-swell characteristics of this material will need to be considered when placed under/near retaining walls and civil structures such as drainage/pavements/culverts/footings.

8.4. Subgrade preparation

It is recommended that the following procedures be adopted for the preparation of engineered fill and subgrade beneath pavements:

- Excavate to design subgrade level. Remove any uncontrolled fill and vegetation to expose the natural clay subgrade and grub out any major roots. Also remove topsoil containing significant organic matter and any silty subsoils. An assessment of the subsoil may be undertaken by a suitably experienced geotechnical professional at the time of construction to confirm the extent of removal required.

- It should be noted that the subgrade would need to be over excavated to place the required subgrade improvement layer.
- The exposed subgrade should then be proof rolled using a heavy vibrating pad foot roller to identify any soft or week spots any soft, wet or weak areas which may require remedial works. The proof rolling should be observed by a suitably experienced Engineer.
- Should extensive soft or weak areas be encountered, a bridging layer is likely to be required, in which case further geotechnical advice should be sought.
- Following proof rolling the subgrade improvement layer should be placed in and compacted to achieve a dry density ratio of at least 98% Standard compaction and within ± 2% of Standard Optimum Moisture Content (SOMC) in accordance with AS1289.5.1.1, 5.4.1 or 5.7.1. The loose layer thickness of the material would need to be decided based on type of material and equipment used.
- Pavement materials (e.g. base and sub-base materials) should be placed in layers not exceeding 200mm loose thickness and compacted to achieve a dry density ratio of 98% Modified (base) and 95% Modified (subbase) in accordance with AS1289 5.2.1 and, 5.4.1., or in compliance with the specific design requirements. The moisture content of the material should be maintained within ± 2% of Standard OMC.

Where engineered fill is required to raise the subgrade level, it should be placed and compacted as described above. Select fill may comprise material such as crushed rock, clayey sand, sandy clay or weathered sedimentary rock. It is recommended that imported fill materials be required to have a maximum particle size after compaction of 50mm and have a liquid limit not exceeding 50%. Alternative materials may be considered but samples should be submitted for approval before use.

It is recommended that subgrade preparation, fill placement and compaction be performed in the presence of a suitably experienced geotechnical practitioner and the level of compaction checked by field density testing. Subgrade preparation should be carried out during dry weather conditions where possible. Provision should be made for effective diversion and removal of all surface water from the prepared subgrade from any source, particularly for sand subgrade preparation.

9. Wetland construction

The results of the permeability tests on remoulded samples compacted to 95% Standard has a permeability ranging between 2 x 10^{-9} m/s and 5 x 10^{-9} m/s and are considered to be suitable for reuse as clay liners.

The in-situ (field) permeability of the soil horizons encountered during the excavation of the wetlands is likely to be influenced by structure and fissures and calcareous pockets within the soils and to improve the performance of the wetlands we recommend that the wetlands construction procedures discussed in Section 9.2 are adopted.

9.1. Liners

Highly or less weathered rock or granular soils are not likely to be suitable materials to form a retarding basin of a wetlands, as defects within the rock mass or the high permeability of granular soils may allow excessive water loss from the wetlands. Some form of liner should be placed over exposed rock or granular materials encountered in the base and batters of the wetlands. The subgrade to the liner should be suitably prepared (i.e. provision of a protective bridging layer) to reduce the risk of damage to the liner by sharp rock edges.

9.1.1. Clay Liner

Based on the results of the laboratory testing, the site won residual clay soils compacted to 98% Standard in accordance with Section 9.2, are expected to have a permeability less than 1 x 10^{-9}m/s,

which is commonly adopted for low permeability clay liners. The dispersion tests indicate these soils are not dispersive but contains calcite or gypsum.

Care should be taken to ensure that the liner does not dry out and crack during or following construction. Where clay liners may be subjected to wetting and drying, the clay liner should be covered by topsoil cover with grass, hard edge systems or other synthetic surface protection.

9.1.2. Geosynthetic Clay Liner (GCL)

An alternative lining system is Geosynthetic Clay Liner (GCL). The GCL about 10mm thick with a layer of sodium bentonite, between cross-linked needle punched geotextiles. In addition, the liner needs to be covered with 300mm of soil, to provide additional protection and to confine the GCL and overlapping joints between the rolls. The top of the liner is located in an anchored trench.

9.1.3. HDPE Liner

High Density Polyethylene (HDPE) liner may also be considered. Again, the subgrade to the liner should be suitably prepared to reduce the risk of damage to the liner. We note that HDPE liners become very slippery when wet and this should be considered as part of the site safety plan if used.

9.1.4. Geocomposite Liner

A new development in lining systems comprises a combined geotextile and geomembrane, such as “Canal”. The geomembrane provides a robust liner while the geotextile provides protection and a non slip surface. The geomembrane has to be welded together. The subgrade to the liner should be suitably prepared to reduce the risk of damage to the liner. The material is susceptible to UV light and where exposed should be covered by topsoil and grass or other hard edge systems.

9.2. Clay liner construction

Where sand/gravel or highly of less weathered rock are encountered in the batters or base of the wetlands, we recommend the placement of a liner to prevent excessive water loss from the wetlands due to high permeability within these layers. Liner options are discussed in Section 9.1.

Where appropriate materials for a clay liner are identified, our recommended construction procedures are as follows:

- Excavate to the design base level
- If the exposed subgrade comprises natural clays it should be scarified to a minimum depth of 300mm. Particles larger than 200mm should be removed, the clay should be moisture conditioned to within 0% to +3% of Standard optimum moisture content and then compacted to a minimum dry density ratio of 98% Standard in accordance with AS1289 5.1.1, 5.4.1 or 5.7.1. Soil treating, if proposed, should be included at this stage. Depending on proposed compaction plant, it may be necessary to place the 300mm compacted layer, in two or more layers.
- If the exposed subgrade comprises rock, sand or gravel lenses, silts or fill materials these should be removed to a depth of 300mm and replaced with a suitable clay material and compacted as described above.
- Where walls are proposed to retain the pond, as opposed to a batter, the clay liner should be placed up against the base of the wall.

It is important that the compacted clay liner be kept moist following compaction to avoid the formation of desiccation cracks prior to commissioning. The desiccation cracks would result in a more permeable clay liner and higher seepage losses. The placement of a sacrificial layer of topsoil over the clay liner would help to reduce drying.

It is recommended that Level 1 inspection and testing requirements be adopted for earthworks, as defined in AS3798-2007 “Guidelines on earthworks for commercial and residential developments”.

9.3. Anticipated construction difficulties

9.3.1. Soft site conditions

Ponded water and soft surface conditions may affect plant accessing the site. The extent is generally depending on the time of year the construction work is undertaken. Drains and working platforms may be required to get plant into the site. In addition, the high plasticity clay soils beneath the soft surface layers may soften if exposed to surface run-off. We recommend that site stripping is undertaken in stages.

9.3.2. Dispersive soils

The dispersive nature of the residual soils means that where soils are in contact with water, in particular fresh water, they have the potential to erode/disperse potentially resulting in unsightly erosion and/or destabilisation of the wetlands batters. We therefore recommend that:

- The wetlands be constructed such that runoff water is not allowed to pond;
- Water runoff is directed into properly constructed and appropriately lined channels;
- Vegetation regrowth is assisted in areas of exposed soil, such as the wetlands batters. This may include the use of geotextile matting, such as Jute.
- Areas that suffer excessive erosion, rilling or piping may benefit from treatment with gypsum, which can reduce the dispersion potential for long enough for re-vegetation to occur.

If the clay liner is constructed out of dispersive soils, there is potential for excessive erosion and or piping to occur, particularly on the water line, if preventative action is not taken. The following preventative action is therefore recommended:

- The clay liner should be well compacted, as noted in Section 9.2 of this report
- A non-dispersive soil cover or some form of surface protection may be placed over the dispersive soils. The options include a non-dispersive clay which could provide half the clay liner thickness, non-dispersive topsoil or a 100mm thick compacted layer of fine crushed rock.

Where a non–dispersive soil cover is proposed (site won or imported), it is recommended that the soils have a minimum Emerson Dispersion Class of at least 6.

10. Limitations

This investigation report has been prepared based on the results of geotechnical investigation carried out at the site and the data included in this report should not be used for any other purpose without our prior review and agreement.

To the best of our knowledge, the presented data in our geotechnical report represents a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these finding represent the actual state of the site at all points.

Your attention is drawn to the attached document entitled "*Important Information about your Coffey Report*".

References

1. Dispersive soils and their management. Technical Reference Manual. Department of Primary Industries and Water, Tasmania
2. Identifying dispersive soils. Government of Western Australia. Department of Agriculture and Food. Note 386 (November 2009)

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

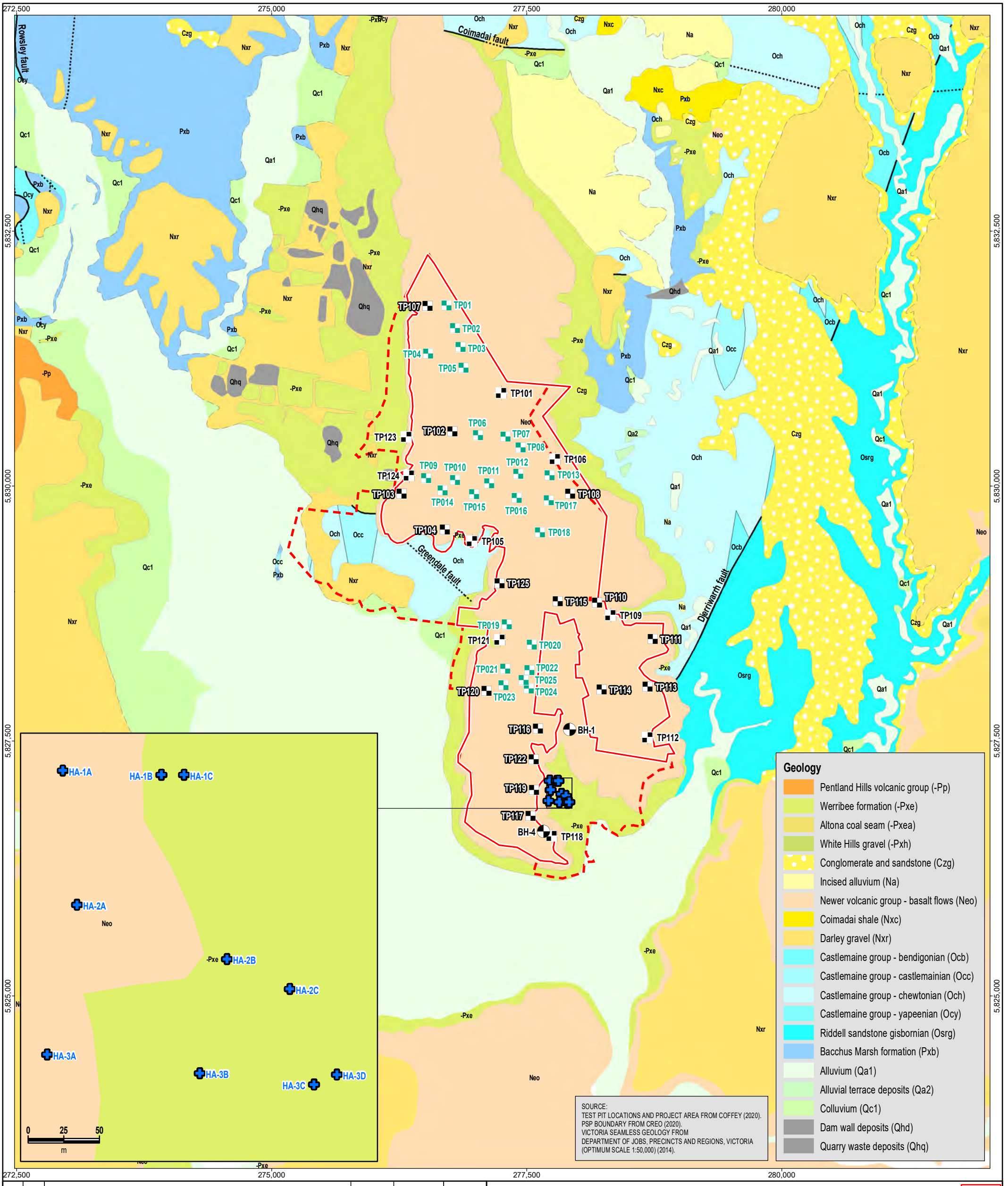
Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

Figures



revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	JS	MJ	05.11.20

LEGEND

- BOREHOLE
- SHALLOW SAMPLE
- TARGET TEST PIT
- TEST PIT
- PREVIOUS TEST PIT
- PROJECT BOUNDARY
- PRECINCT STRUCTURE PLAN BOUNDARY

GEOLOGICAL STRUCTURE

DRAFT

- CONFORMITY
- DISCONFORMITY
- FAULT
- FAULTED CONTACT
- UNCONFORMITY

N

0 0.35 0.7 1.05 1.4 1.75

SCALE 1:35,000 (A3) KILOMETRES

Projection: GDA 1994 MGA Zone 55

drawn	JS
approved	MJ
date	05.11.2020
scale	AS SHOWN
original size	A3

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client:	CREO CONSULTANTS
project:	MERRIMU PRECINCT GEOTECHNICAL INVESTIGATION BACCHUS MARSH, VICTORIA
title:	GEOTECHNICAL INVESTIGATION LOCATIONS RELATIVE TO GEOLOGY
project no:	754-MELGE233440.1
figure no:	FIGURE 1
rev:	A

MXD Template Reference: 233440_AE_GIS001_v0_2

275,000 277,500 280,000

5,832,500 5,830,000 5,827,500 5,825,000

GOODMAN CREEK
COCKATOO CREEK
LERDERDERG RIVER
DJERRIWARRH CREEK
PYRITES CREEK
PARWAN CREEK
WERRIBEE RIVER
WESTERN FREEWAY
OLD WESTERN HIGHWAY

TP107 TP01 TP02 TP03 TP04 TP05 TP101 TP102 TP06 TP123 TP07 TP08 TP106 TP09 TP010 TP124 TP012 TP013 TP011 TP103 TP108 TP014 TP015 TP016 TP017 TP104 TP018 TP105 TP125 TP115 TP110 TP109 TP019 TP121 TP020 TP111 TP021 TP022 TP025 TP120 TP023 TP024 TP114 TP113 TP116 BH-1 TP112 TP122 TP119 TP117 BH-4 TP118

HA-1A HA-1B HA-1C HA-2A HA-2B HA-2C HA-3A HA-3B HA-3C HA-3D

0 25 50 m

0 0.3 0.6 0.9 1.2 1.5 KILOMETRES

SCALE 1:30,000 (A3)

Projection: GDA 1994 MGA Zone 55

SOURCE:
TEST PIT LOCATIONS AND PROJECT AREA FROM COFFEY (2020)
PSP BOUNDARY AND VEGETATION SENSITIVITY FROM CREO (2020)

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	JS	MJ	05.11.20

LEGEND

DRAFT

- PREVIOUS TEST PIT
- BOREHOLE
- SHALLOW SAMPLE
- TARGET TEST PIT
- TEST PIT
- WATERCOURSE
- PROJECT BOUNDARY
- PRECINCT STRUCTURE PLAN BOUNDARY

drawn	JS
approved	MJ
date	05.11.2020
scale	AS SHOWN
original size	A3

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client: CREO CONSULTANTS

project: MERRIMU PRECINCT
GEOTECHNICAL INVESTIGATION
BACCHUS MARSH, VICTORIA

title: GEOTECHNICAL INVESTIGATION LOCATIONS

project no: 754-MELGE233440.1 | figure no: FIGURE 2 | rev: A

MXD Template Reference: 233440_AE_GIS002_v0_2

Appendix A - Results of field investigation

Photograph 1: HA-3C location

Photograph 2: HA-3D location

drawn	**MJ**		client:	**Creo Consultants Pty Ltd**
approved			project:	**Merrimu Precinct** **Additional Geotechnical Investigation** **Soil Sodicity and Dispersiveness Assessment**
date	**27 Oct 2020**			
scale	**NTS**		title:	**Site Photographs**
original size	**A4**		project no: **754-MELGE233440.1**	figure no:

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Photograph 3: HA-1C location

Photograph 4: HA-2C location

drawn	**MJ**		client: **Creo Consultants Pty Ltd**	
approved			project: **Merrimu Precinct Additional Geotechnical Investigation Soil Sodicity and Dispersiveness Assessment**	
date	**27 Oct 2020**			
scale	**NTS**		title: **Site Photographs**	
original size	**A4**		project no: **754-MELGE233440.1**	figure no:

Photograph 5: Erosion feature in gully

Photograph 6: Erosion feature in gully

drawn	**MJ**		client:	**Creo Consultants Pty Ltd**
approved			project:	**Merrimu Precinct** **Additional Geotechnical Investigation** **Soil Sodicity and Dispersiveness Assessment**
date	**27 Oct 2020**			
scale	**NTS**		title:	**Site Photographs**
original size	**A4**		project no: **754-MELGE233440.1**	figure no:

coffey
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Photograph 7: Erosion feature in gully

Photograph 8: Erosion feature in gully

drawn	**MJ**		client:	**Creo Consultants Pty Ltd**
approved		coffey A TETRA TECH COMPANY	project:	**Merrimu Precinct** **Additional Geotechnical Investigation** **Soil Sodicity and Dispersiveness Assessment**
date	**27 Oct 2020**		title:	**Site Photographs**
scale	**NTS**		project no: **754-MELGE233440.1**	figure no:
original size	**A4**			

Photograph 9: Erosion feature in gully

Photograph 10: Erosion feature in gully

drawn	**MJ**		client:	**Creo Consultants Pty Ltd**
approved		coffey A TETRA TECH COMPANY	project:	**Merrimu Precinct** **Additional Geotechnical Investigation** **Soil Sodicity and Dispersiveness Assessment**
date	**27 Oct 2020**		title:	**Site Photographs**
scale	**NTS**		project no: **754-MELGE233440.1**	figure no:
original size	**A4**			

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Soil Description Explanation Sheet (1 of 2)

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 µm to 2.36 mm
	medium	200 µm to 600 µm
	fine	75 µm to 200 µm

MOISTURE CONDITION

Dry Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet As for moist but with free water forming on hands when handled.

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	–	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material	Structure and fabric of parent rock visible.
Residual soil	Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil	Deposited by wind.
Alluvial soil	Deposited by streams and rivers.
Colluvial soil	Deposited on slopes (transported downslope by gravity).
Fill	Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.
Lacustrine soil	Deposited by lakes.
Marine soil	Deposited in ocean basins, bays, beaches and estuaries.

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Soil Description Explanation Sheet (2 of 2)

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)							USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.			GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.			GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)			GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes missing			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.					
		SILTS & CLAYS Liquid limit less than 50	**DRY STRENGTH**	**DILATANCY**	**TOUGHNESS**			
			None to Low	Quick to slow	None		ML	SILT
			Medium to High	None	Medium		CL	CLAY
			Low to medium	Slow to very slow	Low		OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low to medium		MH	SILT
			High	None	High		CH	CLAY
			Medium to High	None	Low to medium		OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture.				Pt	PEAT

• Low plasticity – Liquid Limit W_L less than 35%. • Modium plasticity – W_L between 35% and 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

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Rock Description Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Rock Substance	In engineering terms rock substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic.
Defect	Discontinuity or break in the continuity of a substance or substances.
Mass	Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME	Simple rock names are used rather than precise geological classification.
PARTICLE SIZE	Grain size terms for sandstone are:
Coarse grained	Mainly 0.6mm to 2mm
Medium grained	Mainly 0.2mm to 0.6mm
Fine grained	Mainly 0.06mm (just visible) to 0.2mm
FABRIC	Terms for layering of penetrative fabric (eg. bedding, cleavage etc.) are:
Massive	No layering or penetrative fabric.
Indistinct	Layering or fabric just visible. Little effect on properties.
Distinct	Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric.

CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	Definition
Residual Soil	**RS**	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely Weathered Material	**XW**	Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible.
Highly Weathered Rock	**HW**	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
Moderately Weathered Rock	**MW**	The whole of the rock substance is discoloured, usually by iron staining or bleaching , to the extent that the colour of the fresh rock is no longer recognisable.
Slightly Weathered Rock	**SW**	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Fresh Rock	**FR**	Rock substance unaffected by weathering.

Notes on Weathering:

1. AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
2. Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

ROCK SUBSTANCE STRENGTH TERMS

Term	Abbrev-iation	Point Load Index, $I_{s(50)}$ (MPa)	Field Guide
Very Low	**VL**	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
Low	**L**	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	**M**	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	**H**	1 to 3	A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	**VH**	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
Extremely High	**EH**	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.

Notes on Rock Substance Strength:

1. In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
2. The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
3. The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index $I_{s(50)}$. The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

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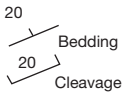
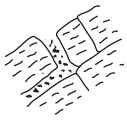
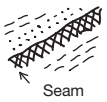
Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES Term	Definition	Diagram	Map Symbol	Graphic Log (Note 1)
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed.			 (Note 2)
Joint	A surface or crack across which the rock has little or no tensile strength. but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.			 (Note 2)
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.			
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.			
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.			
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface.			
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formad by weathering of the rock substance in place.			

DEFECT SHAPE TERMS	
Planar	The defect does not vary in orientation
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps
Irregular	The defect has many sharp changes of orientation

Note: The assessment of defect shape is partly influenced by the scale of the observation.

ROUGHNESS TERMS	
Slickensided	Grooved or striated surface, usually polished
Polished	Shiny smooth surface
Smooth	Smooth to touch. Few or no surface irregularities
Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.

COATING TERMS	
Clean	No visible coating
Stained	No visible coating but surfaces are discoloured
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein.

BLOCK SHAPE TERMS	
Blocky	Approximately equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greate than cross section

Notes on Defects:

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

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Engineering Log - Borehole

Borehole ID.	**BH-1**
sheet:	1 of 3
project no.	**754-MELGE233440.1**
client:	**Creo Consultants**
date started:	**05 Oct 2020**
principal:	
date completed:	**05 Oct 2020**
project:	**Merrimu Precinct**
logged by:	**FR**
location:	**Refer to Figure 1**
checked by:	**MJ**

position: E: 277920; N: 5827607 (Datum Not Specified) surface elevation: 161.40 m (Datum Not Specified) angle from horizontal: 90°

drill model: Hanjin D&B, Track mounted drilling fluid: Polymer hole diameter : 110 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD N		Not Encountered		161	1.0		CH	**CLAY**: high plasticity, brown, with coarse grained basalt, and cobbles and boulders.	M	VSt		**NEWER VOLCANICS**
				160	2.0			Borehole BH-1 continued as cored hole				
				159	3.0							
				158	4.0							
				157	5.0							
				156	6.0							
				155	7.0							
				154								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HQ3 HQ3 core barrel (61.1mm)

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH-1**
sheet:	2 of 3
project no.	**754-MELGE233440.1**
client: **Creo Consultants**	date started: **05 Oct 2020**
principal:	date completed: **05 Oct 2020**
project: **Merrimu Precinct**	logged by: **FR**
location: **Refer to Figure 1**	checked by: **MJ**

position: E: 277920; N: 5827607 (Datum Not Specified) surface elevation: 161.40 m (Datum Not Specified) angle from horizontal: 90°
drill model: Hanjin D&B, Track mounted drilling fluid: Polymer hole diameter : 110 mm

drilling information				material substance					rock mass defects			
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular	general
		161	1.0		started coring at 1.20m							
HQ	Not Encountered	160	2.0		**BASALT**: grey, 1-5% vesicular, vesicles up to 15 mm.	SW		a=6.02 d=1.34	50% 64%		JT, 70°, IR, RO, SN SM, 20°, Clay, 10 mm	
		159						a=6.73 d=9.06				
		158	3.0		**NO CORE:** 0.40 m				0%		SM, 10°, Clay, 10 mm SM, 60°, Clay, 30 mm	
		157	4.0		**BASALT**: as above.	SW		a=7.75 d=6.72	0%			
		156	5.0		**NO CORE:** 0.30 m **BASALT**: as above. becoming grey and brown, with weathered joints	SW DW			0% 0%			
		155	6.0		**NO CORE:** 0.10 m **BASALT**: grey and brown, with weathering on joints. **NO CORE:** 0.10 m **BASALT**: as above. **NO CORE:** 0.10 m **BASALT**: as above.	DW DW DW		a=1.88	0% 0% 0%		Defects are: JT, 0 - 30°, IR, RO - VR, CN - CO, unless otherwise described	
		154	7.0					a=8.22	0%			

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HQ3 HQ3 core barrel (61.1mm)

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

Borehole ID.	**BH-1**
sheet:	3 of 3
project no.	**754-MELGE233440.1**
client:	**Creo Consultants**
date started:	**05 Oct 2020**
principal:	
date completed:	**05 Oct 2020**
project:	**Merrimu Precinct**
logged by:	**FR**
location:	**Refer to Figure 1**
checked by:	**MJ**

position: E: 277920; N: 5827607 (Datum Not Specified) surface elevation: 161.40 m (Datum Not Specified) angle from horizontal: 90°

drill model: Hanjin D&B, Track mounted drilling fluid: Polymer hole diameter : 110 mm

drilling information				material substance						rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ	Not Encountered	153	9.0		**BASALT**: grey-brown, some brecciation.	DW	X	a=0.56 d=0.70	100%		
					NO CORE: 0.90 m				15%		
		152			**BASALT**: grey-brown, some brecciation.	DW	X O	a=0.04 d=0.29	11%		
					NO CORE: 0.20 m				0%		**WERRIBEE FORMATION**
W			10.0		**Sandy GRAVEL (GP)**: fine to coarse grained, red-orange, fine to coarse grained sand, moist, very dense.			SPT 25/10mm, 5/mm N*=R			
		151	11.0		**Sandy CLAY (CH)**: high plasticity, red-orange, fine grained sand, moist, hard.			SPT 7, 18, 22 N*=40			
		150			**SAND (SP)**: fine to medium grained, red-orange, moist, very dense.			SPT 20, 28, 27 N*=55			
			12.0		Borehole BH-1 terminated at 11.95 m Target depth						
		149	13.0								
		148	14.0								
		147	15.0								
		146									

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HQ3 HQ3 core barrel (61.1mm)

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

drawn	**MJ**		client:	**Creo Consultants Pty Ltd**
approved		coffey A TETRA TECH COMPANY	project:	**Merrimu Precinct** **Additional Geotechnical Investigation** **Soil Sodicity and Dispersiveness Assessment**
date	**27 Oct 2020**		title:	**Core Photographs – BH-1**
scale	**NTS**		project no: **754-MELGE233440.1**	figure no:
original size	**A4**			

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Engineering Log - Borehole

Borehole ID.	***BH-4***
sheet:	1 of 3
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date started: ***06 Oct 2020***
principal:	date completed: ***06 Oct 2020***
project: ***Merrimu Precinct***	logged by: ***FR***
location: ***Refer to Figure 1***	checked by: ***MJ***

position: E: 277667; N: 5826610 (Datum Not Specified) surface elevation: 142.20 m (Datum Not Specified) angle from horizontal: 90°
drill model: Hanjin D&B, Track mounted drilling fluid: Polymer hole diameter : 110 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD N		Not Encountered		142			CH	**CLAY**: high plasticity, red-brown, with fine to coarse grained gravel, cobbles and boulders.	M	VSt		**NEWER VOLCANICS**
								BASALT: grey, with clay.				
				141	1.0			Borehole BH-4 continued as cored hole				
				140	2.0							
				139	3.0							
				138	4.0							
				137	5.0							
				136	6.0							
				135	7.0							

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method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HQ3 HQ3 core barrel (61.1mm)

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3
no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH-4**
sheet:	2 of 3
project no.	**754-MELGE233440.1**
client: **Creo Consultants**	date started: **06 Oct 2020**
principal:	date completed: **06 Oct 2020**
project: **Merrimu Precinct**	logged by: **FR**
location: **Refer to Figure 1**	checked by: **MJ**

position: E: 277667; N: 5826610 (Datum Not Specified) surface elevation: 142.20 m (Datum Not Specified) angle from horizontal: 90°
drill model: Hanjin D&B, Track mounted drilling fluid: Polymer hole diameter : 110 mm

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		142			started coring at 1.00m						
HQ3	Not Encountered	141	1.0		**BASALT**: grey-brown, with iron-staining.	DW		a=0.16 d=0.29	57%		SM, 10 - 40°, Clay, 120 mm
		140	2.0		**BASALT**: grey, 1-2% vesicular, vesicles up to 2 mm.	SW		a=8.18 d=9.40	56%		
		139	3.0		**NO CORE:** 1.40 m				0%		
		138	4.0		**BASALT**: as above.	SW					recovered as 2-10 mm gravel
					NO CORE: 0.10 m				0%		
					BASALT: as above.	SW			0%		JT, 80°, CU, RO, SN
		137	5.0		becoming grey and brown, weathering on joints	DW		a=9.82 d=7.96			
		136	6.0					a=2.70 d=4.15			JT, 40°, IR, VR, CN
		135	7.0		**BRECCIATED BASALT**: basalt is medium to high strength in a hard clay matrix, 3-40 mm clasts, grey and red.	HW					Defects are: JT, 0 - 30°, IR, RO - VR, CN - CO, unless otherwise described

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HQ3 HQ3 core barrel (61.1mm)

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

Borehole ID.	**BH-4**
sheet:	3 of 3
project no.	**754-MELGE233440.1**
client: **Creo Consultants**	date started: **06 Oct 2020**
principal:	date completed: **06 Oct 2020**
project: **Merrimu Precinct**	logged by: **FR**
location: **Refer to Figure 1**	checked by: **MJ**

position: E: 277667; N: 5826610 (Datum Not Specified) surface elevation: 142.20 m (Datum Not Specified) angle from horizontal: 90°

drill model: Hanjin D&B, Track mounted drilling fluid: Polymer hole diameter : 110 mm

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
HQ3	Not Encountered	134			**BRECCIATED BASALT**: basalt is very low strength in a hard clay matrix, pale brown and orange. *(continued)*	HW		a=0.06 d=0.06			
		133	9.0		**Sandy CLAY (CH)**: high plasticity, pale brown, yellow, mottled grey, fine to medium grained sand, moist, very dense.			SPT 15, 32, 21/80mm N=R			**WERRIBEE FORMATION**
		132	10.0		becoming pale brown, mottled red, mottled grey			SPT 13, 21, 30/100mm N=R			
		131	11.0		Borehole BH-4 terminated at 11.10 m Target depth						
		130	12.0								
		129	13.0								
		128	14.0								
		127	15.0								

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HQ3 HQ3 core barrel (61.1mm)

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

Photograph 10: Erosion feature in gully

drawn	**MJ**		client:	**Creo Consultants Pty Ltd**
approved		coffey A TETRA TECH COMPANY	project:	**Merrimu Precinct** **Additional Geotechnical Investigation** **Soil Sodicity and Dispersiveness Assessment**
date	**27 Oct 2020**		title:	**Core Photographs – BH-4**
scale	**NTS**		project no: **754-MELGE233440.1**	figure no:
original size	**A4**			

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Engineering Log - Excavation

Excavation ID.	***TP101***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***04 Aug 2020***
principal:	date completed: ***04 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 277385; N: 5830894 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
E	N		Not Encountered	B		0.5		ML	**TOPSOIL: Clayey SILT**: low liquid limit, brown with sand and roots.	M	Fb			**TOPSOIL**
								CH	**CLAY**: high plasticity, dark brown, trace rootlets, trace medium grained gravel.		F			**RESIDUAL SOIL - NEWER VOLCANICS**
						1.0			becoming pale grey, mottled cream, white, trace calcareous pockets		VSt - H			R
						1.5			Refusal on weathered rock Test pit TP101 terminated at 1.5 m Refusal					
						2.0								
						2.5								
						3.0								
						3.5								

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator
HT hand tools

support
N none
S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
D disturbed sample
B bulk disturbed sample
E environmental sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Test pit

Excavated spoil

drawn	**RP**		client:	Creo Consultants	
approved	**SS**		project:	Merrimu Precinct Merrimu	
date	**09-Sep-20**		title:	**TEST PIT PHOTOGRAPHS TP101**	
scale	**N.T.S.**		project no: 754-MELGE233440.1	fig no:	rev:
original size	**A4**				

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Engineering Log - Excavation

Excavation ID.	***TP102***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***04 Aug 2020***
principal:	date completed: ***04 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 276772; N: 5830531 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered			0.0		ML / CH	**TOPSOIL: Clayey SILT**: low liquid limit, brown with sand and roots.	M	Fb			**TOPSOIL**
									CLAY: high plasticity, dark brown, mottled grey, trace rootlets.		F - St			**RESIDUAL SOIL - NEWER VOLCANICS**
						0.5			becoming brown-orange, mottled grey, trace calcareous pockets		VSt - H			
						1.0			becoming pale grey, mottled white					
						1.5								
						2.0			Test pit TP102 terminated at 2.0 m Target depth					
						2.5								
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client:	Creo Consultants
project:	Merrimu Precinct Merrimu
title:	**TEST PIT PHOTOGRAPHS** **TP102**
project no: 754-MELGE233440.1	fig no: / rev:

coffey
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Engineering Log - Excavation

Excavation ID.	***TP103***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***04 Aug 2020***
principal:	date completed: ***04 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 27693; N: 5829912 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered	B		0.5		CH	**CLAY**: high plasticity, dark brown, with fine to coarse graiend sand, trace rootlets, trace calcareous pockets.	M	Fb			**TOPSOIL**
											VSt - H			**RESIDUAL SOIL - NEWER VOLCANICS**
						1.0			becoming brown-orange, mottled grey					
						1.5								
						2.0								
						2.5			Test pit TP103 terminated at 2.4 m Target depth					
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client:	Creo Consultants
project:	Merrimu Precinct Merrimu
title:	**TEST PIT PHOTOGRAPHS** **TP103**
project no: 754-MELGE233440.1	fig no: / rev:

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Engineering Log - Excavation

Excavation ID.	***TP104***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***04 Aug 2020***
principal:	date completed: ***04 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 276698; N: 5829569 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered	D		0.5		CH	**CLAY**: high plasticity, brown-red, with coarse grained gravel, trace rootlets.	M				**TOPSOIL** **RESIDUAL SOIL - NEWER VOLCANICS** calcareous R
						1.0			Refusal on weathered rock Test pit TP104 terminated at 1.0 m Refusal					
						1.5								
						2.0								
						2.5								
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Test pit

Excavated spoil

drawn	**RP**	coffey A TETRA TECH COMPANY	client:	Creo Consultants	
approved	**SS**		project:	Merrimu Precinct Merrimu	
date	**09-Sep-20**		title:	**TEST PIT PHOTOGRAPHS TP104**	
scale	**N.T.S.**		project no: 754-MELGE233440.1	fig no:	rev:
original size	**A4**				

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Engineering Log - Excavation

Excavation ID.	***TP105***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***04 Aug 2020***
principal:	date completed: ***04 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 276966; N: 5829460 (Datum Not Specified) | surface elevation: Not specified | pit orientation: N-S | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered	D		0.5		CH	**CLAY**: high plasticity, brown-red, trace rootlets.	M	Fb VSt - H			**TOPSOIL** **RESIDUAL SOIL - NEWER VOLCANICS**
								CH	**Sandy CLAY**: high plasticity, orange, mottled pale grey, fine to coarse grained sand.	D				calcareous R
				B		1.0		SC	**SAND**: fine to coarse grained, pale brown and orange brown, mottled pale grey.		VD			
						1.5								
						2.0								
						2.5			Refusal on weathered rock Test pit TP105 terminated at 2.5 m Refusal					
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil (calcareous soil)

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client:	Creo Consultants
project:	Merrimu Precinct Merrimu
title:	**TEST PIT PHOTOGRAPHS** **TP105**
project no: 754-MELGE233440.1	fig no: / rev:

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Engineering Log - Excavation

Excavation ID.	***TP106***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***04 Aug 2020***
principal:	date completed: ***04 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 277775; N: 5830264 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
E	N		Not Encountered			0.5		ML CH	**TOPSOIL: Clayey SILT**: low liquid limit, brown with sand, trace rootlets. **CLAY**: high plasticity, dark brown,, with fine to coarse grained gravel, trace boulders. becoming pale brown	M	Fb H			**TOPSOIL** boulder found between 0.0m-0.7m **RESIDUAL SOIL - NEWER VOLCANICS** R
						1.0 1.5 2.0 2.5 3.0 3.5			Refusal on weathered rock / boulders Test pit TP106 terminated at 0.8 m Refusal					

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client:	Creo Consultants
project:	Merrimu Precinct Merrimu
title:	**TEST PIT PHOTOGRAPHS** **TP106**
project no: 754-MELGE233440.1	fig no: / rev:

coffey
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Engineering Log - Excavation

Excavation ID.	***TP107***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***04 Aug 2020***
principal:	date completed: ***04 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 276530; N: 5831764 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered	D		0.5		ML	**TOPSOIL: Clayey SILT**: low liquid limit, brown with sand, trace rootlets.	M	Fb			**TOPSOIL**
								CH	**CLAY**: high plasticity, dark brown, mottled dark grey, trace rootlets.		F - St			**RESIDUAL SOIL - NEWER VOLCANICS**
						1.0			becoming pale brown-pale grey, mottled cream, with fine to coarse grained sand and fine to medium grained gravel		H			calcareous
						1.5			Refusal on weathered rock / boulder Test pit TP107 terminated at 1.4 m Refusal					
						2.0								
						2.5								
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client: Creo Consultants

project: Merrimu Precinct
Merrimu

title: **TEST PIT**
PHOTOGRAPHS TP107

project no: 754-MELGE233440.1 | fig no: | rev:

coffey
A TETRA TECH COMPANY

Engineering Log - Excavation

Excavation ID.	***TP108***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***05 Aug 2020***
principal:	date completed: ***05 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 277926; N: 5829925 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered	D		0.5		CH	**CLAY**: high plasticity, dark grey, dark brown, trace rootlets.	M	Fb / F			**TOPSOIL** / **RESIDUAL SOIL - NEWER VOLCANICS**
						1.0			becoming dark brown, dark grey and red brown		VSt - H			
						1.5								
						2.0								
						2.5								
						3.0			Test pit TP108 terminated at 3.0 m Target depth					
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client:	Creo Consultants
project:	Merrimu Precinct Merrimu
title:	**TEST PIT PHOTOGRAPHS** **TP108**
project no: 754-MELGE233440.1	fig no: / rev:

coffey
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Engineering Log - Excavation

Excavation ID.	***TP109***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***05 Aug 2020***
principal:	date completed: ***05 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 278321; N: 5828732 (Datum Not Specified) | surface elevation: Not specified | pit orientation: N-S | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
E	N		Not Encountered			0.0		CH	**CLAY**: high plasticity, dark brown, trace rootlets, trace fine to coarse grained sand.	M	VSt - H			**TOPSOIL** **RESIDUAL SOIL - NEWER VOLCANICS**
						0.5			becoming pale grey, trace fine to coarse grained gravel, trace calcareous pockets	D				R
				D		1.0			becoming pale grey- yellow brown					side wall full of rocks and boulders
						1.5								
						2.0			Refusal on weathered rock Test pit TP109 terminated at 1.9 m Refusal					
						2.5								
						3.0								
						3.5								

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

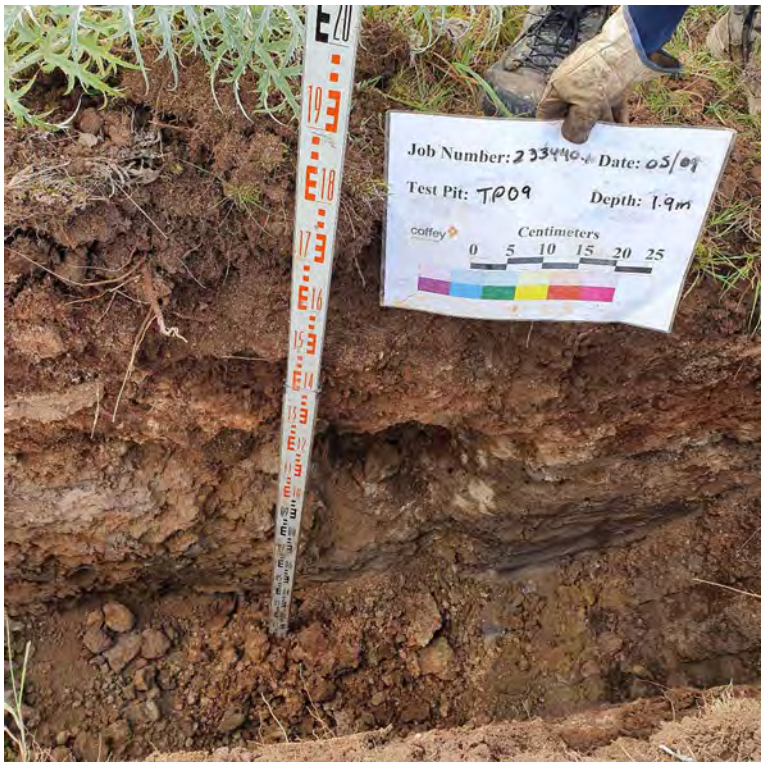
water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense



Test pit

Excavated spoil

drawn	**RP**	coffey A TETRA TECH COMPANY	client:	Creo Consultants	
approved	**SS**		project:	Merrimu Precinct Merrimu	
date	**09-Sep-20**		title:	**TEST PIT PHOTOGRAPHS TP109**	
scale	**N.T.S.**		project no: 754-MELGE233440.1	fig no:	rev:
original size	**A4**				

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Engineering Log - Excavation

Excavation ID.	***TP110***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***05 Aug 2020***
principal:	date completed: ***05 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 278191; N: 5828852 (Datum Not Specified) | surface elevation: Not specified | pit orientation: E-W | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.5 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered	D		0.5		CH	**CLAY**: high plasticity, dark brown, mottled orange, trace rootlets, trace fine to coarse grained sand.	M	VSt - H			**TOPSOIL**
									becoming orange brown and grey-brown, calcareous	D				**RESIDUAL SOIL - NEWER VOLCANICS**
						1.0			increasing boulders					calcareous below 0.7 m depth
						1.5			Refusal on weathered rock / boulder Test pit TP110 terminated at 1.6 m Refusal					R
						2.0								
						2.5								
						3.0								
						3.5								

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

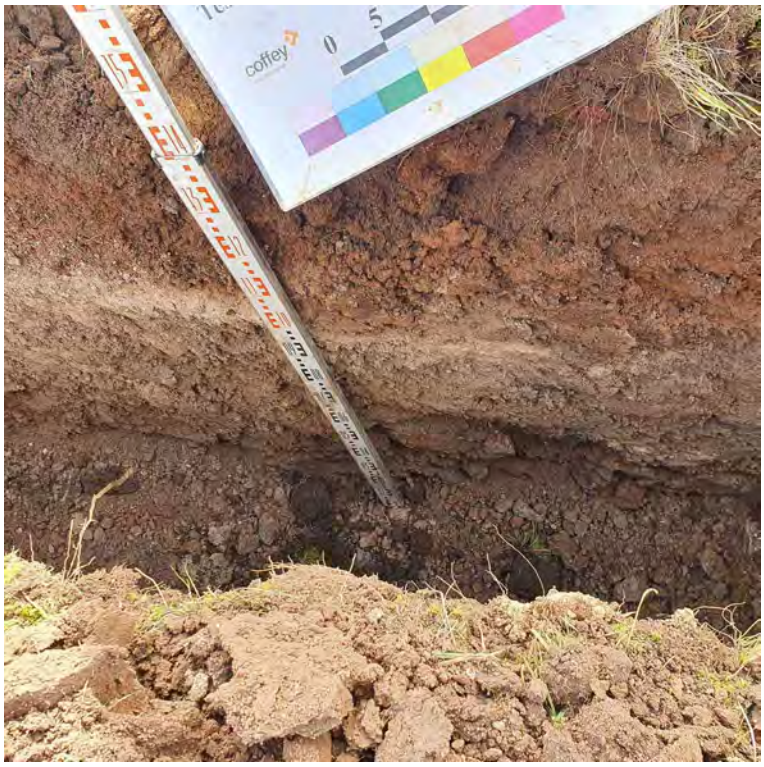
water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense



Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

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client:	Creo Consultants
project:	Merrimu Precinct Merrimu
title:	**TEST PIT PHOTOGRAPHS** **TP110**
project no: 754-MELGE233440.1	fig no: / rev:

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Engineering Log - Excavation

Excavation ID.	***TP111***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***05 Aug 2020***
principal:	date completed: ***05 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 278737; N: 5828499 (Datum Not Specified) | surface elevation: Not specified | pit orientation: N-S | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
E	N		Not Encountered			0.0		CH	**CLAY**: high plasticity, dark grey-dark brown, trace fine grained sand, trace rootlets.	D	VSt - H			**TOPSOIL** **RESIDUAL SOIL - NEWER VOLCANICS**
						0.5		CH	**CLAY**: high plasticity, pale brown-orange, mottled grey-red, with fine to coarse grained sand, trace fine to coarse grained gravel and boulder.	D				R calcareous
						1.0			Refusal on weathered rock Test pit TP111 terminated at 1.1 m Refusal					
						1.5								
						2.0								
						2.5								
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

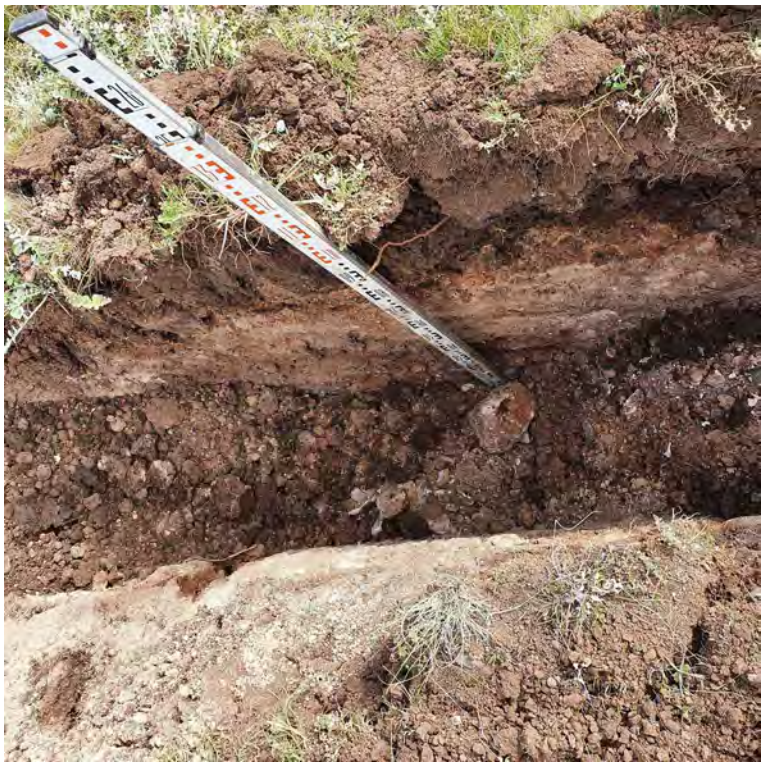
water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense



Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
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client:	Creo Consultants
project:	Merrimu Precinct Merrimu
title:	**TEST PIT PHOTOGRAPHS** **TP111**
project no: 754-MELGE233440.1	fig no: / rev:

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Engineering Log - Excavation

Excavation ID.	***TP112***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***05 Aug 2020***
principal:	date completed: ***05 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 278683; N: 5827533 (Datum Not Specified) | surface elevation: Not specified | pit orientation: N-S | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.5 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
E	N		Not Encountered			0.5		CH	**CLAY**: high plasticity, dark brown, trace rootlets, trace fine to coarse grained gravel, trace fine to coarse grained sand, trace rootlets.	M	VSt - H			**TOPSOIL**
														RESIDUAL SOIL - NEWER VOLCANICS
						1.0			becoming pale brown, dark grey, mottled white, calcareous with boulders up to 500mm in size	D				R
						1.5			Refusal on weathered rock Test pit TP112 terminated at 1.1 m Refusal					
						2.0								
						2.5								
						3.0								
						3.5								

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client: Creo Consultants

project: Merrimu Precinct
Merrimu

title: **TEST PIT PHOTOGRAPHS**
TP112

project no: 754-MELGE233440.1 | fig no: | rev:

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Engineering Log - Excavation

Excavation ID.	***TP113***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***05 Aug 2020***
principal:	date completed: ***05 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 278686; N: 5828030 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.5 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered			0.5		CH	**CLAY**: high plasticity, brown, trace fine grained sand, trace rootlets.	D	VSt - H			**TOPSOIL**
								CH	**CLAY**: high plasticity, yellow brown, mottled grey, with fine to coarse grained gravel, trace fine to coarse grained sand, calcareous mottling.					**RESIDUAL SOIL - NEWER VOLCANICS**
						1.0			Refusal on weathered rock Test pit TP113 terminated at 0.9 m Refusal					R
						1.5								
						2.0								
						2.5								
						3.0								
						3.5								

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

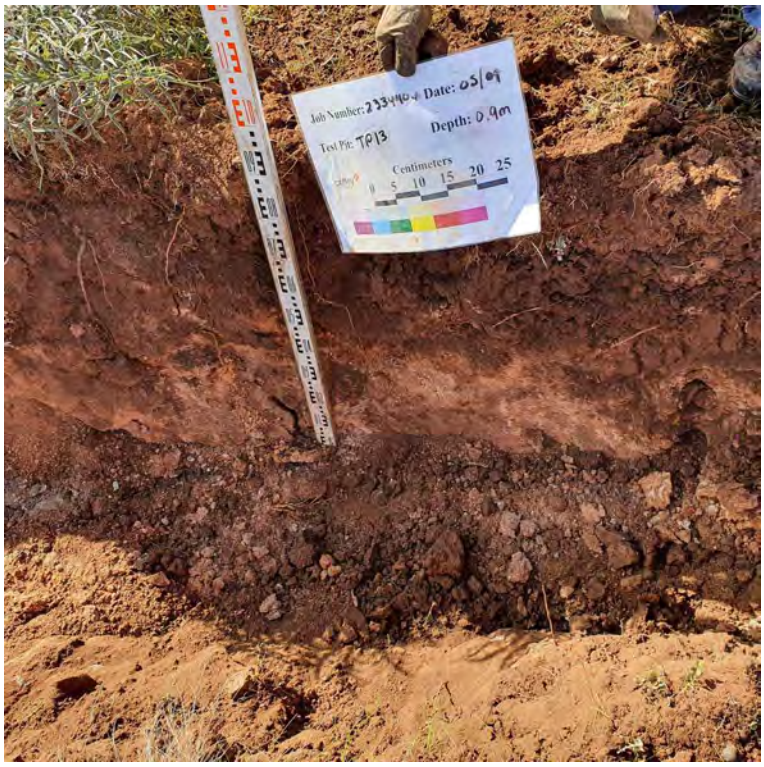
water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense



Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
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client: Creo Consultants

project: Merrimu Precinct
Merrimu

title: **TEST PIT PHOTOGRAPHS**
TP113

project no: 754-MELGE233440.1 | fig no: | rev:

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Engineering Log - Excavation

Excavation ID.	***TP114***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***05 Aug 2020***
principal:	date completed: ***05 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 278234; N: 5828001 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered	D		0.5		CH	**CLAY**: high plasticity, brown-orange, trace rootlets.	M				**TOPSOIL**
									calcareous between 0.5 m and 1.3 m depth					**RESIDUAL SOIL - NEWER VOLCANICS**
						1.0			becoming mottled pale grey-orange brown, trace calcareous pockets					
						1.5								
						2.0								
						2.5								
						3.0								
						3.5			Test pit TP114 terminated at 3.2 m Target depth					

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

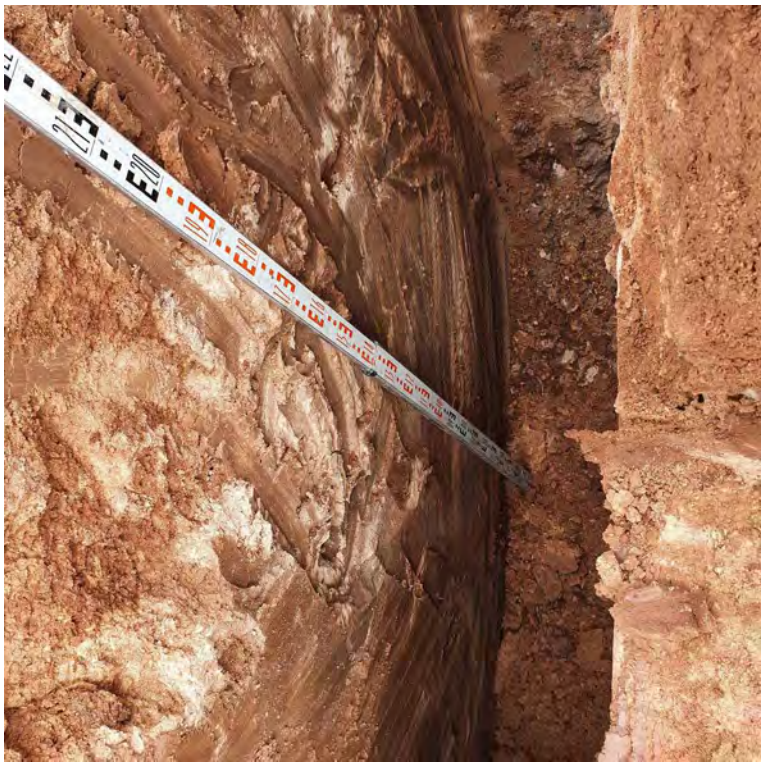
water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense



Test pit

Backfilled test pit location

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
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client:	Creo Consultants
project:	Merrimu Precinct Merrimu
title:	**TEST PIT PHOTOGRAPHS** **TP114**
project no: 754-MELGE233440.1	fig no: / rev:

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Engineering Log - Excavation

Excavation ID.	***TP115***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***05 Aug 2020***
principal:	date completed: ***05 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 277806; N: 5828870 (Datum Not Specified) | surface elevation: Not specified | pit orientation: E-W | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.5 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered	D		0.5		CH	**CLAY**: high plasticity, brown-orange, mottled grey, trace rootlets, trace fine to coarse grained sand.	D	Fb VSt - H			**TOPSOIL** **RESIDUAL SOIL - NEWER VOLCANICS**
						1.0			becoming pale grey, mottled pale brown					R
						1.5								
						2.0			Test pit TP115 terminated at 2.0 m Target depth					
						2.5								
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client: Creo Consultants

project: Merrimu Precinct
Merrimu

title: **TEST PIT PHOTOGRAPHS**
TP115

project no: 754-MELGE233440.1 | fig no: | rev:

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Engineering Log - Excavation

Excavation ID.	***TP116***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***05 Aug 2020***
principal:	date completed: ***05 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 277610; N: 5827616 (Datum Not Specified) | surface elevation: Not specified | pit orientation: E-W | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
E	N		Not Encountered	D		0.5		CH	**CLAY**: high plasticity, dark brown, with fine to coarse grained gravel, trace rootlets.	M	Fb H			**TOPSOIL** **RESIDUAL SOIL - NEWER VOLCANICS**
						1.0		GC	**CLAYEY GRAVEL**: fine to coarse grained, pale brown, pale grey, mottled dark grey, calcareous. with boulders	D	VD			R encountered big boulders, grey-dark grey mottled white
						1.5								
						2.0			Refusal on weathered rock Test pit TP116 terminated at 1.8 m Refusal					
						2.5								
						3.0								
						3.5								

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator
HT hand tools

support
N none
S shoring

penetration
1 2 3 — no resistance ranging to refusal

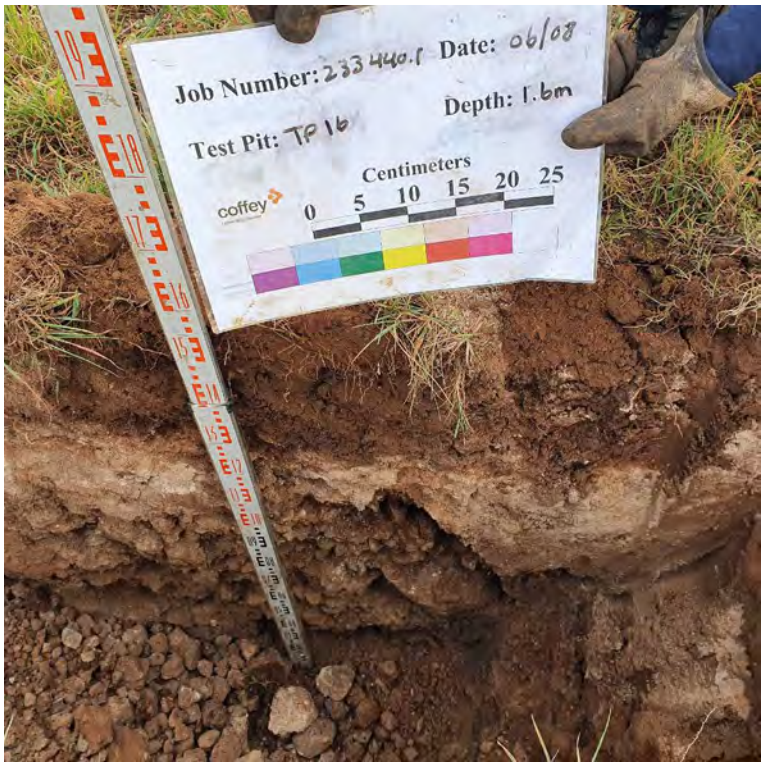
water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
D disturbed sample
B bulk disturbed sample
E environmental sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense



TP116

Excavated spoil

drawn	RP	coffey A TETRA TECH COMPANY	client:	Creo Consultants
approved	SS		project:	Merrimu Precinct Merrimu
date	09-Sep-20		title:	**TEST PIT PHOTOGRAPHS** **TP116**
scale	N.T.S.		project no: 754-MELGE233440.1	fig no: / rev:
original size	A4			

coffey
A TETRA TECH COMPANY

Engineering Log - Excavation

Excavation ID.	***TP117***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***06 Aug 2020***
principal:	date completed: ***06 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 277539; N: 5826762 (Datum Not Specified) | surface elevation: Not specified | pit orientation: N-S | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.5 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered			0.0		CH	**CLAY**: high plasticity, dark brown, trace rootlets.	M	Fb / H			
						0.5		GC	**CLAYEY GRAVEL**: fine to coarse grained, pale grey-grey, low plasticity clay, with calcareous fragments. calcareous	D	VD			boulders on side wall, white to pale grey R
						1.0			Refusal on weathered rock Test pit TP117 terminated at 1.1 m Refusal					
						1.5								
						2.0								
						2.5								
						3.0								
						3.5								

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator
HT hand tools

support
N none
S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
D disturbed sample
B bulk disturbed sample
E environmental sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client:	Creo Consultants
project:	Merrimu Precinct Merrimu
title:	**TEST PIT** **PHOTOGRAPHS TP117**
project no: 754-MELGE233440.1	fig no: / rev:

coffey
A TETRA TECH COMPANY

Engineering Log - Excavation

Excavation ID.	***TP118***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***06 Aug 2020***
principal:	date completed: ***06 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: Not Specified | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 3.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/100 mm) 2 4 6 8 10	structure and additional observations
E	N		Not Encountered	B		0.0		CH	**CLAY**: high plasticity, dark brown-red brown, trace rootlets.	M	H			**TOPSOIL**
														RESIDUAL SOIL - NEWER VOLCANICS
						0.5			**CLAYEY GRAVEL**: fine to coarse grained, grey, mottled white, high plasticity clay, calcareous.	D				
											VD			**EXTREMELY WEATHERED BASALT**
														R
						1.0			Refusal on weathered rock Test pit TP118 terminated at 0.8 m Refusal					
						1.5								
						2.0								
						2.5								
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**	coffey A TETRA TECH COMPANY	client:	Creo Consultants	
approved	**SS**		project:	Merrimu Precinct Merrimu	
date	**09-Sep-20**		title:	**TEST PIT PHOTOGRAPHS TP118**	
scale	**N.T.S.**		project no: 754-MELGE233440.1	fig no:	rev:
original size	**A4**				

coffey
A TETRA TECH COMPANY

Engineering Log - Excavation

Excavation ID.	***TP119***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***06 Aug 2020***
principal:	date completed: ***06 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: Not Specified | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.5 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered			0.0		CH	**CLAY**: high plasticity, dark brown-brown, trace rootlets.	M	H			**TOPSOIL** **RESIDUAL SOIL - NEWER VOLCANICS**
						0.5		GC	**CLAYEY GRAVEL**: fine to coarse grained, grey-dark grey, mottled white, calcareous.	D	VD			**EXTREMELY WEATHERED BASALT** boulders seen on side walls R
						1.0			Refusal due to weathered rock Test pit TP119 terminated at 1.3 m Refusal					
						1.5								
						2.0								
						2.5								
						3.0								
						3.5								

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator
HT hand tools

support
N none
S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
D disturbed sample
B bulk disturbed sample
E environmental sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Test pit

Excavated spoil

drawn	RP	coffey A TETRA TECH COMPANY	client:	Creo Consultants	
approved	SS		project:	Merrimu Precinct Merrimu	
date	09-Sep-20		title:	**TEST PIT PHOTOGRAPHS TP119**	
scale	N.T.S.		project no: 754-MELGE233440.1	fig no:	rev:
original size	A4				

coffey
A TETRA TECH COMPANY

Engineering Log - Excavation

Excavation ID.	***TP120***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***06 Aug 2020***
principal:	date completed: ***06 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 277168; N: 5827987 (Datum Not Specified) | surface elevation: Not specified | pit orientation: E-W | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.5 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered	D		0.5		CH	**CLAY**: high plasticity, dark brown, trace rootlets.	M	Fb			**TOPSOIL**
											F - St			**RESIDUAL SOIL - NEWER VOLCANICS**
						1.0			becoming pale grey-yellow brown, mottled orange		H			
						1.5								
						2.0			Test pit TP120 terminated at 2.1 m Target depth					
						2.5								
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client: Creo Consultants

project: Merrimu Precinct
Merrimu

title: **TEST PIT PHOTOGRAPHS**
TP120

project no: 754-MELGE233440.1 | fig no: | rev:

coffey
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Engineering Log - Excavation

Excavation ID.	***TP121***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***06 Aug 2020***
principal:	date completed: ***06 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 277234; N: 5828492 (Datum Not Specified) | surface elevation: Not specified | pit orientation: N-S | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.5 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered			0.5		CH	**CLAY**: high plasticity, dark brown, trace rootlets.	M	Fb			**TOPSOIL**
											H			**RESIDUAL SOIL - NEWER VOLCANICS**
									encountered big boulders, pale grey-white	D				
						1.0			Refusal on weathered rock Test pit TP121 terminated at 0.8 m Refusal					R
						1.5								
						2.0								
						2.5								
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client:	Creo Consultants
project:	Merrimu Precinct Merrimu
title:	**TEST PIT PHOTOGRAPHS** **TP121**
project no: 754-MELGE233440.1	fig no: / rev:

coffey
A TETRA TECH COMPANY

Engineering Log - Excavation

Excavation ID.	***TP122***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***06 Aug 2020***
principal:	date completed: ***06 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 277569; N: 5827317 (Datum Not Specified) | surface elevation: Not specified | pit orientation: N-S | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered			0.5		CH	**CLAY**: high plasticity, dark brown, trace rootlets.	M	Fb			**TOPSOIL**
											H			**RESIDUAL SOIL - NEWER VOLCANICS**
										D				Boulders on side wall
				B		1.0		GC	**CLAYEY GRAVEL**: fine to coarse grained, pale brown-pale grey, mottled grey, calcareous mottling with boulders.		VD			**EXTREMELY WEATHERED BASALT**
														R
						1.5			Refusal due to weathered rock Test pit TP122 terminated at 1.4 m Refusal					
						2.0								
						2.5								
						3.0								
						3.5								

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator
HT hand tools

support
N none
S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
D disturbed sample
B bulk disturbed sample
E environmental sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TP122

Excavated spoil

drawn	**RP**
approved	**SS**
date	**09-Sep-20**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client: Creo Consultants

project: Merrimu Precinct
Merrimu

title: **TEST PIT PHOTOGRAPHS**
TP122

project no: 754-MELGE233440.1 | fig no: | rev:

coffey
A TETRA TECH COMPANY

Engineering Log - Excavation

Excavation ID.	***TP123***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***04 Aug 2020***
principal:	date completed: ***04 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 276318; N: 5830483 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
			Not Encountered	B		0.5			**TOPSOIL**: low liquid limit, brown with sand, trace rootlets.	M	Fb			**TOPSOIL**
								CH	**CLAY**: high plasticity, dark brown-pale brown, trace rootlets, trace fine to coarse grained gravel.		H			**RESIDUAL SOIL - NEWER VOLCANICS**
						1.0			grading gravelly becoming pale brown-orange mottled grey					R
						1.5		GP	**GRAVEL**: fine - coarse grained, pale brown, with fines, trace cobbles.		VD			**EXTREMELY WEATHERED BASALT**
						2.0			Refusal due to boulders and weathered rock Test pit TP123 terminated at 1.7 m Refusal					
						2.5								
						3.0								
						3.5								

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator
HT hand tools

support
N none
S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
D disturbed sample
B bulk disturbed sample
E environmental sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Test pit

Excavated spoil

drawn	**RP**	coffey A TETRA TECH COMPANY	client:	Creo Consultants	
approved	**SS**		project:	Merrimu Precinct Merrimu	
date	**09-Sep-20**		title:	**TEST PIT PHOTOGRAPHS TP123**	
scale	**N.T.S.**		project no: 754-MELGE233440.1	fig no:	rev:
original size	**A4**				

coffey
A TETRA TECH COMPANY

Engineering Log - Excavation

Excavation ID.	***TP124***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***04 Aug 2020***
principal:	date completed: ***04 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 276346; N: 5830103 (Datum Not Specified) | surface elevation: Not specified | pit orientation: | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered			0.0		ML	**TOPSOIL**: low liquid limit, brown with sand, trace rootlets.	M	Fb			**TOPSOIL**
								CH	**CLAY**: high plasticity, dark grey, mottled white, trace rootlets.		F - St			**RESIDUAL SOIL - NEWER VOLCANICS**
						0.5			becoming pale brown-orange, mottled pale grey		VSt - H			
						1.0			becoming pale grey, trace calcareous pockets					R
						1.5			Refusal on weathered rock Test pit TP124 terminated at 1.4 m Refusal					
						2.0								
						2.5								
						3.0								
						3.5								

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**	coffey A TETRA TECH COMPANY	client:	Creo Consultants	
approved	**SS**		project:	Merrimu Precinct Merrimu	
date	**09-Sep-20**		title:	**TEST PIT PHOTOGRAPHS TP124**	
scale	**N.T.S.**		project no: 754-MELGE233440.1	fig no:	rev:
original size	**A4**				

coffey
A TETRA TECH COMPANY

Engineering Log - Excavation

Excavation ID.	***TP125***
sheet:	1 of 1
project no.	***754-MELGE233440.1***
client: ***Creo Consultants***	date excavated: ***05 Aug 2020***
principal:	date completed: ***05 Aug 2020***
project: ***Merrimu Precinct***	logged by: ***MZ***
location: ***Merrimu***	checked by: ***SS***

position: E: 277235; N: 5829046 (Datum Not Specified) | surface elevation: Not specified | pit orientation: N-S | DCP id.: 8

equipment type: 15t Excavator | excavation method: E | excavation dimensions: 2.0 m long 0.5 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/100 mm) (2 4 6 8 10)	structure and additional observations
E	N		Not Encountered	B		0.5		CH	**CLAY**: high plasticity, dark brown-red brown, trace rootlets.	M	F - St			**TOPSOIL**
									becoming brown-red brown		H			**RESIDUAL SOIL - NEWER VOLCANICS**
						1.0		CH	**CLAY**: high plasticity, grey, mottled orange.					R
						1.5								
						2.0								
						2.5			Refusal on weathered rock Test pit TP125 terminated at 2.6 m Refusal					
						3.0								
						3.5								

CDF_0_9_07_LIBRARY.GLB rev:AU Log COF EXCAVATION + PSP/DCP 754-MELGE233440.1 (2).GPJ <<DrawingFile>> 01/09/2020 17:44

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator
- HT hand tools

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- VS vane shear peak/remouded (kPa)

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Test pit

Excavated spoil

drawn	**RP**	coffey A TETRA TECH COMPANY	client:	Creo Consultants	
approved	**SS**		project:	Merrimu Precinct Merrimu	
date	**09-Sep-20**		title:	**TEST PIT PHOTOGRAPHS TP125**	
scale	**N.T.S.**		project no: 754-MELGE233440.1	fig no:	rev:
original size	**A4**				

Appendix B – Results of laboratory testing

Material Test Report

Ground Science Pty Ltd
Ground Science Laboratory
13 Brock Street Thomastown Victoria 3074
Phone: (03) 9464 4617
Email: chris@groundscience.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Chris Senserrick
Laboratory Manager
NATA Accredited Laboratory Number: 15055

Report Number: **GS5387/1-1**
Issue Number: 1
Date Issued: 19/10/2020
Client: Coffey Information
Level 1, 436 Johnston St, Abbotsford, Melbourne VIC 3067
Contact: Farid Khayyer
Project Number: GS5387/1
Project Name: Merrimu Precinct
Project Location: Various
Client Reference: GS5387/1
Work Request: 483
Sample Number: 53871-S1
Date Sampled: 15/10/2020
Dates Tested: 15/10/2020 - 19/10/2020
Sample Location: **HA1B (0.2m)**

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	SILT, low to medium plasticity, brown.		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

Material Test Report

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Report Number: **GS5387/1-1**
Issue Number: 1
Date Issued: 19/10/2020
Client: Coffey Information
Level 1, 436 Johnston St, Abbotsford, Melbourne VIC 3067
Contact: Farid Khayyer
Project Number: GS5387/1
Project Name: Merrimu Precinct
Project Location: Various
Client Reference: GS5387/1
Work Request: 483
Sample Number: 53871-S2
Date Sampled: 15/10/2020
Dates Tested: 15/10/2020 - 19/10/2020
Sample Location: **HA1C (0.3m)**

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	SILT, low to medium plasticity, brown.		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

Material Test Report

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Report Number: **GS5387/1-1**
Issue Number: 1
Date Issued: 19/10/2020
Client: Coffey Information
Level 1, 436 Johnston St, Abbotsford, Melbourne VIC 3067
Contact: Farid Khayyer
Project Number: GS5387/1
Project Name: Merrimu Precinct
Project Location: Various
Client Reference: GS5387/1
Work Request: 483
Sample Number: 53871-S3
Date Sampled: 15/10/2020
Dates Tested: 15/10/2020 - 19/10/2020
Sample Location: **HA2C (0.3m)**

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	CLAY, low to medium plasticity, brown.		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

Material Test Report

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Issue Number: 1
Date Issued: 19/10/2020
Client: Coffey Information
Level 1, 436 Johnston St, Abbotsford, Melbourne VIC 3067
Contact: Farid Khayyer
Project Number: GS5387/1
Project Name: Merrimu Precinct
Project Location: Various
Client Reference: GS5387/1
Work Request: 483
Sample Number: 53871-S4
Date Sampled: 15/10/2020
Dates Tested: 15/10/2020 - 19/10/2020
Sample Location: **HA3B (0.4m)**

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	SILT, low to medium plasticity, brown.		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

Material Test Report

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Laboratory Manager
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Report Number: **GS5387/1-1**
Issue Number: 1
Date Issued: 19/10/2020
Client: Coffey Information
Level 1, 436 Johnston St, Abbotsford, Melbourne VIC 3067
Contact: Farid Khayyer
Project Number: GS5387/1
Project Name: Merrimu Precinct
Project Location: Various
Client Reference: GS5387/1
Work Request: 483
Sample Number: 53871-S5
Date Sampled: 15/10/2020
Dates Tested: 15/10/2020 - 19/10/2020
Sample Location: **HA3C (0.3m)**

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	SILT, low to medium plasticity, brown.		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

Material Test Report

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Issue Number: 1
Date Issued: 19/10/2020
Client: Coffey Information
Level 1, 436 Johnston St, Abbotsford, Melbourne VIC 3067
Contact: Farid Khayyer
Project Number: GS5387/1
Project Name: Merrimu Precinct
Project Location: Various
Client Reference: GS5387/1
Work Request: 483
Sample Number: 53871-S6
Date Sampled: 15/10/2020
Dates Tested: 15/10/2020 - 19/10/2020
Sample Location: **HA3D (0.3m)**

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	CLAY, low to medium plasticity, brown.		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

Material Test Report

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Report Number: **GS5387/1-1**
Issue Number: 1
Date Issued: 19/10/2020
Client: Coffey Information
Level 1, 436 Johnston St, Abbotsford, Melbourne VIC 3067
Contact: Farid Khayyer
Project Number: GS5387/1
Project Name: Merrimu Precinct
Project Location: Various
Client Reference: GS5387/1
Work Request: 483
Sample Number: 53871-S7
Date Sampled: 15/10/2020
Dates Tested: 15/10/2020 - 19/10/2020
Sample Location: **BH1 (11.5m)**

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	SILT, low to medium plasticity, brown.		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

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Report Number: **GS5387/1-1**
Issue Number: 1
Date Issued: 19/10/2020
Client: Coffey Information
Level 1, 436 Johnston St, Abbotsford, Melbourne VIC 3067
Contact: Farid Khayyer
Project Number: GS5387/1
Project Name: Merrimu Precinct
Project Location: Various
Client Reference: GS5387/1
Work Request: 483
Sample Number: 53871-S8
Date Sampled: 15/10/2020
Dates Tested: 15/10/2020 - 19/10/2020
Sample Location: **BH1 (10.5m)**

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	SILT, low to medium plasticity, brown.		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

Material Test Report

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Report Number: **GS5387/1-1**
Issue Number: 1
Date Issued: 19/10/2020
Client: Coffey Information
Level 1, 436 Johnston St, Abbotsford, Melbourne VIC 3067
Contact: Farid Khayyer
Project Number: GS5387/1
Project Name: Merrimu Precinct
Project Location: Various
Client Reference: GS5387/1
Work Request: 483
Sample Number: 53871-S9
Date Sampled: 15/10/2020
Dates Tested: 15/10/2020 - 19/10/2020
Sample Location: **BH4 (9.7m)**

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	CLAY, medium to high plasticity, brown.		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

Material Test Report

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Approved Signatory: Chris Senserrick
Laboratory Manager
NATA Accredited Laboratory Number: 15055

Report Number: **GS5387/1-1**
Issue Number: 1
Date Issued: 19/10/2020
Client: Coffey Information
Level 1, 436 Johnston St, Abbotsford, Melbourne VIC 3067
Contact: Farid Khayyer
Project Number: GS5387/1
Project Name: Merrimu Precinct
Project Location: Various
Client Reference: GS5387/1
Work Request: 483
Sample Number: 53871-S10
Date Sampled: 15/10/2020
Dates Tested: 15/10/2020 - 19/10/2020
Sample Location: **BH4 (10.7m)**

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	CLAY, medium to high plasticity, grey.		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

ACN 31 105 704 078

13 Brock Street, Thomastown, VIC P 03 9464 4617 Email reception@groundscience.com.au

Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MA**
Sample number:	#349		
Sample identification:	TP103 @ 1 - 1.5m		

Start time :

does the sample slake

[ ] no → [ ] 7 sample swells

[X] yes [ ] 8 no swell

time dispersion commences

start :

end:

[ ] 1 complete dispersion

[ ] 2 partial dispersion

[X] no dispersion

remoulded sample

[ ] 3 dispersion

time dispersion commences

start :

end:

[X] no dispersion

calcite / gypsum present

[X] 4 present

[ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

[ ] 5 disperses (remains cloudy)

[ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *gravelly CLAY, medium to high plasticity, brown, fine to coarse*

EMERSON CLASS NUMBER

4

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Chris Senserrick
Approved Signatory

Date: 26/08/2020

ACN 31 105 704 078

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Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MB**
Sample number:	#350		
Sample identification:	TP122 @ 1 - 1.50m		

Start time :

does the sample slake

- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start :

end:

- [X] no dispersion

calcite / gypsum present

- [X] 4 present
- [ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *silty CLAY, low plasticity, brown*

EMERSON CLASS NUMBER

4

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Chris Senserrick
Approved Signatory

Date: 26/08/2020

ACN 31 105 704 078

13 Brock Street, Thomastown, VIC P 03 9464 4617 Email reception@groundscience.com.au

Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MC**
Sample number:	#351		
Sample identification:	TP105 @ 1 - 1.5m		

Start time :

does the sample slake

- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start :

end:

- [X] no dispersion

calcite / gypsum present

- [X] 4 present
- [ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *CLAY, low to medium plasticity, brown*

EMERSON CLASS NUMBER

4

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Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MD**
Sample number:	#352		
Sample identification:	TP118 @ 0.0 - 0.5m		

Start time :

does the sample slake

- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start :

end:

- [X] no dispersion

calcite / gypsum present

- [ ] 4 present
- [X] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [X] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *CLAY/ SILT, high plasticity, brown*

EMERSON CLASS NUMBER

6

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Approved Signatory

Date: 26/08/2020

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Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**ME**
Sample number:	#353		
Sample identification:	TP123 @ 1.1 - 1.5m		

Start time :

does the sample slake

- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start :

end:

- [X] no dispersion

calcite / gypsum present

- [X] 4 present
- [ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *clayey SILT, medium to high plasticity, brown.*

EMERSON CLASS NUMBER

4

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Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MF**
Sample number:	#354		
Sample identification:	TP101 @ 1.15 - 1.5m		

Start time :

does the sample slake

[ ] no → [ ] 7 sample swells

[X] yes [ ] 8 no swell

time dispersion commences

start :

end:

[ ] 1 complete dispersion

[ ] 2 partial dispersion

[X] no dispersion

remoulded sample

[ ] 3 dispersion

time dispersion commences

start :

[X] no dispersion

end:

calcite / gypsum present

[X] 4 present

[ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

[ ] 5 disperses (remains cloudy)

[ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *silty CLAY, medium to high plasticity, brown*

EMERSON CLASS NUMBER

4

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Date: 26/08/2020

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13 Brock Street, Thomastown, VIC P 03 9464 4617 Email reception@groundscience.com.au

Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MG**
Sample number:	#355		
Sample identification:	TP105 @ 0.4 - 0.5m		

Start time :

does the sample slake

- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start :

end:

- [X] no dispersion

calcite / gypsum present

- [X] 4 present
- [ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *SILT, low to medium plasticity, brown*

EMERSON CLASS NUMBER

4

Chris Senserrick
Approved Signatory

Date: 26/08/2020

ACN 31 105 704 078
13 Brock Street, Thomastown, VIC P 03 9464 4617 Email reception@groundscience.com.au

Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MH**
Sample number:	#356		
Sample identification:	TP108 @ 2.5m		

Start time :

does the sample slake
- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences
start :
end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences
start :
end:

- [X] no dispersion

calcite / gypsum present

- [ ] 4 present
- [X] absent

5 :1 water: soil mix
10 mins of vigorous shaking

- [X] 5 disperses (remains cloudy)
- [ ] 6 floculates (clear at surface)

water type: *distilled*
water temp : *18"C*
description : *clayey SILT, medium to high plasticity, brown*

EMERSON CLASS NUMBER

5

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Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MI**
Sample number:	#357		
Sample identification:	TP109 @ 1.5m		

Start time :

does the sample slake

- [ ] no → [ ] 7 sample swells
- [X] yes → [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start :

end:

- [X] no dispersion

calcite / gypsum present

- [X] 4 present
- [ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *gravelly clayey SILT, medium to high plasticity, brown, fine to coarse*

EMERSON CLASS NUMBER

4

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ACN 31 105 704 078
13 Brock Street, Thomastown, VIC P 03 9464 4617 Email reception@groundscience.com.au

Test Results - Emerson Dispersion - AS1289 3.8.1

Client: COFFEY INFORMATION (ABBOTSFORD)
Job No. **GS5116/1**
Project: MERRIMU PRECINCT - ADDITIONAL TESTING
Date: **20/08/2002**
Location: -
Report No. **MJ**
Sample number: #358
Sample identification: TP110 @ 0.5m

Start time :

does the sample slake
[ ] no → [ ] 7 sample swells
[X] yes [ ] 8 no swell

time dispersion commences
start :
end:

[ ] 1 complete dispersion
[ ] 2 partial dispersion
[X] no dispersion

remoulded sample
[X] 3 dispersion

time dispersion commences
start : 8.30
end: 10.30
[ ] no dispersion

calcite / gypsum present
[ ] 4 present
[ ] absent

5 :1 water: soil mix
10 mins of vigorous shaking
[ ] 5 disperses (remains cloudy)
[ ] 6 floculates (clear at surface)

water type: *distilled*
water temp : *18"C*
description : *clayey SILT, medium to plasticity, brown*

EMERSON CLASS NUMBER

3

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Chris Senserrick
Approved Signatory

Date: 26/08/2020

ACN 31 105 704 078

13 Brock Street, Thomastown, VIC P 03 9464 4617 Email reception@groundscience.com.au

Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MK**
Sample number:	#359		
Sample identification:	TP114 @ 2.5m		

Start time :

does the sample slake

- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start : 8.30

end:

- [X] no dispersion

calcite / gypsum present

- [X] 4 present
- [ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *CLAY, medium to high plasticity, brown*

EMERSON CLASS NUMBER

4

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Chris Senserrick
Approved Signatory

Date: 26/08/2020

ACN 31 105 704 078

13 Brock Street, Thomastown, VIC P 03 9464 4617 Email reception@groundscience.com.au

Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**ML**
Sample number:	#360		
Sample identification:	TP115 @ 1.5 - 1.6m		

Start time :

does the sample slake

- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start : 8.30

end:

- [X] no dispersion

calcite / gypsum present

- [X] 4 present
- [ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *CLAY, medium to high plasticity, grey*

EMERSON CLASS NUMBER

4

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Test Results - Emerson Dispersion - AS1289 3.8.1

Client: COFFEY INFORMATION (ABBOTSFORD)

Job No. **GS5116/1**

Project: MERRIMU PRECINCT - ADDITIONAL TESTING

Date: **20/08/2002**

Location: -

Report No. **MM**

Sample number: #361

Sample identification: TP116 @ 0.5m

Start time :

does the sample slake

[ ] no → [ ] 7 sample swells

[X] yes [ ] 8 no swell

time dispersion commences

start :

end:

[ ] 1 complete dispersion

[X] 2 partial dispersion

[ ] no dispersion

remoulded sample

[X] 3 dispersion

time dispersion commences

start : 8.30

end:

[ ] no dispersion

calcite / gypsum present

[ ] 4 present

[ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

[ ] 5 disperses (remains cloudy)

[ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *silty CLAY, low to medium plasticity, brown.*

EMERSON CLASS NUMBER

3

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Date: 26/08/2020

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Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MN**
Sample number:	#362		
Sample identification:	TP120 @ 1.5m		

Start time :

does the sample slake

- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start : 8.30

end:

- [X] no dispersion

calcite / gypsum present

- [X] 4 present
- [ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *CLAY, medium to high plasticity, grey.*

EMERSON CLASS NUMBER

4

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Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MO**
Sample number:	#364		
Sample identification:	TP125 @ 1.2 - 1.5m		

Start time :

does the sample slake

- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start : 8.30

end:

- [X] no dispersion

calcite / gypsum present

- [ ] 4 present
- [X] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [X] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *CLAY, medium to high plasticity, grey*

EMERSON CLASS NUMBER

6

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Chris Senserrick
Approved Signatory

Date: 26/08/2020

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13 Brock Street, Thomastown, VIC P 03 9464 4617 Email reception@groundscience.com.au

Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MP**
Sample number:	#365		
Sample identification:	TP108 @ 0.5m		

Start time :

does the sample slake

- [ ] no → 7 sample swells
- [X] yes
- [ ] 8 no swell

time dispersion commences

start :

end:

- [ ] 1 complete dispersion
- [ ] 2 partial dispersion
- [X] no dispersion

remoulded sample

- [ ] 3 dispersion

time dispersion commences

start : 8.30

end:

- [X] no dispersion

calcite / gypsum present

- [X] 4 present
- [ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

- [ ] 5 disperses (remains cloudy)
- [ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *CLAY, medium to high plasticity, brown*

EMERSON CLASS NUMBER

4

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Approved Signatory

Date: 26/08/2020

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Test Results - Emerson Dispersion - AS1289 3.8.1

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Date:	**20/08/2002**
Location:	-	Report No.	**MQ**
Sample number:	#367		
Sample identification:	TP104 @ 0.0 - 0.5m		

Start time :

does the sample slake

[ ] no → [ ] 7 sample swells

[X] yes → [ ] 8 no swell

time dispersion commences

start :

end:

[ ] 1 complete dispersion

[ ] 2 partial dispersion

[X] no dispersion

remoulded sample

[ ] 3 dispersion

time dispersion commences

start : 8.30

[X] no dispersion

end:

calcite / gypsum present

[X] 4 present

[ ] absent

5 :1 water: soil mix

10 mins of vigorous shaking

[ ] 5 disperses (remains cloudy)

[ ] 6 floculates (clear at surface)

water type: *distilled*

water temp : *18"C*

description : *CLAY/SILT, low to medium plasticity, brown*

EMERSON CLASS NUMBER

4

Chris Senserrick
Approved Signatory

Date: 26/08/2020

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13 Brock Street Thomastown VIC, P 03 9464 4617 Email reception@groundscience.com.au

PERMEABILITY - FALLING HEAD AS1289 6.7.2

Client :	COFFEY INFORMATION (ABBOTSFORD)	Job No.	GS5116/1
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Report No.	MW
Location:	-	Test date:	31-Aug-20

Sample identification	TP103 @ 1 - 1.5m
Sample number	# 349
Source	-

Coefficient of permeability (m/sec)	SPECIMEN DID NOT SATURATE
Hydraulic Gradient	Various
Specimen compacted Density Ratio (%)	95
Specimen compacted Moisture ratio (%)	101
Surcharge applied to specimen (kPa)	3
Surcharge applied to specimen (kg)	5.5
Percentage of material retained (%)	1.1
Sieve Size used (mm)	19
specimen description	gravelly CLAY, medium to high plasticity, brown, fine to coarse

Notes:		Sample remoulded to a target of 98% SMDD @ OMC
Maximum Dry Density	t/m^3	1.36
Optimum Moisture Conten	%	33.0
Compaction test method		AS1289 5.1.1
Sampling Method		Sampled by client, tested as received
Comments		MDD and OMC obtained by standard compaction AS1289.5.1.1 Sample failed to saturate therefore deemed impermeable according to RC cop 500.16 4(e)

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Date of issue
2/09/2020

Aaron Stuart
Approved Signatory

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13 Brock Street Thomastown VIC, P 03 9464 4617 Email reception@groundscience.com.au

PERMEABILITY - FALLING HEAD AS1289 6.7.2

Client :	COFFEY INFORMATION (ABBOTSFORD)	Job No.	GS5116/1
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Report No.	MV
Location:	-	Test date:	31-Aug-20

Sample identification	TP122 @ 1 - 1.50m
Sample number	# 350
Source	-

Coefficient of permeability (m/sec)	3E-09
Hydraulic Gradient	Various
Specimen compacted Density Ratio (%)	95
Specimen compacted Moisture ratio (%)	100
Surcharge applied to specimen (kPa)	3
Surcharge applied to specimen (kg)	5.5
Percentage of material retained (%)	7.4
Sieve Size used (mm)	19
specimen description	silty CLAY, low plasticity, brown

Notes:		Sample remoulded to a target of 95% SMDD @ OMC
Maximum Dry Density	t/m^3	1.43
Optimum Moisture Conten	%	28.0
Compaction test method		AS1289 5.1.1
Sampling Method		Sampled by client, tested as received

Comments

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Date of issue
7/09/2020

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PERMEABILITY - FALLING HEAD AS1289 6.7.2

Client :	COFFEY INFORMATION (ABBOTSFORD)	Job No.	GS5116/1
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Report No.	MU
Location:	-	Test date:	31-Aug-20

Sample identification	TP105 @ 1 - 1.5m
Sample number	#351
Source	-

Coefficient of permeability (m/sec)	2E-09
Hydraulic Gradient	Various
Specimen compacted Density Ratio (%)	95
Specimen compacted Moisture ratio (%)	99
Surcharge applied to specimen (kPa)	3
Surcharge applied to specimen (kg)	5.5
Percentage of material retained (%)	0
Sieve Size used (mm)	19
specimen description	sandy SILT/CLAY, low to medium plasticity, brown, sand fine to coarse, trace gravel.

Notes: Sample remoulded to a target of 95% SMDD @ OMC

Maximum Dry Density	t/m^3	1.80
Optimum Moisture Conten	%	15.5
Compaction test method		AS1289 5.1.1
Sampling Method		Sampled by client, tested as received

Comments

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Date of issue 7/09/2020

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PERMEABILITY - FALLING HEAD AS1289 6.7.2

Client :	COFFEY INFORMATION (ABBOTSFORD)	Job No.	GS5116/1
Project:	MERRIMU PRECINCT	Report No.	MT
Location:	-	Test date:	02-Sep-20

Sample identification	TP23 @ 1.1 - 1.5m
Sample number	# 353
Source	-

Coefficient of permeability (m/sec)	5E-09
Hydraulic Gradient	Various
Specimen compacted Density Ratio (%)	95
Specimen compacted Moisture ratio (%)	98
Surcharge applied to specimen (kPa)	3
Surcharge applied to specimen (kg)	5.5
Percentage of material retained (%)	26
Sieve Size used (mm)	19
specimen description	gravelly CLAY, medium to high plasticity, brown, fine to coarse

Notes:		Sample remoulded to a target of 98% SMDD @ OMC
Maximum Dry Density	t/m^3	1.72
Optimum Moisture Conten	%	20.0
Compaction test method		AS1289 5.1.1
Sampling Method		Sampled by client, tested as received

Comments

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Date of issue
9/09/2020

Aaron Stuart
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Test Results - Pinhole Dispersion

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	GS5116/1
Project:	MERRIMU PROJECT	Report No.	MZ
Location	-	Test Date	01-Sep-20

Sample Number		#349
Sample Id		TP03
Depth		1 - 1.5m
Test Method		AS1289 3.8.3 - 2014
Soil Description		CLAY, medium plasticity, dark brown
Maxiumum Dry Density	t/m3	1.36
Optimum Moisture Content	%	33.0
Natural Moisture Content	%	32.7
Specimen Moisture Content	%	33.0
Bulk Density of Specimen	t/m3	1.718
Rate of Flow	mL/s	0.4
PINHOLE DISPERSION		
DESCRIPTION		D1
DESIGNATION		Highly Dispersive
Specimen cure period		> 48 HOURS
Water type		potable water
Note		Sample remoulded to a target of 98% SMDD @ OMC Specimen is based on material passing 2.36mm sieve only

Comments: Sampled by client, tested as received.
MDD & OMC tested in accordance with AS1289 5.1.1

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date: 8/09/2020

Approved Signatory: Ernie Gmehling

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Test Results - Pinhole Dispersion

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	GS5116/1
Project:	MERRIMU PROJECT	Report No.	NA
Location	-	Test Date	01-Sep-20

Sample Number		#350
Sample Id		TP22
Depth		1.0 - 1.5m
Test Method		AS1289 3.8.3 - 2014
Soil Description		clayey SILT, low to medium plasticity, dark brown
Maxiumum Dry Density	t/m3	1.43
Optimum Moisture Content	%	28.0
Natural Moisture Content	%	26.0
Specimen Moisture Content	%	27.9
Bulk Density of Specimen	t/m3	1.739
Rate of Flow	mL/s	3.8
PINHOLE DISPERSION		
DESCRIPTION		ND2
DESIGNATION		Completely Erosion Resistant
Specimen cure period		> 48 HOURS
Water type		potable water
Note		Sample remoulded to a target of 98% SMDD @ OMC Specimen is based on material passing 2.36mm sieve only
Comments		Sampled by client, tested as received. MDD & OMC tested in accordance with AS1289 5.1.1

NATA Accredited Laboratory No. 15055
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date: 8/09/2020

Approved Signatory Ernie Gmehling

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Test Results - Pinhole Dispersion

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	GS5116/1
Project:	MERRIMU PROJECT	Report No.	NB
Location	-	Test Date	01-Sep-20

Sample Number		#351
Sample Id		TP05
Depth		1.0 - 1.5m
Test Method		AS1289 3.8.3 - 2014
Soil Description		silty CLAY, medium plasticity, brown, trace gravel.
Maxiumum Dry Density	t/m3	1.80
Optimum Moisture Content	%	15.5
Natural Moisture Content	%	15.0
Specimen Moisture Content	%	14.9
Bulk Density of Specimen	t/m3	1.975
Rate of Flow	mL/s	2.5
PINHOLE DISPERSION		
DESCRIPTION		ND2
DESIGNATION		Completely Erosion Resistant
Specimen cure period		> 48 HOURS
Water type		potable water
Note		Sample remoulded to a target of 98% SMDD @ OMC Specimen is based on material passing 2.36mm sieve only
Comments		Sampled by client, tested as received. MDD & OMC tested in accordance with AS1289 5.1.1

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Test Results - Pinhole Dispersion

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	GS5116/1
Project:	MERRIMU PROJECT	Report No.	NC
Location	-	Test Date	01-Sep-20

Sample Number		#352
Sample Id		TP18
Depth		0.0 - 0.5m
Test Method		AS1289 3.8.3 - 2014
Soil Description		silty CLAY, low to medium plasticity, brown
Maxiumum Dry Density	t/m3	1.41
Optimum Moisture Content	%	24.5
Natural Moisture Content	%	25.2
Specimen Moisture Content	%	24.3
Bulk Density of Specimen	t/m3	1.668
Rate of Flow	mL/s	2.3
PINHOLE DISPERSION		
DESCRIPTION		ND2
DESIGNATION		Completely Erosion Resistant
Specimen cure period		> 48 HOURS
Water type		potable water
Note		Sample remoulded to a target of 98% SMDD @ OMC Specimen is based on material passing 2.36mm sieve only

Comments: Sampled by client, tested as received.
MDD & OMC tested in accordance with AS1289 5.1.1

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Test Results - Pinhole Dispersion

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	GS5116/1
Project:	MERRIMU PROJECT	Report No.	ND
Location	-	Test Date	01-Sep-20

Sample Number		#353
Sample Id		TP23
Depth		1.1 - 1.5m
Test Method		AS1289 3.8.3 - 2014
Soil Description		silty CLAY, low to medium plasticity, brown
Maxiumum Dry Density	t/m3	1.72
Optimum Moisture Content	%	20.0
Natural Moisture Content	%	19.6
Specimen Moisture Content	%	20.0
Bulk Density of Specimen	t/m3	1.961
Rate of Flow	mL/s	4.5
PINHOLE DISPERSION		
DESCRIPTION		ND2
DESIGNATION		Completely Erosion Resistant
Specimen cure period		> 48 HOURS
Water type		potable water
Note		Sample remoulded to a target of 98% SMDD @ OMC Specimen is based on material passing 2.36mm sieve only

Comments: Sampled by client, tested as received.
MDD & OMC tested in accordance with AS1289 5.1.1

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Approved Signatory: Ernie Gmehling

GroundScience
A C N 105 704 078
13 Brock Street, Thomastown, VIC P 03 9464 4617 **Email** reception@groundscience.com.au

Particle Size Distribution & Atterberg Limits Test Report

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Test Date:	**18-Aug-20**
Location:	-	Report No.	**LW**
Lab Reference No.	**#351**	Sample Identification:	**TP105 @ 1 - 1.5m**

Laboratory Specimen Classification: sandy SILT/CLAY, low to medium plasticity, brown, sand fine to coarse, trace gravel.

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	**100**	
75 mm	**100**	
53mm	**100**	
37.5 mm	**100**	
26.5 mm	**100**	
19.0 mm	**100**	
13.2 mm	**99**	
9.5 mm	**98**	
6.7 mm	**96**	
4.75 mm	**95**	
2.36 mm	**93**	
1.18 mm	**88**	
600 um	**84**	
425 um	**82**	
300 um	**80**	
150 um	**71**	
75 um	**61**	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	**ND**	
Plastic Limit	%	AS1289 3.2.1	**ND**	
Plasticity Index	%	AS1289 3.3.1	**ND**	
Linear Shrinkage	%	AS1289 3.4.1	**ND**	
Moisture Content	%	AS1289 2.1.1	**8.3**	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	-
Linear shrinkage mould length:	250 mm

ND = not determined NO = not obtainable NP = non plastic

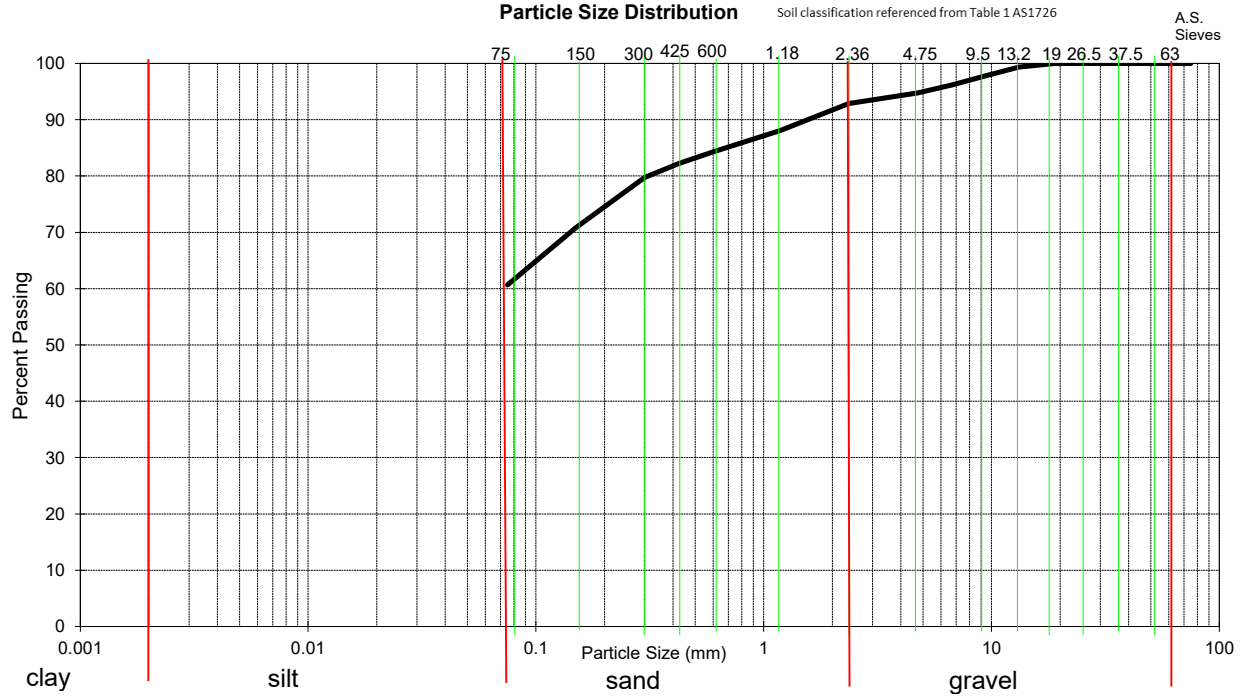
Moisture / Dry Density Relationship AS 1289 5.2.1

Maximum Dry Density: t/m^3

Optimum Moisture Content: %

Notes: Sampling Method Sampled by client, tested as received

Particle Size Distribution Soil classification referenced from Table 1 AS1726



Date: 26/08/2020

NATA Accredited Laboratory No. 15055
Accredited for compliance with ISO/IEC 17025 - Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/National Standards. .

Chris Senserrick
Approved Signatory

GroundScience
A C N 105 704 078
13 Brock Street, Thomastown, VIC P 03 9464 4617 **Email** reception@groundscience.com.au

Particle Size Distribution & Atterberg Limits Test Report

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Test Date:	**14-Aug-20**
Location:	-	Report No.	**LX**
Lab Reference No.	**#365**	Sample Identification:	**TP108 @ 0.5m**

Laboratory Specimen Classification: CLAY/SILT, medium to high plasticity, brown, trace sand.

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	**100**	
75 mm	**100**	
53mm	**100**	
37.5 mm	**100**	
26.5 mm	**100**	
19.0 mm	**100**	
13.2 mm	**100**	
9.5 mm	**100**	
6.7 mm	**100**	
4.75 mm	**100**	
2.36 mm	**100**	
1.18 mm	**100**	
600 um	**99**	
425 um	**98**	
300 um	**97**	
150 um	**95**	
75 um	**92**	

Consistency Limits and Moisture Content

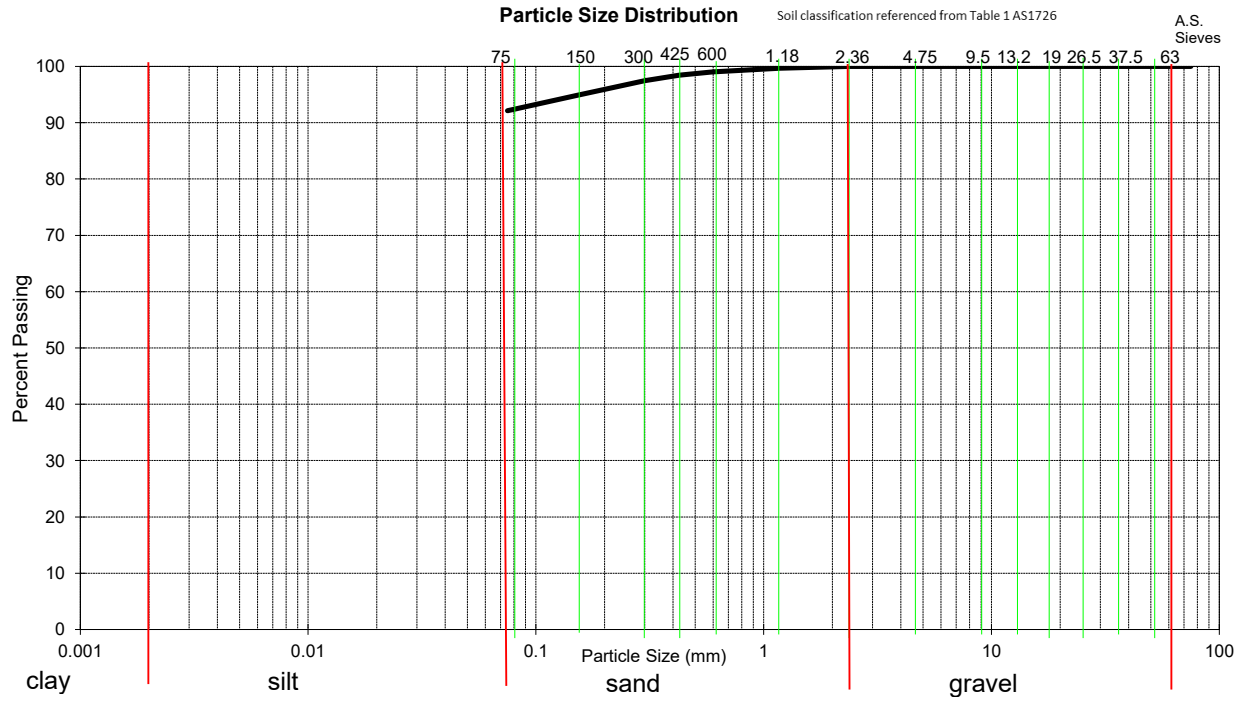
Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	**ND**	
Plastic Limit	%	AS1289 3.2.1	**ND**	
Plasticity Index	%	AS1289 3.3.1	**ND**	
Linear Shrinkage	%	AS1289 3.4.1	**ND**	
Moisture Content	%	AS1289 2.1.1	**27.9**	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	-
Linear shrinkage mould length:	250 mm

ND = not determined NO = not obtainable NP = non plastic

Moisture / Dry Density Relationship	AS 1289 5.2.1
Maximum Dry Density:	t/m^3
Optimum Moisture Content:	%

Notes: Sampling Method Sampled by client, tested as received



Date: 26/08/2020

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13 Brock Street, Thomastown, VIC P 03 9464 4617 **Email** reception@groundscience.com.au

Particle Size Distribution & Atterberg Limits Test Report

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Test Date:	**14-Aug-20**
Location:	-	Report No.	**LY**
Lab Reference No.	**#366**	Sample Identification:	**TP120 @ 1.5m**

Laboratory Specimen Classification: CLAY/SILT, medium to high plasticity, grey, trace sand.

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	**100**	
75 mm	**100**	
53mm	**100**	
37.5 mm	**100**	
26.5 mm	**100**	
19.0 mm	**100**	
13.2 mm	**100**	
9.5 mm	**100**	
6.7 mm	**100**	
4.75 mm	**100**	
2.36 mm	**100**	
1.18 mm	**100**	
600 um	**99**	
425 um	**98**	
300 um	**98**	
150 um	**95**	
75 um	**92**	

Consistency Limits and Moisture Content

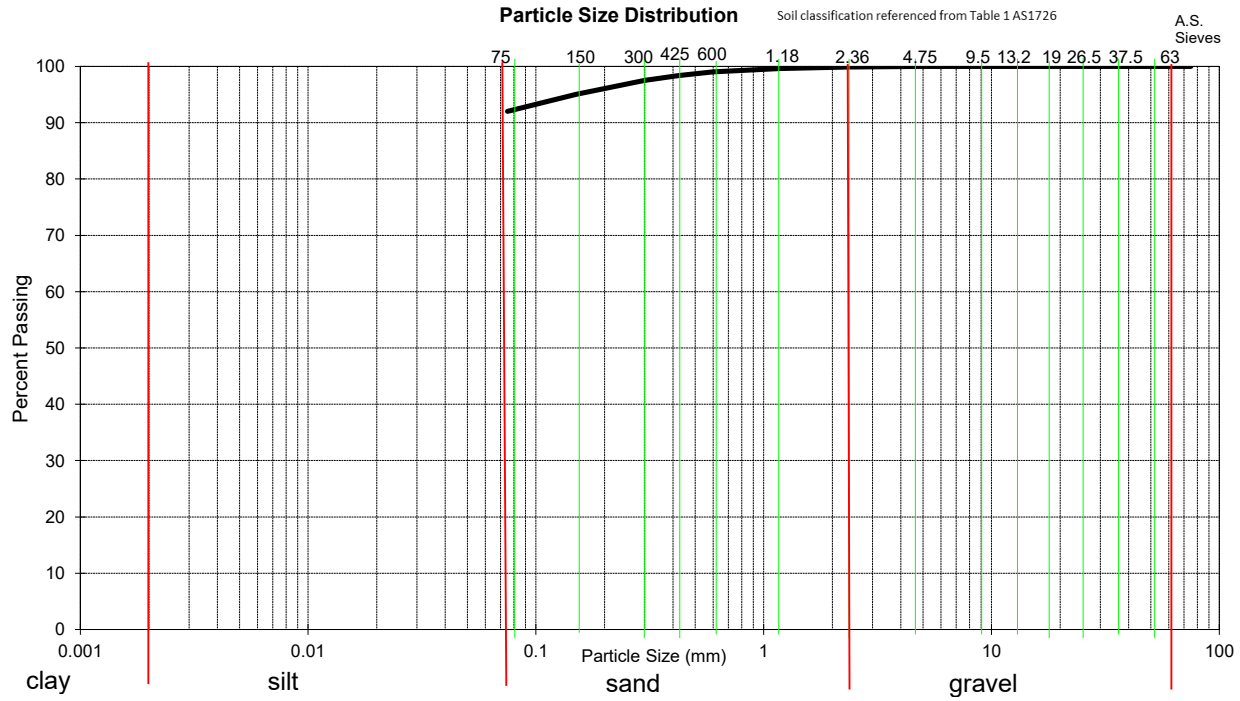
Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	**ND**	
Plastic Limit	%	AS1289 3.2.1	**ND**	
Plasticity Index	%	AS1289 3.3.1	**ND**	
Linear Shrinkage	%	AS1289 3.4.1	**ND**	
Moisture Content	%	AS1289 2.1.1	**34.6**	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	-
Linear shrinkage mould length:	250 mm

ND = not determined NO = not obtainable NP = non plastic

Moisture / Dry Density Relationship	AS 1289 5.2.1
Maximum Dry Density:	t/m^3
Optimum Moisture Content:	%

Notes: Sampling Method Sampled by client, tested as received



Date: 26/08/2020

NATA Accredited Laboratory No. 15055
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Chris Senserrick
Approved Signatory

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13 Brock Street, Thomastown, VIC P 03 9464 4617 **Email** reception@groundscience.com.au

Particle Size Distribution & Atterberg Limits Test Report

Client:	COFFEY INFORMATION (ABBOTSFORD)	Job No.	**GS5116/1**
Project:	MERRIMU PRECINCT - ADDITIONAL TESTING	Test Date:	**14-Aug-20**
Location:	-	Report No.	**LZ**
Lab Reference No.	**#367**	Sample Identification:	**TP104 @ 0.0 - 0.5m**

Laboratory Specimen Classification: CLAY/SILT, medium to high plasticity, brown, trace sand, trace gravel.

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	**100**	
75 mm	**100**	
53mm	**100**	
37.5 mm	**100**	
26.5 mm	**100**	
19.0 mm	**100**	
13.2 mm	**100**	
9.5 mm	**99**	
6.7 mm	**99**	
4.75 mm	**99**	
2.36 mm	**99**	
1.18 mm	**98**	
600 um	**98**	
425 um	**97**	
300 um	**97**	
150 um	**95**	
75 um	**95**	

Consistency Limits and Moisture Content

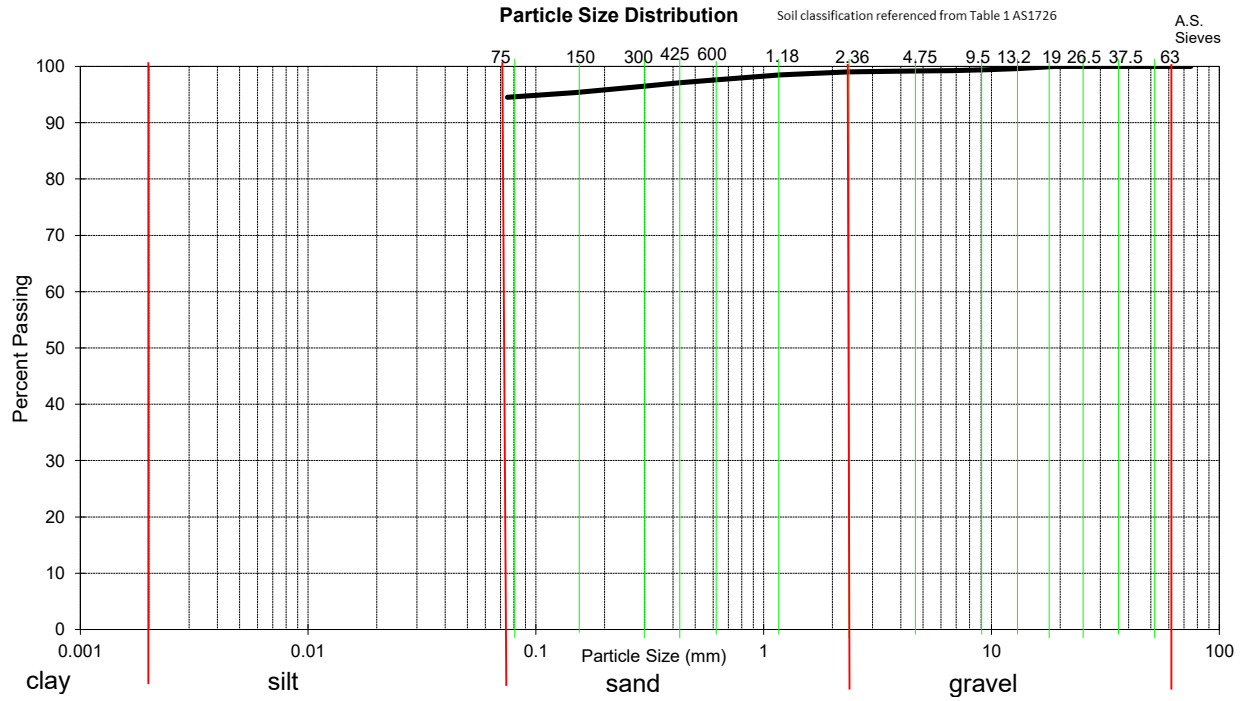
Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	**ND**	
Plastic Limit	%	AS1289 3.2.1	**ND**	
Plasticity Index	%	AS1289 3.3.1	**ND**	
Linear Shrinkage	%	AS1289 3.4.1	**ND**	
Moisture Content	%	AS1289 2.1.1	**22.7**	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	-
Linear shrinkage mould length:	250 mm

ND = not determined NO = not obtainable NP = non plastic

Moisture / Dry Density Relationship	AS 1289 5.2.1
Maximum Dry Density:	t/m^3
Optimum Moisture Content:	%

Notes: Sampling Method Sampled by client, tested as received



Date: 26/08/2020

NATA Accredited Laboratory No. 15055
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Chris Senserrick
Approved Signatory

Appendix C – Results of laboratory testing (chemical)

Coffey Environments Pty Ltd VIC
Level 1, 436 Johnston Street
Abbotsford
VIC 3067

Attention: **Michael Jamieson**

Report **750523-S**
Project name
Project ID 754MELGE23340
Received Date Oct 13, 2020

Client Sample ID			**HA-1B_0.20**	**HA-1C_0.30**	**HA-2C_0.30**	**HA-3B_0.40**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Oc24625**	**M20-Oc24626**	**M20-Oc24627**	**M20-Oc24628**
Date Sampled			**Oct 07, 2020**	**Oct 07, 2020**	**Oct 07, 2020**	**Oct 07, 2020**
Test/Reference	LOR	Unit				
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	29	10	730	17
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	7.9	7.4	9.4	7.3
Exchangeable Sodium Percentage (ESP)	0.1	%	6.1	7.2	6.5	6.6
% Moisture	1	%	4.2	7.3	12	2.7

Client Sample ID			**HA-3C_0.30**	**HA-3D_0.30**	**BH 1_11.5**	**BH 1_10.5**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Oc24629**	**M20-Oc24630**	**M20-Oc24631**	**M20-Oc24632**
Date Sampled			**Oct 07, 2020**	**Oct 07, 2020**	**Oct 07, 2020**	**Oct 07, 2020**
Test/Reference	LOR	Unit				
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	270	110	47	67
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	9.3	9.5	9.4	9.4
Exchangeable Sodium Percentage (ESP)	0.1	%	9.6	4.9	22	32
% Moisture	1	%	12	13	9.3	11

Client Sample ID			**BH 4_9.7**	**BH 4_10.7**
Sample Matrix			**Soil**	**Soil**
Eurofins Sample No.			**M20-Oc24633**	**M20-Oc24634**
Date Sampled			**Oct 07, 2020**	**Oct 07, 2020**
Test/Reference	LOR	Unit		
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	360	370
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	8.6	9.4
Exchangeable Sodium Percentage (ESP)	0.1	%	23	11
% Moisture	1	%	13	12

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Conductivity (1:5 aqueous extract at 25°C as rec.)	Melbourne	Oct 16, 2020	7 Days
- Method: LTM-INO-4030 Conductivity			
pH (1:5 Aqueous extract at 25°C as rec.)	Melbourne	Oct 16, 2020	7 Days
- Method: LTM-GEN-7090 pH in soil by ISE			
Exchangeable Sodium Percentage (ESP)	Melbourne	Oct 19, 2020	28 Days
- Method: LTM-MET-3060 - Cation Exchange Capacity (CEC) & Exchangeable Sodium Percentage (ESP)			
% Moisture	Melbourne	Oct 16, 2020	14 Days
- Method: LTM-GEN-7080 Moisture			

eurofins | Environment Testing

ABN: 50 005 085 521 web: www.eurofins.com.au email: EnviroSales@eurofins.com

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Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
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Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Newcastle
4/52 Industrial Drive
Mayfield East NSW 2304
PO Box 60 Wickham 2293
Phone : +61 2 4968 8448

New Zealand

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Penrose, Auckland 1061
Phone : +64 9 526 45 51
IANZ # 1327

Christchurch
43 Detroit Drive
Rolleston, Christchurch 7675
Phone : 0800 856 450
IANZ # 1290

Company Name: Coffey Environments Pty Ltd VIC
Address: Level 1, 436 Johnston Street
Abbotsford
VIC 3067

Project Name:
Project ID: 754MELGE23340

Order No.:
Report #: 750523
Phone: 03 9290 7000
Fax:

Received: Oct 13, 2020 1:30 PM
Due: Oct 20, 2020
Priority: 5 Day
Contact Name: Michael Jamieson

Eurofins Analytical Services Manager : Harry Bacalis

Sample Detail						Conductivity (1:5 aqueous extract at 25°C as rec.)	Exchangeable Sodium Percentage (ESP)	pH (1:5 Aqueous extract at 25°C as rec.)	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X
Sydney Laboratory - NATA Site # 18217									
Brisbane Laboratory - NATA Site # 20794									
Perth Laboratory - NATA Site # 23736									
Mayfield Laboratory									
External Laboratory									
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**				
1	HA-1B_0.20	Oct 07, 2020		Soil	M20-Oc24625	X	X	X	X
2	HA-1C_0.30	Oct 07, 2020		Soil	M20-Oc24626	X	X	X	X
3	HA-2C_0.30	Oct 07, 2020		Soil	M20-Oc24627	X	X	X	X
4	HA-3B_0.40	Oct 07, 2020		Soil	M20-Oc24628	X	X	X	X
5	HA-3C_0.30	Oct 07, 2020		Soil	M20-Oc24629	X	X	X	X
6	HA-3D_0.30	Oct 07, 2020		Soil	M20-Oc24630	X	X	X	X
7	BH 1_11.5	Oct 07, 2020		Soil	M20-Oc24631	X	X	X	X
8	BH 1_10.5	Oct 07, 2020		Soil	M20-Oc24632	X	X	X	X
9	BH 4_9.7	Oct 07, 2020		Soil	M20-Oc24633	X	X	X	X

eurofins | Environment Testing

ABN: 50 005 085 521 web: www.eurofins.com.au email: EnviroSales@eurofins.com

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Phone : 0800 856 450
IANZ # 1290

Company Name: Coffey Environments Pty Ltd VIC
Address: Level 1, 436 Johnston Street
Abbotsford
VIC 3067

Project Name:
Project ID: 754MELGE23340

Order No.:
Report #: 750523
Phone: 03 9290 7000
Fax:

Received: Oct 13, 2020 1:30 PM
Due: Oct 20, 2020
Priority: 5 Day
Contact Name: Michael Jamieson

Eurofins Analytical Services Manager : Harry Bacalis

Sample Detail						Conductivity (1:5 aqueous extract at 25°C as rec.)	Exchangeable Sodium Percentage (ESP)	pH (1:5 Aqueous extract at 25°C as rec.)	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X
Sydney Laboratory - NATA Site # 18217									
Brisbane Laboratory - NATA Site # 20794									
Perth Laboratory - NATA Site # 23736									
Mayfield Laboratory									
External Laboratory									
10	BH 4_10.7	Oct 07, 2020		Soil	M20-Oc24634	X	X	X	X
Test Counts						10	10	10	10

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram

mg/L: milligrams per litre

ug/L: micrograms per litre

ppm: Parts per million

ppb: Parts per billion

%: Percentage

org/100mL: Organisms per 100 millilitres

NTU: Nephelometric Turbidity Units

MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Conductivity (1:5 aqueous extract at 25°C as rec.)	uS/cm	< 10			10	Pass	
Exchangeable Sodium Percentage (ESP)	%	< 0.1			0.1	Pass	
LCS - % Recovery							
Conductivity (1:5 aqueous extract at 25°C as rec.)	%	97			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (1:5 aqueous extract at 25°C as rec.)	M20-Oc24627	CP	uS/cm	730	630	15	30%	Pass	
pH (1:5 Aqueous extract at 25°C as rec.)	M20-Oc24627	CP	pH Units	9.4	9.5	pass	30%	Pass	
% Moisture	M20-Oc24627	CP	%	12	12	1.0	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Harry Bacalis	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal (VIC)
Scott Beddoes	Senior Analyst-Inorganic (VIC)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Ground Science
13 Brock St
Thomastown
VIC 3074

Attention: **Tim Senserrick**

Report **738426-S-V2**
Project name MERRIMU PRECINT-ADDITIONAL TESTING
Project ID GS5116/1 COFFEY MELBOURNE
Received Date Aug 18, 2020

Client Sample ID			**#359 SAMPLE TP114**	**#360 SAMPLE TP115**	**#362 SAMPLE TP120**	**#363 SAMPLE TP122**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Au26035**	**M20-Au26036**	**M20-Au26037**	**M20-Au26038**
Date Sampled			**Aug 17, 2020**	**Aug 17, 2020**	**Aug 17, 2020**	**Aug 17, 2020**
Test/Reference	LOR	Unit				
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	2000	2300	2400	290
Exchangeable Sodium Percentage (ESP)	0.1	%	26	26	24	4.7
% Moisture	1	%	27	26	26	14

Client Sample ID			**#365 SAMPLE TP108**	**#367 SAMPLE TP104**
Sample Matrix			**Soil**	**Soil**
Eurofins Sample No.			**M20-Au26039**	**M20-Au26040**
Date Sampled			**Aug 17, 2020**	**Aug 17, 2020**
Test/Reference	LOR	Unit		
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	-	210
Exchangeable Sodium Percentage (ESP)	0.1	%	19	2.8
% Moisture	1	%	23	18

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Conductivity (1:5 aqueous extract at 25°C as rec.)	Melbourne	Aug 19, 2020	7 Days
- Method: LTM-INO-4030 Conductivity			
Exchangeable Sodium Percentage (ESP)	Melbourne	Aug 19, 2020	28 Days
- Method: LTM-MET-3060 - Cation Exchange Capacity (CEC) & Exchangeable Sodium Percentage (ESP)			
% Moisture	Melbourne	Aug 18, 2020	14 Days
- Method: LTM-GEN-7080 Moisture			

eurofins | Environment Testing

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NATA # 1261
Site # 1254 & 14271

Sydney
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Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
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NATA # 1261 Site # 20794

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Newcastle
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Christchurch
43 Detroit Drive
Rolleston, Christchurch 7675
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IANZ # 1290

Company Name: Ground Science
Address: 13 Brock St
Thomastown
VIC 3074

Project Name: MERRIMU PRECINT-ADDITIONAL TESTING
Project ID: GS5116/1 COFFEY MELBOURNE

Order No.: ENG 146
Report #: 738426
Phone: 9464 4617
Fax: 9464 4618

Received: Aug 18, 2020 10:00 AM
Due: Aug 25, 2020
Priority: 5 Day
Contact Name: Tim Senserrick

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Conductivity (1:5 aqueous extract at 25°C as rec.)	Exchangeable Sodium Percentage (ESP)	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X
Sydney Laboratory - NATA Site # 18217								
Brisbane Laboratory - NATA Site # 20794								
Perth Laboratory - NATA Site # 23736								
Newcastle Laboratory								
External Laboratory								
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**			
1	#359 SAMPLE TP14	Aug 17, 2020		Soil	M20-Au26035	X	X	X
2	#360 SAMPLE TP15	Aug 17, 2020		Soil	M20-Au26036	X	X	X
3	#362 SAMPLE TP20	Aug 17, 2020		Soil	M20-Au26037	X	X	X
4	#363 SAMPLE TP22	Aug 17, 2020		Soil	M20-Au26038	X	X	X
5	#365 SAMPLE TP8	Aug 17, 2020		Soil	M20-Au26039	X	X	X
6	#367 SAMPLE	Aug 17, 2020		Soil	M20-Au26040	X	X	X

eurofins | Environment Testing

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Rolleston, Christchurch 7675
Phone : 0800 856 450
IANZ # 1290

Company Name:	Ground Science	**Order No.:**	ENG 146	**Received:**	Aug 18, 2020 10:00 AM
Address:	13 Brock St Thomastown VIC 3074	**Report #:**	738426	**Due:**	Aug 25, 2020
		Phone:	9464 4617	**Priority:**	5 Day
		Fax:	9464 4618	**Contact Name:**	Tim Senserrick
Project Name:	MERRIMU PRECINT-ADDITIONAL TESTING				
Project ID:	GS5116/1 COFFEY MELBOURNE				

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail	Conductivity (1:5 aqueous extract at 25°C as rec.)	Exchangeable Sodium Percentage (ESP)	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271	X	X	X
Sydney Laboratory - NATA Site # 18217			
Brisbane Laboratory - NATA Site # 20794			
Perth Laboratory - NATA Site # 23736			
TP4			
Test Counts	6	6	6

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram | **mg/L:** milligrams per litre | **ug/L:** micrograms per litre

ppm: Parts per million | **ppb:** Parts per billion | **%:** Percentage

org/100mL: Organisms per 100 millilitres | **NTU:** Nephelometric Turbidity Units | **MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (1:5 aqueous extract at 25°C as rec.)	B20-Au03522	NCP	uS/cm	17	18	2.8	30%	Pass	
% Moisture	M20-Au25825	NCP	%	20	20	3.0	30%	Pass	

Comments

V2: Report updated with amended sample IDs as per client request.

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	No
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Savini Suduweli	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal (VIC)
Scott Beddoes	Senior Analyst-Inorganic (VIC)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Ground Science
13 Brock St
Thomastown
VIC 3074

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Tim Senserrick**

Report **739362-S**
Project name COFFEY (MELBOURNE)
Project ID GS5116/1
Received Date Aug 21, 2020

Client Sample ID			**#349 SAMPLE TP103**	**#350 SAMPLE TP122**	**#351 SAMPLE TP105**	**#352 SAMPLE TP118**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Au34034**	**M20-Au34035**	**M20-Au34036**	**M20-Au34037**
Date Sampled			**Aug 19, 2020**	**Aug 19, 2020**	**Aug 19, 2020**	**Aug 19, 2020**
Test/Reference	LOR	Unit				
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	1600	-	280	-
Exchangeable Sodium Percentage (ESP)	0.1	%	23	-	-	-
% Moisture	1	%	24	16	7.8	21
Exchangeable Sodium Percentage (ESP)						
Exchangeable Sodium Percentage (ESP)	0.1	%	-	4.5	5.0	2.6

Client Sample ID			**#353 SAMPLE TP123**	**#354 SAMPLE TP101**	**#355 SAMPLE TP105**	**#356 SAMPLE TP108**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Au34038**	**M20-Au34039**	**M20-Au34040**	**M20-Au34041**
Date Sampled			**Aug 19, 2020**	**Aug 19, 2020**	**Aug 19, 2020**	**Aug 19, 2020**
Test/Reference	LOR	Unit				
% Moisture	1	%	17	21	11	27
Exchangeable Sodium Percentage (ESP)						
Exchangeable Sodium Percentage (ESP)	0.1	%	3.3	18	2.0	32

Client Sample ID			**#357 SAMPLE TP9**
Sample Matrix			**Soil**
Eurofins Sample No.			**M20-Au34042**
Date Sampled			**Aug 19, 2020**
Test/Reference	LOR	Unit	
% Moisture	1	%	21
Exchangeable Sodium Percentage (ESP)			
Exchangeable Sodium Percentage (ESP)	0.1	%	16

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Conductivity (1:5 aqueous extract at 25°C as rec.)	Melbourne	Aug 25, 2020	7 Days
- Method: LTM-INO-4030 Conductivity			
Exchangeable Sodium Percentage (ESP)	Melbourne	Aug 25, 2020	28 Days
- Method: LTM-MET-3060 - Cation Exchange Capacity (CEC) & Exchangeable Sodium Percentage (ESP)			
Exchangeable Sodium Percentage (ESP)	Melbourne	Aug 25, 2020	28 Days
- Method: LTM-MET-3060 Cation Exchange Capacity (CEC) & Exchangeable Sodium Percentage (ESP)			
% Moisture	Melbourne	Aug 21, 2020	14 Days
- Method: LTM-GEN-7080 Moisture			

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Company Name: Ground Science
Address: 13 Brock St
Thomastown
VIC 3074

Project Name: COFFEY (MELBOURNE)
Project ID: GS5116/1

Order No.: ENG 148
Report #: 739362
Phone: 9464 4617
Fax: 9464 4618

Received: Aug 21, 2020 2:53 PM
Due: Aug 28, 2020
Priority: 5 Day
Contact Name: Tim Senserrick

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Moisture Set	Exchangeable Sodium Percentage (ESP)
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
Perth Laboratory - NATA Site # 23736							
Newcastle Laboratory							
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	#349 SAMPLE TP03	Aug 19, 2020		Soil	M20-Au34034	X	X
2	#350 SAMPLE TP22	Aug 19, 2020		Soil	M20-Au34035	X	X
3	#351 SAMPLE TP05	Aug 19, 2020		Soil	M20-Au34036	X	X
4	#352 SAMPLE TP18	Aug 19, 2020		Soil	M20-Au34037	X	X
5	#353 SAMPLE TP23	Aug 19, 2020		Soil	M20-Au34038	X	X
6	#354 SAMPLE	Aug 19, 2020		Soil	M20-Au34039	X	X

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Project Name: COFFEY (MELBOURNE)
Project ID: GS5116/1

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Received: Aug 21, 2020 2:53 PM
Due: Aug 28, 2020
Priority: 5 Day
Contact Name: Tim Senserrick

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Moisture Set	Exchangeable Sodium Percentage (ESP)
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
Perth Laboratory - NATA Site # 23736							
	TP1						
7	#355 SAMPLE TP5	Aug 19, 2020		Soil	M20-Au34040	X	X
8	#356 SAMPLE TP8	Aug 19, 2020		Soil	M20-Au34041	X	X
9	#357 SAMPLE TP9	Aug 19, 2020		Soil	M20-Au34042	X	X
Test Counts						9	9

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram | **mg/L:** milligrams per litre | **ug/L:** micrograms per litre

ppm: Parts per million | **ppb:** Parts per billion | **%:** Percentage

org/100mL: Organisms per 100 millilitres | **NTU:** Nephelometric Turbidity Units | **MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Conductivity (1:5 aqueous extract at 25°C as rec.)	uS/cm	< 10			10	Pass	
LCS - % Recovery							
Conductivity (1:5 aqueous extract at 25°C as rec.)	%	107			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	M20-Au34042	CP	%	21	20	4.0	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Savini Suduweli	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal (VIC)
Scott Beddoes	Senior Analyst-Inorganic (VIC)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Ground Science
13 Brock St
Thomastown
VIC 3074

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Tim Senserrick**

Report **741006-S**
Project name MERRIMU PRECINCT
Project ID GS5116/1 COFFEY (MELBOURNE)
Received Date Aug 31, 2020

Client Sample ID			**#359 SAMPLE TP114**	**#360 SAMPLE TP115**	**#362 SAMPLE TP120**	**#363 SAMPLE TP122**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Au50117**	**M20-Au50118**	**M20-Au50119**	**M20-Au50120**
Date Sampled			**Aug 17, 2020**	**Aug 17, 2020**	**Aug 17, 2020**	**Aug 17, 2020**
Test/Reference	LOR	Unit				
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	-	-	-	-
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	9.0	8.7	9.0	8.8
% Moisture	1	%	26	25	24	15

Client Sample ID			**#365 SAMPLE TP108**	**#367 SAMPLE TP104**	**#349 SAMPLE TP103**	**#350 SAMPLE TP122**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Au50121**	**M20-Au50122**	**M20-Au50123**	**M20-Au50124**
Date Sampled			**Aug 17, 2020**	**Aug 17, 2020**	**Aug 19, 2020**	**Aug 19, 2020**
Test/Reference	LOR	Unit				
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	1300	-	-	-
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	8.8	8.6	9.2	-
% Moisture	1	%	24	18	22	-

Client Sample ID			**#351 SAMPLE TP5**	**#352 SAMPLE TP18**	**#353 SAMPLE TP23**	**#354 SAMPLE TP1**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Au50125**	**M20-Au50126**	**M20-Au50127**	**M20-Au50128**
Date Sampled			**Aug 19, 2020**	**Aug 19, 2020**	**Aug 19, 2020**	**Aug 19, 2020**
Test/Reference	LOR	Unit				
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	280	55	79	1000
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	9.2	7.4	9.1	9.3
% Moisture	1	%	8.1	22	15	21

Client Sample ID			#355 SAMPLE TP105	#356 SAMPLE TP108	#357 SAMPLE TP109
Sample Matrix			**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Au50129**	**M20-Au50130**	**M20-Au50131**
Date Sampled			**Aug 19, 2020**	**Aug 19, 2020**	**Aug 19, 2020**
Test/Reference	LOR	Unit			
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	96	1700	1200
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	9.1	8.2	9.2
% Moisture	1	%	10	26	20

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Conductivity (1:5 aqueous extract at 25°C as rec.)	Melbourne	Sep 01, 2020	7 Days
- Method: LTM-INO-4030 Conductivity			
pH (1:5 Aqueous extract at 25°C as rec.)	Melbourne	Aug 31, 2020	7 Days
- Method: LTM-GEN-7090 pH in soil by ISE			
% Moisture	Melbourne	Aug 31, 2020	14 Days
- Method: LTM-GEN-7080 Moisture			

eurofins | Environment Testing

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NATA # 1261 Site # 18217

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NATA # 1261 Site # 20794

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Company Name:	Ground Science	**Order No.:**	
Address:	13 Brock St Thomastown VIC 3074	**Report #:**	741006
		Phone:	9464 4617
		Fax:	9464 4618
Project Name:	MERRIMU PRECINCT		
Project ID:	GS5116/1 COFFEY (MELBOURNE)		

Received:	Aug 31, 2020 9:52 AM
Due:	Sep 7, 2020
Priority:	5 Day
Contact Name:	Tim Senserrick

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Conductivity (1:5 aqueous extract at 25°C as rec.)	pH (1:5 Aqueous extract at 25°C as rec.)	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X
Sydney Laboratory - NATA Site # 18217								
Brisbane Laboratory - NATA Site # 20794								
Perth Laboratory - NATA Site # 23736								
Newcastle Laboratory								
External Laboratory								
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**			
1	#359 SAMPLE TP14	Aug 17, 2020		Soil	M20-Au50117	X	X	X
2	#360 SAMPLE TP15	Aug 17, 2020		Soil	M20-Au50118	X	X	X
3	#362 SAMPLE TP20	Aug 17, 2020		Soil	M20-Au50119	X	X	X
4	#363 SAMPLE TP22	Aug 17, 2020		Soil	M20-Au50120	X	X	X
5	#365 SAMPLE TP8	Aug 17, 2020		Soil	M20-Au50121	X	X	X
6	#367 SAMPLE	Aug 17, 2020		Soil	M20-Au50122	X	X	X

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Project Name: MERRIMU PRECINCT
Project ID: GS5116/1 COFFEY (MELBOURNE)

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Priority: 5 Day
Contact Name: Tim Senserrick

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Conductivity (1:5 aqueous extract at 25°C as rec.)	pH (1:5 Aqueous extract at 25°C as rec.)	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X
Sydney Laboratory - NATA Site # 18217								
Brisbane Laboratory - NATA Site # 20794								
Perth Laboratory - NATA Site # 23736								
	TP4							
7	#349 SAMPLE TP3	Aug 19, 2020		Soil	M20-Au50123	X	X	X
8	#350 SAMPLE TP22	Aug 19, 2020		Soil	M20-Au50124	X	X	X
9	#351 SAMPLE TP5	Aug 19, 2020		Soil	M20-Au50125	X	X	X
10	#352 SAMPLE TP18	Aug 19, 2020		Soil	M20-Au50126	X	X	X
11	#353 SAMPLE TP23	Aug 19, 2020		Soil	M20-Au50127	X	X	X
12	#354 SAMPLE TP1	Aug 19, 2020		Soil	M20-Au50128	X	X	X
13	#355 SAMPLE TP5	Aug 19, 2020		Soil	M20-Au50129	X	X	X

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Received: Aug 31, 2020 9:52 AM
Due: Sep 7, 2020
Priority: 5 Day
Contact Name: Tim Senserrick

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Conductivity (1:5 aqueous extract at 25°C as rec.)	pH (1:5 Aqueous extract at 25°C as rec.)	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X
Sydney Laboratory - NATA Site # 18217								
Brisbane Laboratory - NATA Site # 20794								
Perth Laboratory - NATA Site # 23736								
14	#356 SAMPLE TP8	Aug 19, 2020		Soil	M20-Au50130	X	X	X
15	#357 SAMPLE TP9	Aug 19, 2020		Soil	M20-Au50131	X	X	X
Test Counts						15	15	15

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram
mg/L: milligrams per litre
ug/L: micrograms per litre
ppm: Parts per million
ppb: Parts per billion
%: Percentage
org/100mL: Organisms per 100 millilitres
NTU: Nephelometric Turbidity Units
MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank									
Conductivity (1:5 aqueous extract at 25°C as rec.)			uS/cm	< 10			10	Pass	
LCS - % Recovery									
Conductivity (1:5 aqueous extract at 25°C as rec.)			%	97			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (1:5 aqueous extract at 25°C as rec.)	M20-Au50122	CP	uS/cm	120	130	9.7	30%	Pass	
pH (1:5 Aqueous extract at 25°C as rec.)	M20-Au50122	CP	pH Units	8.6	8.6	pass	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	M20-Au50124	CP	%	15	13	16	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Savini Suduweli	Analytical Services Manager
Scott Beddoes	Senior Analyst-Inorganic (VIC)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

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