Urban Geological Mapping Project
Report 2

Ulverstone Engineering Geology Project

Mineral Resources Tasmania
Department of Infrastructure, Energy and Resources

Tasmania
Explore the possibilities

Cover: *Looking southwest from Braddons Lookout over the alluvial plains bordering the River Forth on the eastern margin of the study area, with the higher ground formed of Tertiary basalt and older rocks rising in the background.*

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REPORT 2

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Report prepared 1994
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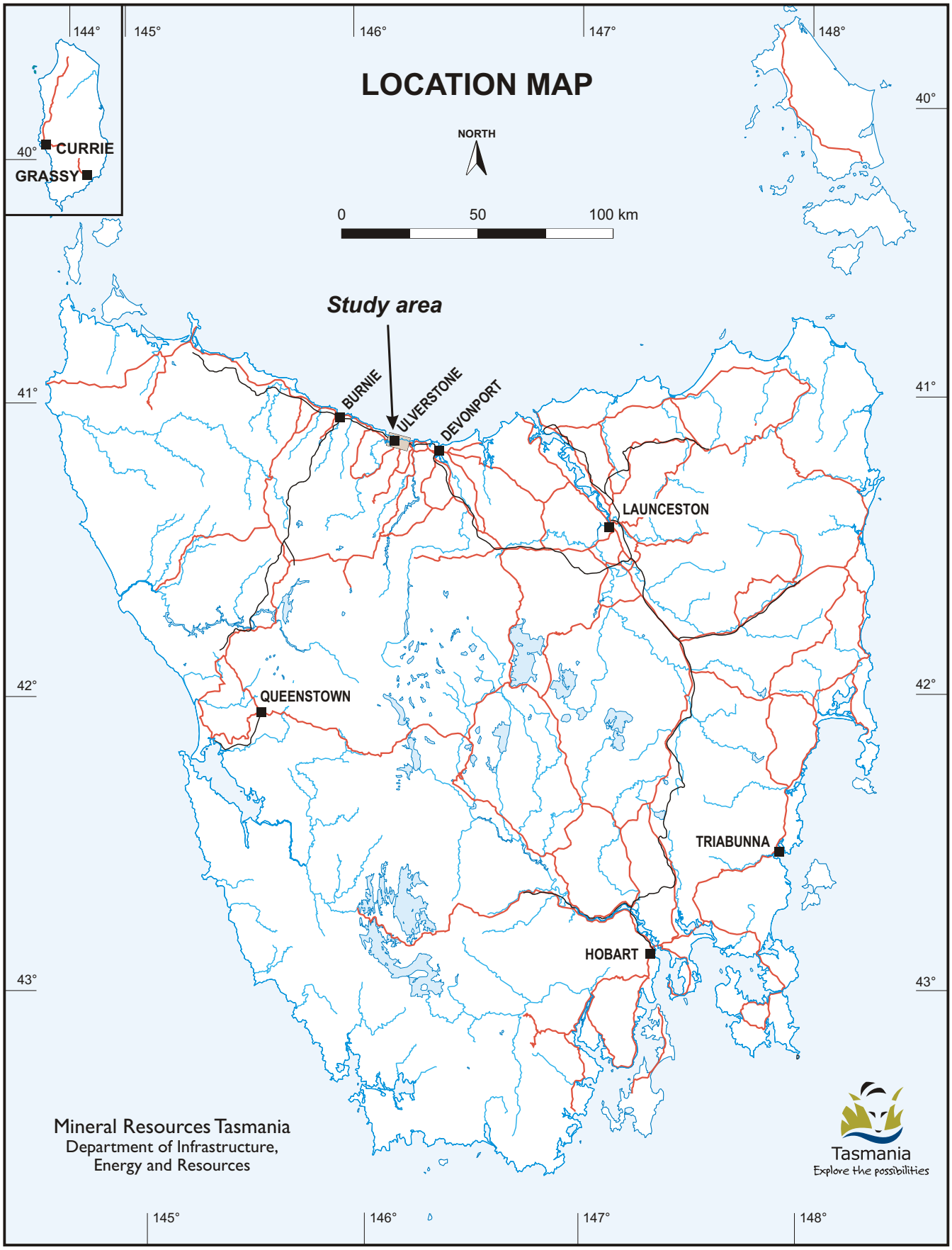

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CONTENTS

Introduction … 5
Study area … 5
Terminology and standards … 5
Use of the maps … 5
Investigation methods … 5
Laboratory soil testing … 7
Moisture Content … 7
Liquid Limit … 7
Plastic Limit … 7
Plasticity Index … 8
Linear Shrinkage … 8
Soil Particle Density … 8
Particle Size Distribution … 8
Emmerson Class Number … 8
Bulk Density … 8
Physiography … 8
Coastal and alluvial surface … 8
Coastal escarpment and steep slopes … 9
Higher flat to gently sloping surface … 9
General geology … 9
Precambrian … 9
Cambrian … 9
Tertiary … 9
Quaternary … 9
Soil descriptions and characteristics … 10
Basement (Precambrian–Cambrian) … 10
Sub-basaltic sediments (Tertiary) … 10
Basalt and intra-basaltic sediments (Tertiary) … 10
Quaternary … 11
Slope deposits … 11
Alluvium … 11
Coastal plain deposits … 11
Geological hazards … 12
Shrink-swell and dispersion potential … 12
Landslides … 12
Buried channels … 12
Faults … 12
Earthquakes … 12
Floods … 12
Coastal processes … 12
Acknowledgements … 12
References … 12
Appendix 1: Logs for data points 1 to 65 (boreholes) … 19
Appendix 2: Summary of laboratory soil testing, data points 1 to 65 … 86
Appendix 3: Details of data points 66–157 … 88
Appendix 4: Summary of X-ray diffraction results … 94
Appendix 5: Details of water bores (data points 159 to 200) … 98
Appendix 6: Log of diamond drill hole, Ulverstone (data point 158) … 100

Appendix 7: Palynology report — Ulverstone diamond drill hole … … … … … … … … … … … … … … … 102
Appendix 8: The petrology of some basalt samples, Ulverstone diamond drill hole … … … … … … … … 103

Tables

1. Relationship between the swelling potential of clays and plasticity index … … … … … … … … … … … … 8

Figures

1. Location of study area … 6
2. Geology of the Ulverstone area … 13
3. Physiography of the Ulverstone area … 14
4. Slope classification of the Ulverstone area … 15
5. Particle size distribution chart, coastal plain and alluvial plain samples … … … … … … … … … … … … 16
6. Particle size distribution chart, coastal plain sand samples … … … … … … … … … … … … … … … … … 17
7. Unified soil classification system … 18

WHIPPY, F. 1994. Ulverstone engineering geology project. *Report Urban Geological Mapping Project Tasmania* 2.

Introduction

The Ulverstone Engineering Geology Project was jointly funded by the Tasmanian Government and the Ulverstone Municipal Council. The study was undertaken as a special project supervised by the then Division of Mines and Mineral Resources over a period of eighteen weeks from the end of August to the end of December 1990.

The objective of the project was to produce an engineering geology map of the area, with an accompanying report, for development planning purposes. The 1:10 000 scale map (Urban Engineering Geology Series Map 3 — Engineering Geology Ulverstone) and the three 1:25 000 scale maps were published in 1991 but further work on the report was delayed until 1994. This report, issued in 2014, is a compilation of the material that was prepared for publication in 1994 but not finalised at the time.

Study area

Ulverstone is located on the North West Coast of Tasmania (fig. 1). The 40 km^2 project area forms a coastal strip extending from the 146° 08' longitude in the west to the River Forth in the east. The 41°11'31" latitude marks the southern limit of the area, with Bass Strait forming the northern boundary.

The data presented in this report were derived as part of a regional-scale study and as such should not be used for site-specific design purposes. The data should serve to provide an indication of the different types of material which occur in the Ulverstone area and some of their properties, and give basic information for areas where development is being considered.

Terminology and standards

The procedures for soil descriptions and classifications (weathering, soil and rock strengths) as compiled by Moon (1980) are used in this report.

The soils are classified according to the Unified Soils Classification system (fig. 7).

Use of the maps

The maps associated with this project include:

1. An engineering geology map (the main map for the project) at a scale of 1:10 000.
2. A map of the geology of the area at 1:25 000 scale (fig. 2).
3. A map of the physiography of the area at 1:25 000 scale (fig. 3).
4. A slope class map at 1:25 000 scale (fig. 4) showing zones of 0–10° and zones of greater than 10°.

The engineering geology map shows the distribution of various soils and rocks with the legend describing their properties and associated potential hazards. The survey only deals with broad-scale features and soil properties on a regional scale to provide general information. The map should not be used to replace site-specific investigations for particular projects.

The geological hazards associated with the various materials shown on the maps should alert planners and designers of projects of possible problems that should be investigated. For example the engineering geology map shows old landslide areas as well as recently active landslides. Old landslide areas are marked as discrete zones, but it should not be assumed that it is only these zones and the active landslide areas where problems can occur. Around the contour from these zones are often areas with similar or greater slope angle and underlain by the same or similar material. Such areas should also be treated with caution. Alteration of drainage patterns, oversteepening of slopes by excavation and removal of trees could also alter the current apparent stability of these areas.

The slope classification map (fig. 4) will aid in determining zones where investigations may be warranted.

The shear strength measurements (residual factors) show that quite low values have been measured on some of the soil types and development on slopes of greater than 10° where these materials are present should be treated with extreme caution. Occasionally soils on slopes of less than 10° may also require some investigation.

Investigation method

The study of the area was undertaken using established procedures and techniques. These included collation and interpretation of available data, aerial photograph interpretation, mapping, drilling and laboratory soil testing.

Field mapping was undertaken on 1:5000 scale orthophoto maps and data points were also plotted at this scale. Information was later transferred to a 1:10 000 scale base map provided by the Ulverstone Municipal Council, and the final map was drawn from this base.

Grid references provided in this report were taken from the 1:5000 scale orthophoto maps which cover the area. All grid references are AGD66 datum and are MGA co-ordinates in Zone 55.

A total of 54 holes were drilled for sampling purposes and to provide an indication of overburden thickness. Drilling was undertaken using a trailer-mounted powered auger with a maximum practical depth capability of seven metres. Although this was beyond the expected depth of influence for most development activities, the drill was used to gather as much information as possible, especially within sloping and landslide-affected areas.

The distribution of sampling (auger hole) sites was made with two objectives:

- to obtain representative samples of the various types of material in the area;
- to collect more data on sloping and landslide-affected areas by adopting a closer spacing between sites selected for drilling.

The achievement of these objectives was governed by site accessibility and time constraints.

Disturbed samples were bagged for laboratory soil testing at each auger hole site . Undisturbed samples were taken with cylindrical, thin-wall steel tubes (63 mm diameter, 450 mm

Figure 1. *Location of study area.*

long) and square, thin-wall steel samplers (inside dimensions 70 70 mm, length 300 mm) pushed hydraulically into the ground. The undisturbed samples were trimmed and sealed at both ends and later extruded for laboratory soil testing. The square steel samplers were used specifically to obtain samples for the determination of shear strength parameters using a shear box.

Soils were logged in the field for engineering classification, moisture content and strength. *In situ* strength determinations were made using a shear vane and pocket penetrometer. An estimate of the degree of compactness in cohesionless material was made by the relative rate of drilling penetration.

The classifications used for various soil properties determined in the field are presented in Figure 7. The auger hole logs (data points 1 to 54) are presented in Appendix 1. Profiles on two existing cuttings and a trench (data points 55 to 57) were also logged in a similar manner to the auger holes. These logs are also given in Appendix 1.

In areas where the groundwater table was reached during drilling, the water level was recorded and the specific conductance of the water measured. Specific conductance and water level measurements were also carried out in some of the existing boreholes, a well and seepages.

Surface grab samples (data points 58 to 65) were also collected (Appendix 1). Laboratory test results on samples from data points 1 to 65 are presented in Appendix 2.

Results of investigations previously undertaken by the then Division of Mines and Mineral Resources, Department of Main Roads and Ulverstone Municipal Council (data points 66 to 157) have been incorporated into this report and are presented in Appendix 3. Water bore logs (data points 159 to 200) are presented in Appendix 5.

The locations of the data points (incorporating previous work and those undertaken for this project) are shown on the accompanying 1:10 000 scale engineering geology map of Ulverstone.

Laboratory soil testing

Laboratory testing of soils was undertaken for classification purposes, under the Unified Soil Classification System, and for providing an indication of the adverse properties of materials in the area with regard to some development related activities.

A total of 104 samples was collected for testing and reference purposes (Appendix 2). The location of the samples are given in the logs (Appendix 1) and on the 1:10 000 scale engineering geology map of Ulverstone. The samples took the form of auger bit cuttings, thin-wall tube samples and surface grab samples. Tests performed on the samples included moisture content, liquid limit, plastic limit, linear shrinkage, soil particle density, particle size distribution, dispersion (Emmerson class number), bulk wet density, X-ray diffraction, and shear strength parameters.

X-ray diffraction analyses for mineralogical composition determination and shear strength parameters determination (using a shear box) were conducted according to the standard procedures of the Division of Mines and Mineral Resources. Results of X-ray diffraction analyses are presented in Appendix 4.

The remainder of the tests were carried out in accordance with AS1289 (SAA, 1977) using the following standard procedures:

- AS1289 B1.1: Determination of the moisture content of a soil — oven drying method (standard method);
- AS1289 C1.1: Determination of the liquid limit of soil — oven drying method (standard method);
- AS1289 C2.1: Determination of the plastic limit of a soil;
- AS1289 C3.1: Calculation of the plasticity index of a soil;
- AS1289 C4.1: Determination of the linear shrinkage of a soil;
- AS1289 C5.1: Determination of the soil particle density of a soil;
- AS1289 C6.1: Determination of the particle size distribution of a soil — standard method of analysis by sieving;
- AS1289 C8.1: Determination of the Emmerson class number of a soil;
- AS1289 E3.3: Determination of the field dry density of soil — core cutter method for fine-grained soils (modified using thin wall sample tube).

These tests were selected as they were considered to be the most relevant for engineering classification purposes and some of the parameters determined from the tests could be used to derive or infer other properties. Brief descriptions of the tests with some implications are given below.

Moisture Content (MC)

This is the ratio of the weight of water to the dry weight of the soil. The moisture content of a soil can vary for considerable depths below the surface as a result of seasonal changes (often 1–2 metres and sometimes greater). Below this zone the moisture content remains relatively constant. The behaviour of a soil (whether it behaves as a solid, a plastic or a liquid) is largely dependent on its moisture (or water) content. Changes in moisture content are particularly relevant in areas of reactive (expansive) soil.

Liquid Limit (LL)

The liquid limit is defined as the moisture content at which the soil just starts to become fluid under a series of standard shocks (Bureau of Reclamation, 1974). The property is measured using a liquid limit machine and the moisture content at which 25 blows of the machine closes a standard groove cut in the soil pat is arbitrarily defined as the liquid limit.

The Liquid Limit is used with the plasticity index to classify cohesive soils according to degree of plasticity.

Plastic Limit (PL)

This is the moisture content at which the soil ceases to be plastic. It is determined by measuring the moisture content at which a thread of soil rolled to a diameter of 3 mm will just crumble.

Plasticity Index (PI)

The plasticity index is the difference between liquid limit and plastic limit. Chen (1975) has established the relationship between the swelling potential of clays and plasticity index.

Table 1

Relationship between the swelling potential of clays and plasticity index

Swelling Potential	*Plasticity Index*
Low	0–15
Medium	10–35
High	20–55
Very High	55 and above

Linear Shrinkage (LS)

This is the decrease in length expressed as a percentage of the original length when a sample of soil is oven dried from a moisture content of about the liquid limit (AS1726; SAA:1975).

The linear shrinkage is generally used as an indication of the swell potential of a soil.

Soil Particle Density (SPD)

This parameter is defined as the mass of soil particles after drying to constant mass per unit volume of dry material excluding voids.

Particle Size Distribution (PSD)

This test is used for classification purposes and to give an indication of the origin of soils.

Emmerson Class Number

This test gives an indication of the dispersive potential of a soil which is determined by classifying the reaction of soil crumbs in water. It is an important indicator of the erodibility of a soil.

Bulk Density

Bulk density is defined as the weight of the material per unit volume. The determination of the parameter was made to provide an indication of values, as this is one of the factors used in slope stability analysis.

Physiography

The area is dissected by the valleys of the Leven, Gawler and Forth rivers, Masons and Buttons creeks, and Clayton Rivulet. The rivers have well developed alluvial flats towards their mouths whilst the creeks have narrow, discontinuous alluvial flats along their lengths.

The drainage systems are basically dendritic, with local drainage densities being much greater within areas underlain by Cambrian and Precambrian basement rocks compared to areas underlain by Tertiary basalt. Relatively higher infiltration rates within the basalt areas, compared to areas underlain by basement rocks, would explain the difference in drainage densities. The presence of springs within basalt areas is evidence of higher infiltration and storage capabilities.

The major drainage systems occur within basement rocks. This suggests that basalt flows caused lateral displacement of the drainage systems resulting in the formation of post-basaltic drainage along the contacts of basalt and basement rocks. The presence of sub-basaltic sediments (sand and gravel) on ridges between the present drainage valleys is evidence of lateral displacement of drainage systems.

The sub-basaltic sediments represent deposits of major pre-basaltic drainage systems.

The area can be divided into three main physiographic units (fig. 3):

- coastal and alluvial plains;
- coastal escarpment and steep slopes;
- higher flat to gently sloping surface.

These units correspond to Burns' (1964) coastal marine platform; coastal escarpment and dissected surfaces; and lower coastal surface respectively.

Coastal and alluvial surface

Although these two landforms have different characteristics with respect to material composition and topographic location, they have been combined into one unit in this study. The two surfaces merge where the rivers enter the coastal plain and the boundary between the two is often difficult to determine. Similarities between the landforms include low-lying flat to gently sloping surfaces and the occasional presence of swampy areas. The unit includes recent beach deposits.

The Forth and Leven rivers have well developed alluvial plains. Burns (1964) recognised the presence of an older alluvial surface at a higher elevation than the present system and indicated that this older surface corresponds well with a higher strand line representing the limit of inland coastline migration. The surfaces (higher alluvial surfaces and strandline) are easily identifiable on old aerial photographs of the area.

In the study area, alluvial plain development by the creeks is limited to narrow discontinuous stretches along their lengths.

The coastal plain is a major landform in the area and represents a former marine platform exposed as a result of a relative fall in sea level and the northward migration of the coastline. Burns (1964) suggests that the relative fall in sea level probably occurred during the Pleistocene.

The present beach is more of a depositional site fed by sediments from the Leven and Forth rivers. The beach profiles are gently sloping, with wide intertidal flats indicating low energy environments. The presence of berms containing coarse gravel to medium-sized boulders indicates occasional high energy environments resulting from storm activity.

The coastal plain is continuous from east to west but narrows towards the western limit of the study area. The inland limit of the coastal plain generally approximates the 25 m contour. Except for parts of the eastern portion, which is still used for grazing, the coastal plain is being gradually covered by urban development. The Ulverstone urban area is centred along the banks of the River Leven.

Coastal escarpment and steep slopes

These two landforms are combined into one unit because of similarities in slopes and topographic locations.

The coastal escarpment is an area of steep landform which is continuous along the inland fringe of the coastal plain, interrupted only by the valleys of the major drainage systems. The other areas of steep slopes occur along valley sides.

The steepness of slopes within these landforms generally reflect the composition and weathering susceptibilities of the underlying basalt and basement rocks, or the degree of compactness for sub-basaltic sediments, which are generally loosely compacted. The steepest slopes occur in areas underlain by basement rocks, while areas underlain by sub-basaltic sediments (sand and gravel) have the lowest slope angles.

The basalt is more susceptible to weathering and it is rare to find anything other than highly weathered exposures along slopes, these areas being composed mainly of transported soils. As these soils are relatively low-strength materials they cannot support very steep slopes, resulting in lower slope angles compared to areas underlain by basement rocks. Sloping areas underlain by these rocks have thinner overburden and more rock exposure, resulting in relatively steeper slopes.

Urban development within the coastal escarpment and steep slopes unit is limited to areas of more gentle slopes, with grazing being the dominant land use. The steepening of slopes due to mass movements (landslide and soil creep) has occurred and continues to occur in a few sites.

Higher flat to gently sloping surface

This surface is composed mainly of basalt except for small areas in the west and to the south which are underlain by basement rocks and sub-basaltic sediments respectively.

The thickest development of overburden as a result of weathering occurs within this unit and this surface is extensively cultivated, except for areas on the fringe of the urban centre which have accommodated urban sprawl.

Burns (1964) suggested that the surface is erosional, probably developed during the Pliocene.

General geology

The following summary of the geology of the Ulverstone area is based on Burns (1964) and work undertaken during this project.

The basement rocks consist of folded and regionally metamorphosed Precambrian and Cambrian rocks. Sand and gravel of Tertiary age overlie the basement in some areas. Tertiary basalt flows and intra-basaltic sediments overlie the above units. Rocks between the Cambrian and Tertiary are not exposed in the area. Unconsolidated Quaternary sediments cover the alluvial and coastal plains and colluvium occurs on some of the slopes.

The geology of the area is shown in Figure 2.

Precambrian

Burns (1964) subdivided the Precambrian into two divisions on the basis of structure and degree of metamorphism. The Forth Metamorphics and Ulverstone Metamorphics belong to the 'Lower Division' and the Rocky Cape Group to the 'Upper Division', with the boundary between the divisions being a thrust fault. The Rocky Cape Group occurs west of the thrust with the metamorphic assemblages occurring to the east of the thrust.

The Forth Metamorphics underlie the Ulverstone Metamorphics. The Forth Metamorphics consist of schist and quartzite, with outcrop occurring along and east of Buttons Creek. The Ulverstone Metamorphics consist of quartzite with interlayered schist and subordinate conglomerate. The boundary between the two metamorphic units is defined by the first appearance of garnet in the schist and the last appearance of conglomerate in the Ulverstone Metamorphics.

The Rocky Cape Group is composed of alternations of mudstone and sandstone.

Cambrian

The Cambrian is represented by mudstone, volcanic rocks and serpentinite, with these rocks unconformably overlying the Precambrian. Serpentinite occurs at Clayton Rivulet within the Forth Metamorphics. Outcrops of the mudstone and volcanic rocks occur at Cateena Point and on the Bass Highway immediately west of the River Leven.

Tertiary

The Tertiary is represented by sub-basaltic sediments, basalt flows and intra-basaltic sediments.

The sub-basaltic sediments consist of quartz-rich sand and gravel, with silcrete occurring in some areas. The sediments represent pre-basaltic fluvial deposits. The main areas of outcrop are along parts of the River Leven bank (near the town centre), on the ridge between Buttons Creek and Clayton Rivulet, and along the northern parts of the ridge east of Clayton Rivulet.

The basalt flows occur mainly as ridges between the major drainage systems. Textures vary from fine grained to amygdaloidal. The unit is at least 85 m thick (see Appendix 6 — data point 158 for borehole log) and palynology work by Mineral Resources Tasmania indicates a middle Eocene age (Appendix 7).

The intra-basaltic sediments consist mainly of clay and sand with minor gravel of basement and basalt composition. The sediments are lenticular in form and their presence indicates that the basalt unit is composed of several flows. The thickest layer of intra-basaltic sediments found is about three metres.

Quaternary

The Quaternary is represented by alluvium on floodplains, by estuarine, beach, dune and glacial deposits on the coastal plains, and by slope deposits.

The alluvium deposits consist principally of clay and silt with minor sand. The sediments on the coastal plains are

composed dominantly of sand, with a low but variable proportion of clay and gravel.

The glacial sediments consist of mainly quartzite gravel and cobbles and occur in a thin coastal strip extending from just east of The Fish Pond to the River Forth. Work by Colhoun (1976) indicated that the lower Forth Valley was glaciated during the Late Quaternary and that ice crossed the present coastline of Bass Strait.

Slope deposits resulting from mass movement mantle most of the valley sides, especially below basalt ridges. The deposits consist mainly of clay and rock fragments in a clay matrix.

Soil descriptions and characteristics

In the following discussions, the soil characteristics presented for a particular unit are taken from the auger hole logs (Appendix 1). In these logs, bedrock is defined as beginning where relict rock textures are preserved irrespective of strength properties. The auger hole data points are shown on the accompanying engineering geology map.

Results of the X-ray diffraction determinations are provided in Appendix 4.

Basement (Precambrian–Cambrian)

Soils derived from the *in situ* weathering of Precambrian and Cambrian rocks have been included into one unit because of similarities in characteristics and depth of soil development.

Most basement rocks encountered in auger holes were extremely to highly weathered and outcrops are generally highly weathered. The basement rocks have very low to low strengths when extremely weathered to highly weathered.

Rock strength in the basement unit is controlled by the rock type and the orientation of discontinuities. Low rock strengths would be expected if measurements were undertaken in the same direction as discontinuities, while higher strengths would be measured perpendicular to discontinuities. Quartzite and conglomerate would have higher strengths than schist and mudstone.

Soil development within the unit is relatively thin, and no soils thicker than one metre were encountered during drilling. The thickness of completely weathered material within some rock types can vary by up to about three metres (see data points 24 and 40).

The soil developed on these rocks consists of medium to high plasticity clay with some gravel (rock fragments). The major mineral constituents are kaolinite, illite, quartz and mica, except in soils developed on serpentinite where montmorillonite and serpentine are the major mineral components.

The presence of illite and montmorillonite, and plasticity index values of between 17 and 78, indicate medium to very high swelling potential (see table 1). The wide range in values reflects different parent rock material and indicates the need for site-specific investigations where development is to be undertaken.

The dispersion potential for clay in the unit is generally low. Anomalous areas of high dispersion potential occur (e.g. data point 40), indicating different parent material for the soils developed. Identification of a sample from data point 40 (4.5 m depth) by MRT mineralogist/petrologist R. Bottrill showed that the material was an ultrabasic schist.

No landslides have been mapped within the unit, indicating low susceptibility to mass movement. However slope failure will occur if current regimes are altered with a resulting increase in moisture conditions and slope angles.

Excavations through rocks types in the unit are reasonably stable as shown by some road cuttings along the Bass Highway.

Sub-basaltic sediments (Tertiary)

These sediments were derived from the underlying basement rocks and are similar to basement in composition. The main mineral constituents are quartz, kaolinite and montmorillonite.

The sediments consist of quartz-rich sand and gravel, silcrete and clay, with exposed areas mainly composed of sand and gravel. The silcrete is extremely hard and has only been located in isolated spots near the junction of River Road and Hall Street at West Ulverstone and on the slopes behind this junction.

The sand deposits are generally loose but in some areas are weakly cemented. Clays are of high plasticity with high swell and dispersion potential.

Landslides have not been mapped in the unit, although the toes of some landslides on the lower parts of the escarpment are believed to involve sub-basaltic sediments. The absence of landslides wholly formed within the unit is probably due to its occurrence on land with a low slope angle and limited exposures of the dominantly clay material. Shear strength measurements of a clay sample from the unit provided values of $c'_r = 2$ and $'_r = 8$. Excavations within the clay layers of this unit should be undertaken with care, as instability may be created by the formation of steep high cuts.

Basalt and intra-basaltic sediments (Tertiary)

Thick weathering profiles occur in the basalt, with areas covered by this unit being used extensively for farming. Where outcrop occurs the rocks are mainly extremely to highly weathered, with fresh to slightly weathered basalt being found only on the tops of some ridges and where the rock has been exposed by excavations. In its extremely weathered state the basalt has extremely low to very low strength.

Soils developed on the basalt consist of red-brown to orange-brown high plasticity clay. The main constituents of the soils are montmorillonite, halloysite and goethite, except in two samples (11 – data point 6 and 82 – data point 44) where anomalous values of quartz were detected. The relatively high quartz content in these samples may indicate the presence of thin layers of intra-basaltic sediments.

Laboratory soil testing indicates that the basalt soils have a high swelling potential, with plasticity indices greater than 40. The soils have low dispersion potential, with Emmerson class numbers of 5 and 6. The consistency of the soils vary

from soft to very stiff, with consistency generally increasing towards the soil-rock boundary.

The intra-basaltic sediments consist mainly of clay and sand, with minor gravel composed of basalt and basement material. In some exposures the sand is weakly cemented. The clay and sandy clay are generally red-brown with grey mottling. Soft to firm consistency is common for the clay layers, with the sandy clay material being firm to stiff. The main mineral constituents are montmorillonite, halloysite and quartz.

When exposed the clay and sandy clay sediments generally develop a dry cracked crust (up to 150 mm deep), under which high moisture conditions exist. Gullies up to one metre deep have developed in some exposures.

Field observations and laboratory soil testing indicate that the clay zones in the intra-basaltic sediments have high shrink-swell and dispersion potential.

Ancient landslides occur on slopes composed of basalt and intra-basaltic material. Areas within the unit where slope angles are greater than 10° and where high moisture conditions (seepages, soggy/swampy ground, green vegetation) exist are likely to be highly susceptible to instability. The locations of areas subject to landslides are shown on the 1:10 000 scale engineering geology map of Ulverstone.

Quaternary

Slope deposits

These deposits contain clay and gravel (rock fragments) derived from basement rocks, basalt and Tertiary sediments (both sub-basalt and intra-basaltic) in a clay matrix. The clays are mainly light to dark brown in colour and in some cases contain light grey and/or orange mottling. The mottled clay was mainly encountered in auger holes within landslides and probably represents zones of lower permeability.

A shallow or perched water table is common in landslides within the unit. Water conductivity values of between 110–140 S/cm were recorded from auger holes where the water table was reached.

The main soil types developed on the unit are high plasticity clays and gravel (rock fragments) in a high plasticity clay matrix. Laboratory measurement of soil properties gave a wide range of results for the unit, reflecting the range of parent material from which the soils were derived. The major mineral constituents of the soils are montmorillonite, halloysite and quartz.

Soils derived from basalt and Tertiary sediments have higher plasticity indices, indicating high shrink-swell potential, compared to soils derived from basement rocks. Differences also occur with dispersion potential. Soils derived from basalt and basement rocks have low dispersion potential, whilst those derived from the Tertiary sediments (sub-basaltic and intra-basaltic clay) have very high dispersion potential.

The unit has high shrink-swell and dispersion potential and for planning purposes, the worst characteristics should be adopted unless site-specific investigations are undertaken.

Ancient and active landslides occur on slopes within the unit. Their locations are shown on the1:10 000 scale engineering geology map of Ulverstone. It should be noted that the landslide at Frombergs (near Westella, grid reference 433500 mE 5442700 mN) is still active although it is not shown as such on the map.

Sloping areas within the unit are highly susceptible to landslides and a large number of unstable areas have been mapped in the unit. Care should be exercised if development is undertaken in areas of slope deposits, as new landslides can be created and ancient ones re-activated by changes that will cause an increase in moisture conditions, steepening of slope, and loading of tops of slopes.

Alluvium

Deposits of alluvium occur adjacent to creeks and rivers. These deposits consist of unconsolidated sediments ranging from clay to gravel in grain size, reflecting the varying conditions of depositional environments. Gravel is more common adjacent to the upper reaches of the rivers and creeks while the finer-grained sediments predominate downstream.

A particle distribution chart of two non-cohesive sediments is given in Figure 5. This chart indicates the presence of well graded sands (SW) and sand/silt (SM) or sand/clay (SC) mixtures.

The cohesive sediments tested consisted of high plasticity clay and silt (CH, MH) with medium to very high swelling potential The major mineral constituents of the soils are halloysite, quartz montmorillonite and goethite. Of the four samples tested, three had low dispersion potential while the fourth showed high dispersion.

Shallow water table levels were encountered in the auger holes drilled on the alluvial plains. Depths to the water levels ranged from 0.5–5.92 m, with water conductivity being generally less than 500 S/cm.

Refusal depths also varied and suggest the presence of an uneven bedrock surface and coarse gravel layers.

Coastal plain deposits

The coastal plain is covered by mixtures of unconsolidated clay, silt, sand and gravel, with sand being the dominant grain size. The sand is generally poorly graded (SP) as a result of wave and/or wind sorting. The particle size distribution graphs for four sand samples are presented in Figures 5 and 6.

Clay was the major constituent in the samples of cohesive material collected. Laboratory soil testing indicated the presence of low to high plasticity clay types (CL, CH) with medium to high swelling potential. Dispersion potential for the cohesive soils is low to high. Quartz, montmorillonite, halloysite and kaolinite are the major mineral components of the soils.

Refusal depths in the coastal plain varied from 1.3 m to greater than seven metres. This indicates the presence of gravel layers and variable bedrock levels. Material sizes greater than coarse gravel would have halted auger penetration.

The variable bedrock levels are probably due to the presence of buried channels. These channels would have

been infilled during the last post-glacial sea level rise. The greatest thickness of sediments would occur in areas of buried channels and adjacent to existing channels.

The water table level on the coastal plain is shallow and generally occurs within two metres of the ground surface. Water conductivities of less than 1000 S/cm were recorded from the auger holes drilled on the coastal plain.

Geological hazards

Shrink-swell and dispersion potential

The shrink-swell and dispersion potential of the soils in the area has been discussed in the section on soil description and characteristics.

In general, basalt soils, cohesive layers in the Tertiary sediments (sub and intra-basalts), some soils developed on the slope deposits, and alluvial clay and silt are highly susceptible to seasonal shrink-swell. Soils with high dispersion potential include cohesive material within the Tertiary sediments, some soils developed on the slope deposits, and some alluvial clay and silt. These materials must be regarded as being particularly erodible when compared to some of the other soil types (e.g. basalt).

Landslides

Sloping areas underlain by basalt with slope angles greater than 10°, and slopes composed of colluvium (slope deposits), are most susceptible to landslides. Risks within the other units can be increased by development methods which result in the steepening of slopes, loading of the tops of slopes, and the increase in moisture conditions.

Buried channels

The variable depth to bedrock in the alluvial and coastal plain areas suggests the presence of buried channels. These channels would have been filled during the last post-glacial sea level rise.

The locations of the channels and the nature of infill material should be investigated in areas where developments are proposed. Channel infill can contain material susceptible to settlement and depths to bedrock will be greater in areas of buried channels and near existing channels.

Faults

Geological faults occur in the Ulverstone area; their locations are shown on the1:10 000 scale engineering geology map of Ulverstone. The degree of fracturing and weathering is expected to be greater and bedrock strengths lower along the faults relative to the surrounding area. There is no evidence to suggest recent movement along the faults.

Earthquakes

Tasmania, as with the rest of Australia, is in a low earthquake risk area compared to the major earthquake belts in the world. Ulverstone is located within the Western Tasmanian earthquake source zone of Michael-Leiba and Gaull (1989). This area has a 10% probability that peak ground motion will not exceed 0.55 m/s^{-2} during a 50 year period. Gaull *et al.* (1990) consider areas of greatest risk to be those where peak ground acceleration of 1.0 m/s^{-2} or greater will be exceeded with 10% probability in a 50 year period.

Since European settlement the larger earthquakes that have been felt have been centred off the far northwest coast of Tasmania.

Floods

Damage due to inundation, silting and undermining of the foundations of structures by strong currents created during floods are the main hazards related to flooding. Development of flood-prone areas should always be undertaken with these factors in mind.

Coastal processes

For proper coastal management, a study of coastal processes occurring in the area, and the expected effects of proposed structures or developments on these processes, should be considered. Interference to the natural coastal processes can lead to the erosion or silting of prime areas.

Acknowledgements

During the course of the project, assistance was received from the Ulverstone Municipal Council's Engineering Section through the provision of plans, reports and access to some sites for sampling purposes. Landowners in the area also allowed ready access to their properties during fieldwork.

The drilling was carried out by B. Cox, while R. Woolley performed the laboratory testing of soils. R. Rallings and J. Giedl of the (then) Department of Main Roads provided access to geotechnical information gathered by their department during investigations for the construction of the Bass Highway and some buildings in the town area.

Advice and assistance received from staff of the Division of Mines and Mineral Resources is gratefully acknowledged.

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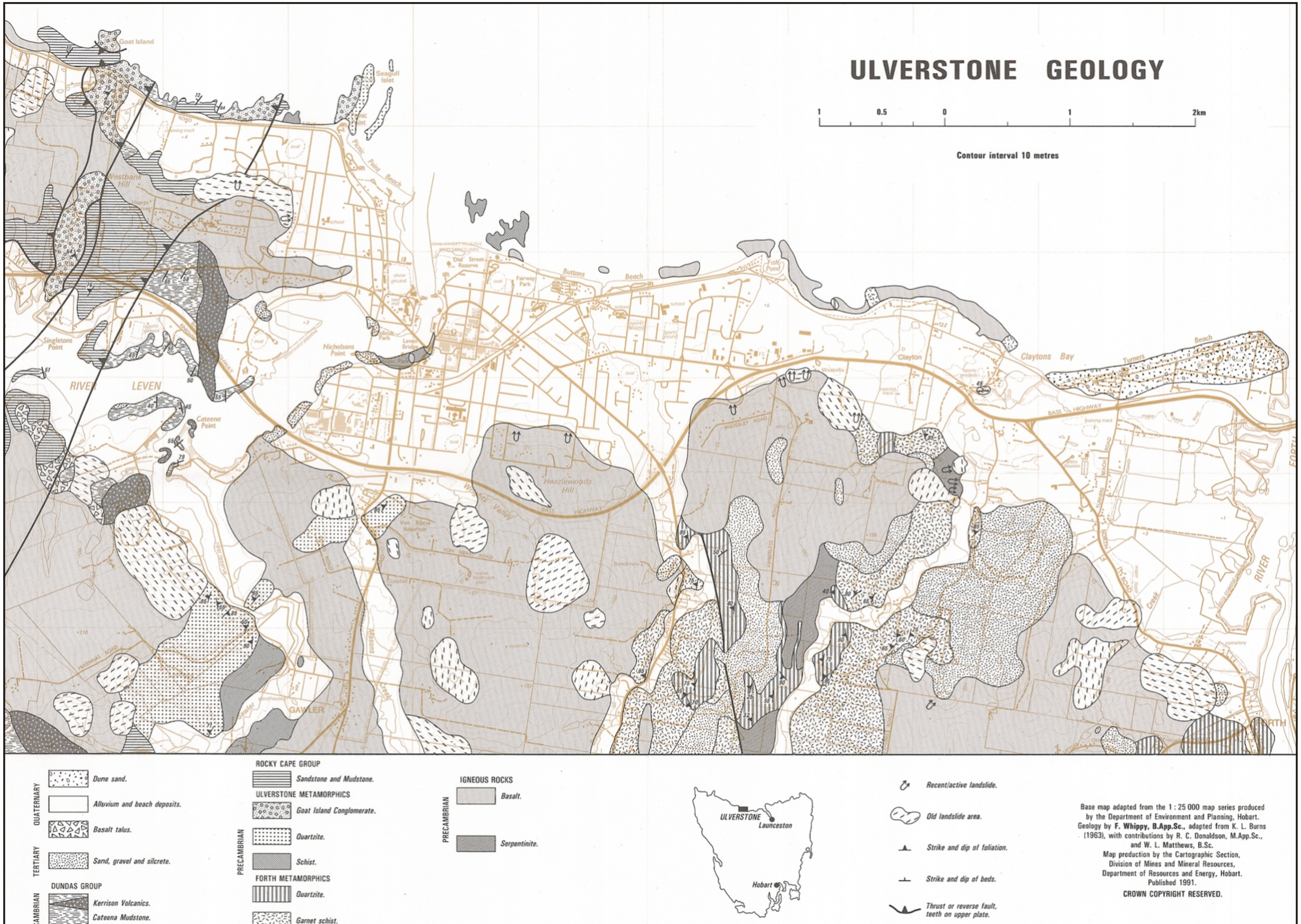

ULVERSTONE GEOLOGY
1 0.5 0 1 2km
Contour interval 10 metres
Goat Island
Seagull Islet
Picnic Point Beach
Westbank Hill
Buttons Beach
Fairway Park
Clayton
Claytons Bay
Turners Beach
BASS HIGHWAY
Singletons Point
RIVER LEVEN
Nicholsons Point
Cateena Point
Heazlewoods Hill
WAVERLEY ROAD
GAWLER
FORTH RIVER
QUATERNARY
Dune sand.
Alluvium and beach deposits.
Basalt talus.
TERTIARY
Sand, gravel and silcrete.
CAMBRIAN
DUNDAS GROUP
Kerrison Volcanics.
Cateena Mudstone.
ROCKY CAPE GROUP
Sandstone and Mudstone.
ULVERSTONE METAMORPHICS
Goat Island Conglomerate.
PRECAMBRIAN
Quartzite.
Schist.
FORTH METAMORPHICS
Quartzite.
Garnet schist.
IGNEOUS ROCKS
PRECAMBRIAN
Basalt.
Serpentinite.
ULVERSTONE
Launceston
Hobart
Recent/active landslide.
Old landslide area.
Strike and dip of foliation.
Strike and dip of beds.
Thrust or reverse fault, teeth on upper plate.
Base map adapted from the 1 : 25 000 map series produced by the Department of Environment and Planning, Hobart.
Geology by F. Whippy, B.App.Sc., adapted from K. L. Burns (1963), with contributions by R. C. Donaldson, M.App.Sc., and W. L. Matthews, B.Sc.
Map production by the Cartographic Section, Division of Mines and Mineral Resources, Department of Resources and Energy, Hobart.
Published 1991.
CROWN COPYRIGHT RESERVED.

Figure 2

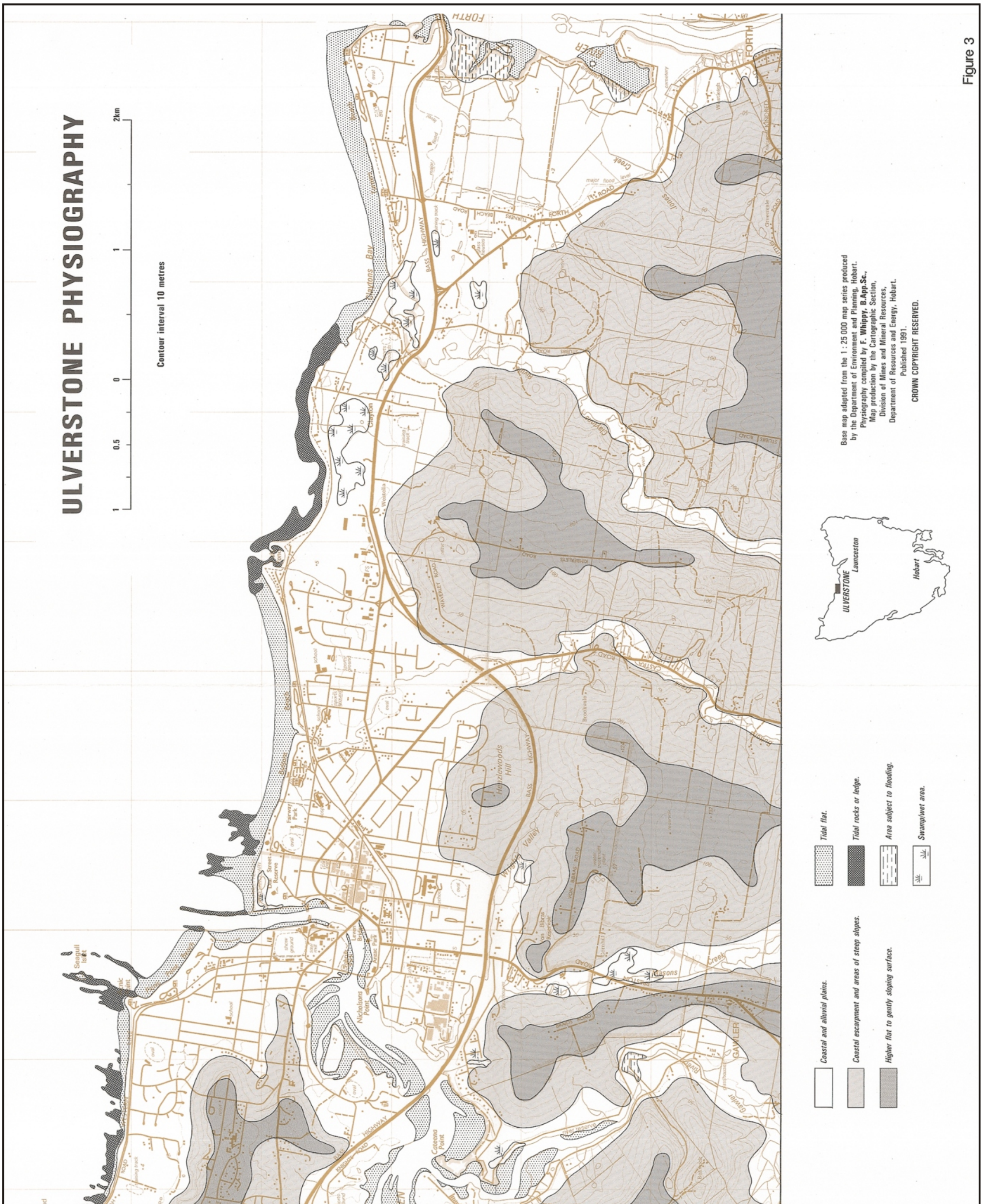
ULVERSTONE PHYSIOGRAPHY
Contour interval 10 metres
1 0.5 0 1 2km
Coastal and alluvial plains.
Coastal escarpment and areas of steep slopes.
Higher flat to gently sloping surface.
Tidal flat.
Tidal rocks or ledge.
Area subject to flooding.
Swamp/wet area.
ULVERSTONE
Launceston
Hobart
Base map adapted from the 1 : 25 000 map series produced
by the Department of Environment and Planning, Hobart.
Physiography compiled by F. Whippy, B.App.Sc.,
Map production by the Cartographic Section,
Division of Mines and Mineral Resources,
Department of Resources and Energy, Hobart.
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Figure 3

Base map adapted from the 1 : 25 000 map series produced by the Department of Environment and Planning, Hobart.
Slope classification compiled by **F. Whippy, B.App.Sc.,**
Map production by the Cartographic Section,
Division of Mines and Mineral Resources,
Department of Resources and Energy, Hobart.
Published 1991.

Figure 4

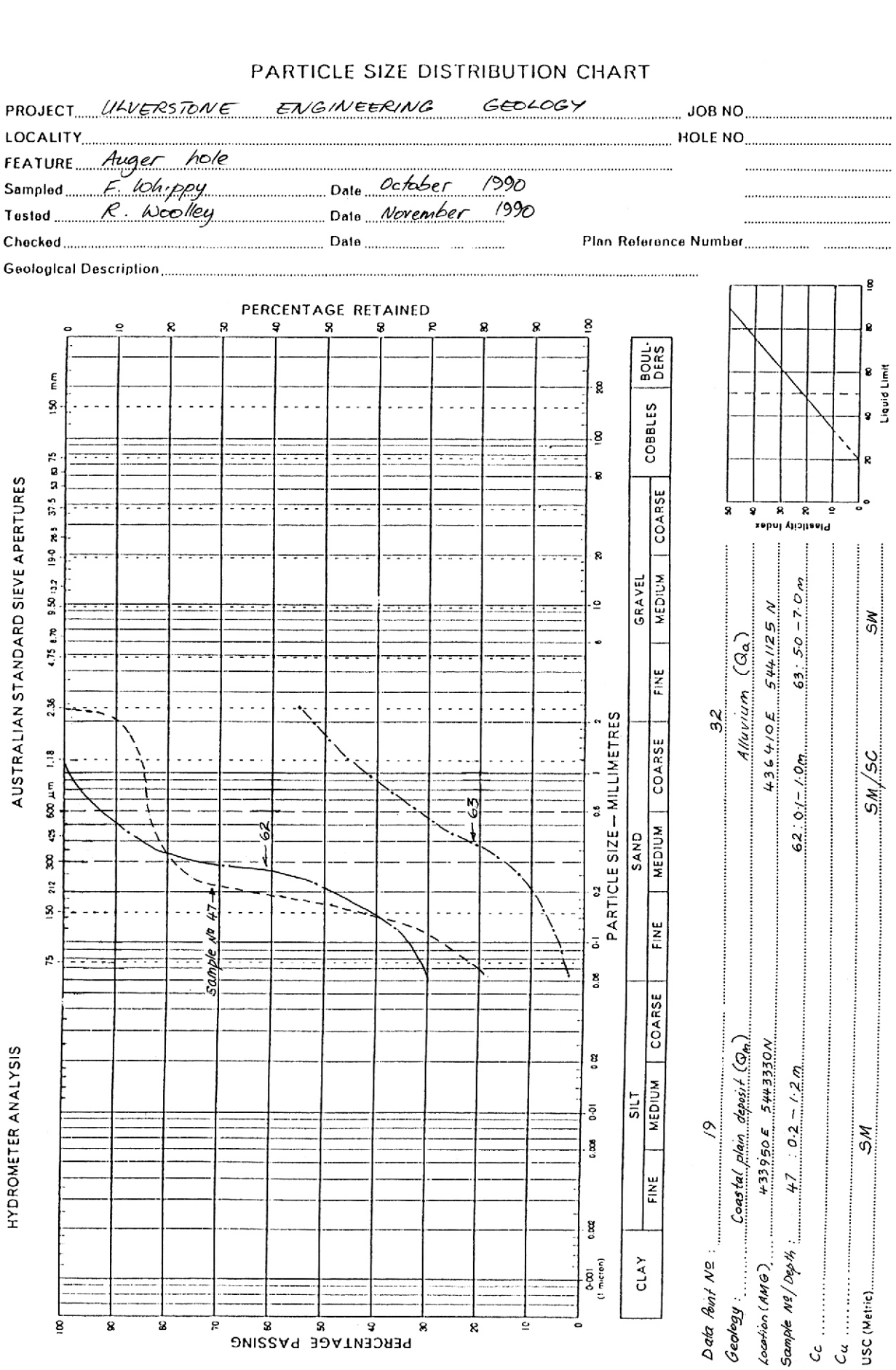


Figure 5

Particle size distribution chart of a coastal plain sample and two alluvial plain samples.

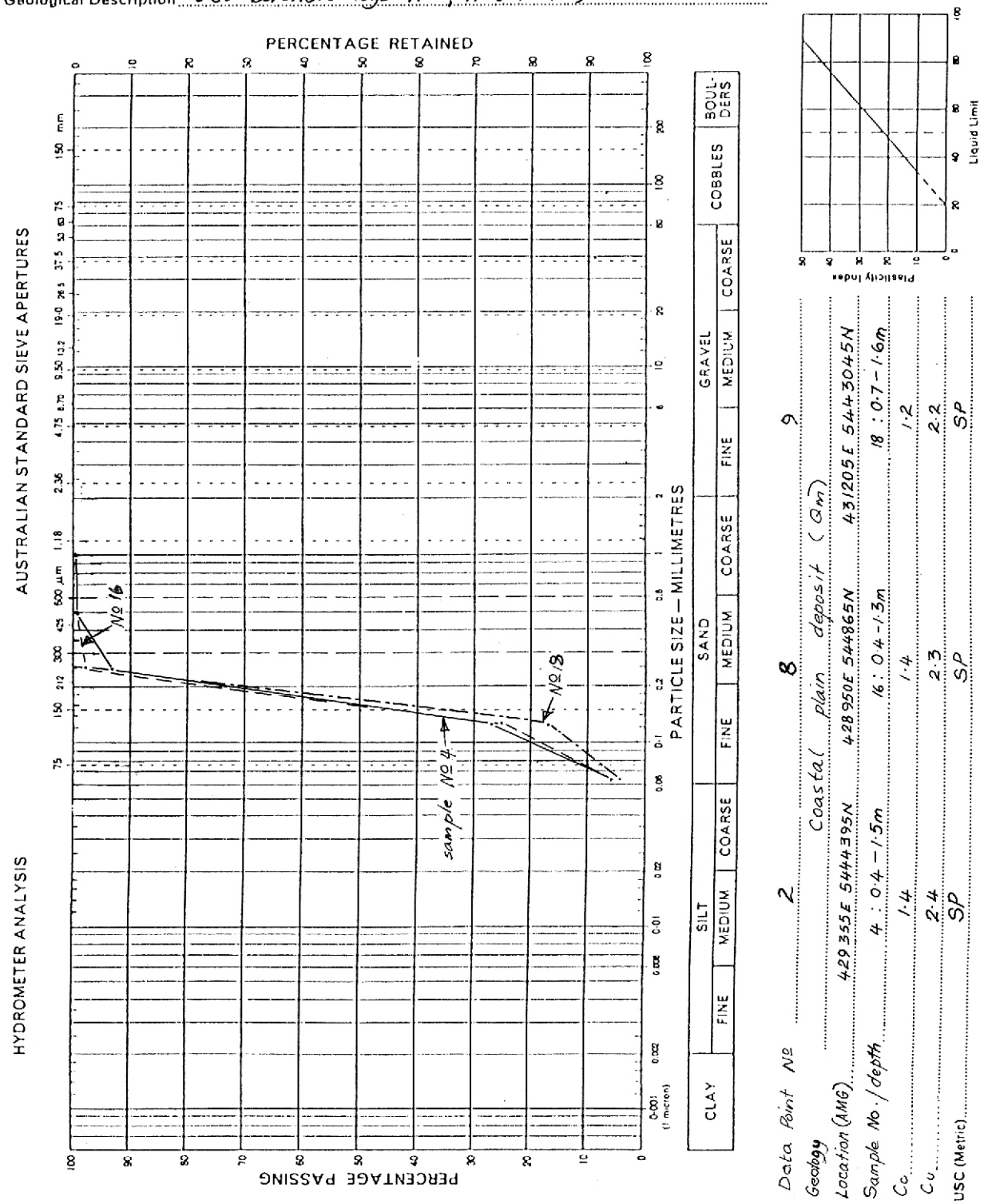
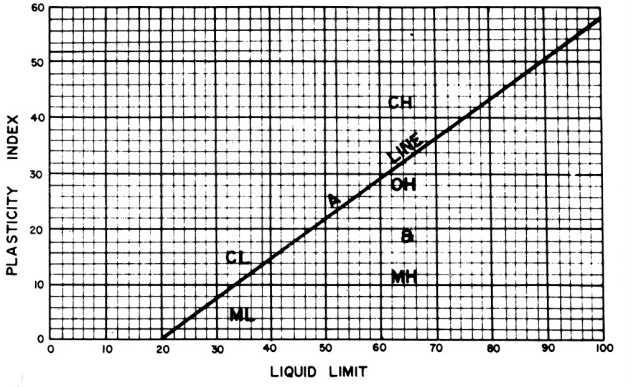


Figure 6

Particle size distribution chart of three samples of coastal plain sand.

Major Divisions			Group Symbols	Typical Names	Field Identification Procedures (Excluding particles larger than 15 mm [3"] and basing fractions on estimated weights)			Laboratory Classification Criteria		Information Required for Describing Soils
COARSE GRAINED SOILS More than half of material is larger than 0.075 mm (BS No. 200 Sieve)	GRAVELS More than half of coarse fraction larger than 5 mm (BS ¾" Sieve)	CLEAN GRAVELS Little or no fines	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6. $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	GW, GP, SW, SP, GM, GC, SM, SC Borderline cases requiring use of dual symbols.	Give typical name; indicate approximate percentages of sand and gravel; max. size; angularity; surface condition and hardness of the coarse grains; local or geological name and pertinent descriptive information; and symbol in parentheses. For undisturbed soils add information on stratification, degree of compactness, cementation and moisture conditions. Example: Silty sand, gravelly; about 20% hard, angular gravel particles 12 mm max. size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand (SM).
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.			Not meeting all gradation requirements for GW.		
		GRAVEL WITH FINES Appreciable amount of fines	GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity. (For identification procedures see ML below.)			Atterberg limits below "A" line or PI less than 4.	Atterberg limits above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.	
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines. (For identification procedures see CL below.)			Atterberg limits above "A" line with PI greater than 7.		
	SANDS More than half of coarse fraction smaller than 5 mm (BS ¾" Sieve)	CLEAN SANDS Little or no fines	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4. $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	Less than 5% smaller than 0.075 mm More than 12% smaller than 0.075 mm 5% to 12% smaller than 0.075 mm	
			SP	Poorly-graded sands, gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.			Not meeting all gradation requirements for SW.		
		SANDS WITH FINES Appreciable amount of fines	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity. (For identification procedures see ML below.)			Atterberg limits below "A" line or PI less than 4.	Atterberg limits above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.	
			SC	Clayey sands, sand-clay mixtures.	Plastic fines. (For identification procedures see CL below.)			Atterberg limits above "A" line with PI greater than 7.		
					Identification Procedure on Fraction Smaller than 0.4 mm (BS No. 36 sieve) size.					
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)			
FINE GRAINED SOILS More than half of material is smaller than 0.075 mm (BS No. 200 Sieve)	SILTS AND CLAYS Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None			Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any; local or geological name; and other pertinent descriptive information and symbol in parentheses. For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, and moisture condition. Example: Clayey silt, brown, slightly plastic, small percentage of fine sand, numerous vertical root holes, firm and dry in place, loess (ML).
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty.	Medium to high	None to very slow	Medium			
			OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight			
	SILTS AND CLAYS Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to Medium			
			CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High			
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium			
Highly Organic Soils			Pt	Peat and other highly organic soils.	Readily identified by colour, odour, spongy feel and frequently by fibrous texture.					

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand with clay binder.

LATERITIC SOILS: These soils may be classified texturally in accordance with the above system, but their properties may be inconsistent with accepted usage because of their tendency to harden on exposure to atmospheric conditions.

FIELD IDENTIFICATION PROCEDURES FOR FINE GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus 0.4 mm (BS No. 36 Sieve) size particles

DILATANCY (Reaction to shaking)
Prepare a pat of moist soil with a volume of about 10 mm^3. Add enough water, if necessary, to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing is a measure of the dilatancy. Very fine clean sands give the quickest and most distinct reaction whereas clays have no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

DRY STRENGTH (Crushing characteristics)
Mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying and then test its strength by breaking and crumbling between the fingers. Fine sand feels gritty whereas typical silt has the smooth feel of flour.

TOUGHNESS (Consistency near plastic limit)
A specimen of soil about 10 mm^3 in size is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about 3 mm in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity and crumbles when the plastic limit is reached. After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.
The toughness of the thread near the plastic limit and the stiffness of the lump when it finally crumbles is indicative of the clay content of the soil.

Figure 7. *Unified Soil Classification System (from SAA Code of Practice for Site Investigation).*

APPENDIX 1

Logs for data points 1 to 65

Geological symbols for logs

F	Fill
A	Topsoil
Qa	Alluvium
Qm	Coastal plain deposits
Sd	Slope deposit (transported soils)
Tbw	Residual soil — basalt parent rock
Tsi	Intra-basaltic sediments
Tbr	Basalt bedrock
Ts	Sub-basaltic sediments
Cw	Residual soil — Cambrian parent rock
Cr	Cambrian bedrock
PEw	Residual soil — Precambrian parent rock
PEr	Precambrian bedrock

r includes extremely weathered material (original rock fabric preserved)

Data point numbers:

1 to 54	auger holes
55	trench
56 and 57	existing excavations
58 to 65	surface grab sample sites

DATA POINT NO 1

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Auger hole

LOCATION Towards head of landslide on property adjacent to Spring Rises - W. Ulverstone

CASING/HOLE COMPLETION
- No support used
- End of hole 4·3m (refusal)

CO-ORDINATES		
	SYSTEM	AMG
	E	426945
	N	5445255
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 42m

penetration (123)	METHOD OF ADVANCING HOLE	ELEVATION (metres)	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C'_r (kPa)	ϕ'_r (deg)	NMC %	water level
	AS		1	CLAY; medium to high plasticity, red-brown, trace fine sand and fine to medium gravel (subangular basalt fragments)							F to St	M < PL															
	T/ST		2	colour change to dark brown, increase in moisture content & consistency	S_d	1/2	CH	35	20	175 220		M ≥ PL		1·77										4	32	50 54	
						* 3					VSt		2·37						80	49	17		3			44	
	AS		3	increase in gravel (HW - SW basalt) content to ≈ 10%.								M > PL															8·10·90
			4	End of hole : 4·3m (refusal)																							

Remarks
- Site on mid slopes of basalt escarpment in the middle of a landslide.
- water level : 3·52m ; conductivity : 290 µS (High water table due to close proximity to dam ?).

METHOD OF ADVANCING HOLE
- AS : auger screwing (d : 100mm).
- T : thin wall tube (d : 63mm).
- ST : square cross section tube (70×70mm).

EXPLANATION
- NMC : Natural Moisture Content.
- BWD : Bulk Wet Density.
- SPD : Soil Particle Density
- * : Mineral composition determined by XRD.
- 8.10.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller B. Cox	Logged F. Whippy
	Date 8.10.90
Plant : Triefus	Drawn F. Whippy
Started 8.10.90	Approved
Finished 8.10.90	Sheet 1 of 1

BOREHOLE LOG

DATA POINT NO 2

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Auger hole

LOCATION Moore Street reserve, towards Josephine Street end – W. Ulverstone

CASING/HOLE COMPLETION
. No support used
. End of hole : 5.05m (refusal)

CO-ORDINATES — SYSTEM AMG; E. 429355; N. 5444395

REDUCED LEVEL — DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 4m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C′ (kPa)	φ′ (deg)	% NMC	water level
	AS	0	SAND; fine to medium grained, black, organic rich (≈ 20–30%)	A						VL	D															
		1	SAND; fine to medium grained, light brown, quartz; trace silt + clay.	Q_m	4	SP				L	M			6		94										9.10.90
											W															
		2	BASALT; extremely weathered, extremely low to very low strength; pockets of clay- high plasticity.	Tb_r																						
		3																								
		4																								
		5	CLAY/SILT; low to medium plasticity, blue-grey, trace fine gravel (quartz-angular).	T_S		CL				St to VSt	M > PL															
			End of hole : 5.05m (refusal)																							

Remarks
· Site on coastal plain
· water level : 0.74m ; conductivity : 670 µS

METHOD OF ADVANCING HOLE
AS : auger screwing (d: 100mm).

EXPLANATION
NMC : Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density
9.10.90 Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller B. Cox
Plant : Triefus
Started 9.10.90
Finished 9.10.90

Logged F. Whippy
Date 9.10.90
Drawn F. Whippy
Approved
Sheet 1 of 1

DATA POINT NO 3

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: Auger hole

LOCATION: Upper Maud Street reserve, towards Clara Street end – N. Ulverstone

CASING/HOLE COMPLETION:
. No support used
. End of hole : 2·89m (refusal)

CO-ORDINATES: SYSTEM AMG; E. 429020; N. 5444215

REDUCED LEVEL: DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 1 m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C'r (kPa)	φ'r (deg)	NMC %	water
	AS	1	CLAY; high plasticity, dark brown, some organics and some coarse sand to fine gravel (HW–SW basalt fragmen-ts)							F	M ≥ PL															
	T		colour change to light brown with grey mottling, increase in moisture content & consistency	S_d	5*/6	CH	70 60	35 30	75 125		M > PL	2.26	1·80	70	16	14		115	86	24		1			44 44	dry
	AS				7*				100 150	St								101	71	21		1	5	15	45	
	ST	2	colour change to orange-brown and decrease in moisture content (decomposed basalt?)								M ≤ PL															
	AS		BASALT; EW–HW; VL strength	T_{bf}																						
		3	End of hole : 2·89m (refusal)																							

Remarks: Site ≈ ½ up basalt escarpment within landslide toe area.
. Seepage present 20m east of auger hole site.
. Basalt (HW–SW) apparently encountered ≈ 2m above Clara St. level during foundation excavations for houses at bottom of slope.

METHOD OF ADVANCING HOLE
AS : auger screwing (d : 100mm).
T : thin wall tube (d : 63mm).
ST : square cross section tube (70×70mm).

EXPLANATION
NMC : Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density.
* : Mineral composition determined by XRD

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Plant : Trietus
Started : 9·10·90
Finished : 9·10·90

Logged : F. Whippy
Date 9.10.90
Drawn F. Whippy
Approved
Sheet 1 of 1

DATA POINT NO. 4

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: Auger hole.

LOCATION: ≈ 300m west of Amy Street; on unstable slopes north of Upper Maud Street.

CASING/HOLE COMPLETION:
. No support used.
. End of hole : 7.3m (required depth).

REDUCED LEVEL — CO-ORDINATES: SYSTEM AMG; E. 428450; N. 5444475; DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 40m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C'r (kPa)	φ'r (deg)	NMC %	water
	AS	1	CLAY; high plasticity, dark brown, some fine gravel (HW–SW basalt).	A		CH				St	M < PL															
			change in colour to red – brown (trace angular quartz in gravel).								M ≥ PL															
		2	change in colour to orange – brown; some sand (coarse grained – quartz and basalt fragments).							St to VSt																9.10.90 ▼
			change in consistency to soft	S_d	8*					S								108	76	24		6			49	
		3	change in consistency – stiff to very stiff.							VSt	M > PL															
		4																								
			CLAY; high plasticity, grey.		9*							2.36						112	79	18		1	2	8	45	
		5																								
			Gravelly CLAY; medium to high plasticity, light grey–green; gravel – fine to medium sub-angular, quartz.	Ts						S to F																
		6																								
		7			10																					
			End of hole : 7.3m (required depth)																							

Remarks: . Site in the middle of landslide displaced mass (mid slopes basalt escarpment).
. water level : 1.74m ; conductivity : 160 µS

METHOD OF ADVANCING HOLE
AS: auger screwing (d: 100mm).

EXPLANATION
NMC : Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density.
* : Mineral composition determined by XRD.
9.10.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller: B. Cox
Plant: Triefus
Started: 9.10.90
Finished: 9.10.90

Logged: F. Whippy
Date: 9.10.90
Drawn: F. Whippy
Approved
Sheet 1 of 1

DATA POINT NO. 5

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: Auger hole

LOCATION: East edge of western most reservoir enclosure - W. Ulverstone.

CASING/HOLE COMPLETION:
- No support used
- End of hole : 7m (required depth).

CO-ORDINATES: SYSTEM AMG; E. 427440; N. 5444525

REDUCED LEVEL: DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 90m

penetration (123)	METHOD OF ADVANCING HOLE	ELEVATION	DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C'r (kPa)	φ'r (deg)	NMC %	water
	AS		1	Sandy SILT; low to medium plasticity, dark grey, some organics; sand - fine grained (quartz, rock fragments)	A		ML				F	M < PL															dry
			2	CLAY; low to medium plasticity, light brown; some gravel - fine to medium quartz (primary)	Pεw		CL																				
				QUARTZITE; extremely to highly weathered, very low strength, cream, medium grained.																							
			3																								
			4	SCHIST; extremely weathered, extremely low strength, some quartz veining. Remoulds to silty SAND; fine grained, trace fine gravel (quartz and rock fragments).	Pεr																						
			5																								
			6																								
			7	End of hole : 7m (required depth)																							

Remarks: Site located on hill (West bank) composed of Pre-Cambrian Goat Island Conglomerate (Ulverstone Metamorphics).

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm).

EXPLANATION

NMC : Natural Moisture Content.

BWD : Bulk Wet Density.

SPD : Soil Particle Density.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : F. Whippy
	Date : 9.10.90
Plant : Triefus	Drawn : F. Whippy
Started : 9.10.90	Approved
Finished : 9.10.90	Sheet 1 of 1

DATA POINT NO 6

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY.
FEATURE: Auger hole.
LOCATION: Beside track to Costa Mesa – W. Ulverstone.
CASING/HOLE COMPLETION: · No support used.
· End of hole : 6·7m (refusal).

REDUCED CO-ORD LEVEL: SYSTEM AMG; E 427275; N 5444825; DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 73m

Penetration 1 2 3	Method of Advancing Hole	Elevation / Depth (metres)	Geological Description (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	Geological Symbol	Sample Number	Classification (USC metric)	Field Tests: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	Consistency / density index	Moisture condition	Laboratory Tests: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C'r (kPa)	φ'r (deg)	NMC %	Water
	AS	1	CLAY; high plasticity, dark brown, some organics.	A						F to St																
	T	2			11*				200 300				1·60					69	35	16		6			34 34	
		3	change in colour to red-brown.	TS_i		CH	>130			St to VSt	M < PL															dry
	AS	4																								
		5	change in colour to orange-brown; some medium grained gravel (limonite) towards end of hole.	Tb_W	12																					
		6																								
		7	End of hole : 6·7m (refusal)																							

Remarks: · Site on basalt ridge.

METHOD OF ADVANCING HOLE
AS : auger screwing (d : 100mm).
T : thin wall tube (d_i : 63mm).
ST : square cross section tube (70 × 70mm).

EXPLANATION
NMC : Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density.
* : Mineral composition determined by XRD.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Plant : Triefus
Started : 9.10.90
Finished : 9.10.90
Logged : F. Whippy
Date : 9.10.90
Drawn F. Whippy
Approved
Sheet 1 of 1

DATA POINT NO 7

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: Auger hole

LOCATION: On slopes between South Road & Bass Highway – opposite Hearps Road.

CASING/HOLE COMPLETION:
. No support used
. End of hole : 7m (required depth).

CO-ORDINATES: SYSTEM AMG; E 428045; N 5443785

REDUCED LEVEL: DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 27m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C'r (kPa)	φ'r (deg)	NMC %	water
	AS	0	SAND; fine grained, dark brown (organics); some silt/clay.	F		SP				L	D															
		1	Sandy SILT; low to medium plasticity, light brown. Sand – fine grained.	Qa		ML				St	M < PL															
		2			14*													59	23	12		6			24	
		3																								dry
		4	MUDSTONE; extremely weathered, extremely low to very low strength; some fine grained thin sandy lenses. Remoulds to high plasticity silt	Cr		MH				VSt	M ≥ PL															
	T				15				275 325				1.60												24	
	AS	5																								
		6																								
		7	End of hole : 7m (required depth)																							

Remarks:
. Site on slopes composed of Cambrian Cateena Point Mudstone.
. Hand dug well ≈ 30m upslope with water level: 6.04m & conductivity: 105 µS.

METHOD OF ADVANCING HOLE
AS : auger screwing (d : 100mm).
T : thin wall tube (d : 63mm).

EXPLANATION
NMC : Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density.
* : Mineral composition determined by XRD

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Logged : F. Whippy
Date : 10.10.90
Plant : Triefus
Drawn : F. Whippy
Started : 10.10.90
Approved
Finished : 10.10.90
Sheet 1 of 1

DATA POINT NO 8

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Auger hole

LOCATION West Ulverstone recreation ground (Amy Street side)

CASING/HOLE COMPLETION . No support used

. End of hole : 3·2m (refusal).

REDUCED LEVEL — CO-ORDINATES: BYSTEM AMG; E. 428950; N. 5444865; DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 3m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C'r (kPa)	φ'r (deg)	N/MC %	water
			Silty SAND; fine grained, dark brown (organics - appreciable).	A		SM					M															
	AS	1	SAND; fine grained, light brown, some peat (slight odour), trace silt.	Qm	16	SP				L	W			6		94										10.10.90 ▼
		2																									
		3	SCHIST; highly weathered, very low strength, some quartz veining	Pεr	17																						
			End of hole : 3·2m (refusal).																								

Remarks
. Site on coastal plain
. water level : 0·52m ; conductivity : 900μS

METHOD OF ADVANCING HOLE
AS : auger screwing (d : 100mm).

EXPLANATION
NMC : Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density
10·10·90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Logged : F. Whippy
Date : 10·10·90
Plant : Triefus
Drawn : F. Whippy
Started : 10.10.90
Approved
Finished : 10.10.90
Sheet 1 of 1

DATA POINT NO 9

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Auger hole

LOCATION Ampol Service Station backyard — junction Eastland Drive and Main Street.

CASING/HOLE COMPLETION
. No support used
. End of hole : 7m (required depth).

REDUCED LEVEL	CO-ORDINATES	
	SYSTEM	AMG
	E.	431205
	N.	5443045
	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 15m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency / density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BWD (g/cm³)	Mechanical Analysis: Clay %	Mechanical Analysis: Silt %	Mechanical Analysis: Sand %	Mechanical Analysis: Gravel %	Index Tests: Liquid Limit %	Index Tests: Plasticity Index %	Index Tests: Linear Shrinkage %	LABORATORY TESTS: Free Swell %	LABORATORY TESTS: Emerson Class No	Shear Strength Parameters: C'r (kPa)	Shear Strength Parameters: φ'r (deg)	LABORATORY TESTS: NMC %	water
	AS	1	Silty SAND; fine to medium grained, black (organics).	A		SM					D to M															
		1	SAND; fine to medium grained, dark brown; thin (5mm) dense layers.		18						M			4		96										10.10.90
		2	change in colour to dark grey.	Q_m		SP				L	W														
		5	Sandy CLAY; low to medium plasticity, light grey with dark grey pockets; trace fine to medium grained gravel (subround to angular quartz and rock fragments), mica rich. (PHYLLITE – weathered in-situ?)	Pe_w	19*	CL/ML				S to F	M > PL											5				
		7	End of hole : 7m (required depth).																							

Remarks
. Site on coastal plain.
. water level : 1·08 ; conductivity : 190 μS

METHOD OF ADVANCING HOLE
AS : auger screwing (d : 100mm).

EXPLANATION
NMC : Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density
* : Mineral composition determined by XRD
10.10.90 Water level on date shown

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : F. Whippy
	Date : 10·10·90
Plant : Triefus	Drawn : F. Whippy
Started : 10.10.90	Approved
Finished : 10. 10. 90	Sheet 1 of 1

DATA POINT NO 10

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: Auger hole

LOCATION: Nature strip at eastern end of Leighlands Avenue – E. Ulverstone.

CASING/HOLE COMPLETION:
. No support used
. End of hole : 3·2m (refusal)

CO-ORDINATES — SYSTEM: AMG; E. 432705; N. 5443575

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 6m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters c'r (kPa)	Shear Strength Parameters φ'r (deg)	NMC %	water
	AS	1	Silty SAND; fine grained, dark brown.	A		SM																				
			SAND; fine to medium grained, brown – grey, quartz.			SP				L	D															
			Sandy CLAY; high plasticity, grey with orange mottling; sand – fine to medium grained & occur in lenses.		20*	CH	60	15	125 / 150	St	M > PL	2·43						62	45	16		5			25	10·10·90 ▼
		2	Clayey SAND; fine to medium grained, light grey; clay – high plasticity	Q_m		SC				L	M to W															
			CLAY; high plasticity, olive-green, trace fine gravel (basalt).			CH				St	M > PL															
			SAND; fine to medium grained (?) (NO RETURN)			SP				L																
		3	GRAVEL; fine to medium grained, angular to subangular; trace clay.			GP																				
			End of hole : 3·2m (refusal).																							

Remarks:
. Site on coastal plain
. water level: 1·41m ; conductivity : 960μS

METHOD OF ADVANCING HOLE
AS : auger screwing (d: 100mm).

EXPLANATION
NMC: Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density
* : Mineral composition determined by XRD
10·10·90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL
(see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Logged : F. Whippy
Date : 10·10·90
Plant : Triefus
Drawn : F. Whippy
Started : 10·10·90
Approved
Finished : 10·10·90
Sheet 1 of 1

DATA POINT NO 11

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: Auger hole

LOCATION: John Wrights' property – slope between Von Bibras Road & Wrights Valley.

CASING/HOLE COMPLETION:
. No support used
. End of hole : 7m (required depth)

CO-ORDINATES: SYSTEM AMG; E 430370; N 5441720

REDUCED LEVEL: DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 47m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters c'r (kPa)	φ'r (deg)	NMC %	water
	AS	0	Silty CLAY; low plasticity, dark brown.	A		CL	65	20	250 / 350	F																
		1	CLAY; high plasticity, red-brown; trace fine to medium sand (basalt fragments).	S_d	21*						M < PL	2.57						87	51	20		G			38	
		2								VSt																
		3				CH																				
		4	increase in moisture content.								M ≥ PL															10.10.90
	T	5	decrease in consistency and increase in moisture content.		22		70	30	125 / 150	St	M > PL		1.74												58 / 56	
	AS	6	red-brown with orange-yellow mottling, increase in cosistency; relict rock texture discernible. (BASALT – EW, EL-VL strength)	Tb_r						VSt																
		7	End of hole : 7m (required depth)																							

Remarks:
. Site towards head of landslide on basalt slope.
. water level : 4.42m ; conductivity : 190 μS

METHOD OF ADVANCING HOLE
AS : auger screwing (d : 100mm).
T : thin wall tube (d : 63mm).

EXPLANATION
NMC : Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density
* : Mineral composition determined by XRD.
10.10.90 ▼ Water level on date shown

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Logged : F. Whippy
Date : 10.10.90
Plant : Triefus
Drawn : F. Whippy
Started : 10.10.90
Approved
Finished : 10.10.90
Sheet 1 of 1

DATA POINT NO 12

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Auger hole

LOCATION Slopes behind dams, Mc Kennas property – end of Von Bribras Road.

CASING/HOLE COMPLETION

. No support used

. End of hole : 5·5m (required depth)

REDUCED LEVEL — CO-ORD INATES: SYSTEM AMG; E. 431200; N. 5441485; DATUM AHD(Tasmania); COLLAR GROUND SURFACE ≈ 77m

penetration	METHOD OF ADVANCING HOLE	ELEVATION	DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C'r (kPa)	φ'r (deg)	NMC %	water
1 2 3				CLAY; medium to high plasticity, black (organics); some silt.	A						F	M < PL															
				colour change to dark brown.							F to St	M > PL															
			1	colour change to red-brown, grey mottling; some fine to medium sand, trace fine gravel (basalt fragments).		23				400 325 375		M > PL														41	
				colour change to dark red-brown and decrease in moisture content.		24		90	20	175 250		M < PL														50	
			2	Gravelly CLAY; f-med. HW basalt frags.		25						M > PL														52	
				red-brown, orange mottling; fr. gravel.		26																				52	
				trace fine sand.		27				250 300																53	
	AS		3		S_d		CH				VSt																
				colour change to yellow-brown; some medium to coarse sand (limonite nodules and rock fragments).								M > PL															
			4			28*							2·50						148	105	29		6			60	12·10·90
			5																								11·10·90
	T					29		40	15	50 150 200	F to St			1·64												74	
				End of hole : 5·5m (required depth).																							

Remarks

- Site in the middle of landslide displaced mass – basalt slopes.
- Water levels : 4·8m (11.10.90), 4·15m (12.10.90); conductivity : 150 µS.

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm).

T : thin wall tube (d; : 63mm).

EXPLANATION

NMC : Natural Moisture Content.

BWD : Bulk Wet Density.

SPD : Soil Particle Density

*: Mineral composition determined by XRD

11·10·90 Water level on date shown

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 11.10.90

Finished : 11.10.90

Logged : F. Whippy

Date : 11·10·90

Drawn : F. Whippy

Approved

Sheet 1 of 1

DATA POINT NO 13

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Auger hole

LOCATION Slope east of Preston Road, above dams - John Wrights property: C. Ulverstone

CASING/HOLE COMPLETION
- No support used
- End of hole : 4·9m (refusal).

CO-ORD INATES: BYSTEM AMG; E. 430270; N. 5440870

REDUCED LEVEL: DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 67m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters c' (kPa)	φ' (deg)	N:MC %	water
	AS		1	CLAY; medium to high plasticity, black (organics); trace fine to medium sand.	A					250 350	F	M < PL														
	AS		2	colour change to dark brown; some fine to coarse sand, trace fine gravel (basalt fragments).				80	30		VSt	M ≥ PL														
			3	colour change to red-brown; trace coarse sand to fine gravel (basalt fragments).	S_d	30*	CH												113	72	22	6			38	12.10.90
				colour change to grey with orange mottling.		31				175 200									105	62	17	3			39	
	ST					32*		55	20				2·68						98	30	21	3	5	21	43	
	AS		4	colour change to dark brown.							St	M >> PL													11.10.90
				some fine to medium gravel (basalt)						150 175																
				End of hole : 4·9m (refusal).																						

Remarks
- Site at the head of a landslide.
- water levels : 4·16m (11.10.90), 3m (12.10.90); conductivity : 400 µS

METHOD OF ADVANCING HOLE
- AS : auger screwing (d: 100mm).
- ST : square cross section tube (70×70mm).

EXPLANATION
- NMC : Natural Moisture Content.
- BWD : Bulk Wet Density.
- SPD : Soil Particle Density.
- * : Mineral composition determined by XRD.
- 11.10.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Logged : F. Whippy
Plant : Triefus
Date : 11.10.90
Started : 11.10.90
Drawn : F. Whippy
Finished : 11.10.90
Approved
Sheet 1 of 1

DATA POINT NO 14

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: Auger hole

LOCATION: Top of ridge above dams - John Wrights' property : C. Ulverstone

CASING/HOLE COMPLETION:
. No support used
. End of hole : 7.2m (required depth).

REDUCED LEVEL — CO-ORDINATES: BYSTEM AMG; E. 430620; N. 5440875; DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 67m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BND (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No.	Shear Strength Parameters: C'r (kPa)	φ'r (deg)	NMC %	water
		0	CLAY; high plasticity, black; trace f-m sand.	A					275	F	≤PL															
		1	colour change to red-brown with yellow/grey mottling							VSt																
			colour change to yellow-brown; trace fine gravel (basalt).				60	25	100																	
		2			33*							2.56		78	19	3		140	98	28		6	5	18	64	
	AS	3	colour change to dark brown; some coarse sand (HW basalt fragments and vesicle infillings).	Tb_W	34	CH				F to St	M > PL															dry
		4	colour change to red-brown																							
		5	colour change to dark brown; some medium sand to fine gravel (vesicle infillings).																							
		6																								
	T	7	light brown with yellow orange mottling; relict texture (EW basalt).		35		20	10	225 275	VSt			1.56												66 82	
			End of hole : 7.2m (required depth).																							

Remarks:
. Site on basalt ridge
. Sample 34 is for interval between 1.8 - 4.3m

METHOD OF ADVANCING HOLE
AS : auger screwing (d: 100mm).
T : thin wall tube (d: 63mm).

EXPLANATION
NMC: Natural Moisture Content.
BWD: Bulk Wet Density.
SPD: Soil Particle Density.
*: Mineral composition determined by XRD

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller: B. Cox
Plant: Triefus
Started: 11.10.90
Finished: 11.10.90

Logged: F. Whippy
Date: 11.10.90
Drawn: F. Whippy
Approved
Sheet 1 of 1

DATA POINT NO 15

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: Auger hole

LOCATION: Beside creek crossing - side road to Mc Kennas homestead: C. Ulverstone

CASING/HOLE COMPLETION:
. No support used
. End of hole : 2.9m (refusal).

CO-ORDINATES: SYSTEM: AMG; E: 429710; N: 5440580

REDUCED LEVEL: DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 33m

penetration (123)	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: c'r (kPa)	φ'r (deg)	NMC %	water
			CLAY; medium to high plasticity, dark brown (organics); some fine sand (rock fragments).	A						F																
	AS	1	same as above with grey-orange mottling.		36*	CH	40	25	150 / 120 / 110		M > PL	2.53						109	81	21		5	4	18	32	
			colour change to blue-grey with orange mottling.	Qa			90	25	200 / 210	St																11-10-90
		2	Sandy CLAY; medium to high plasticity, olive green; some fine gravel; sand-medium to coarse; quartz, rock fragments.		37						M < LL															
			End of hole : 2.9m (refusal)																							

Remarks:
. Site on alluvial flat.
. water level : 1.8m ; conductivity : 500μS (auger hole); 180μS (creek).

METHOD OF ADVANCING HOLE
AS : auger screwing (d : 100mm).

EXPLANATION
NMC : Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density
* : Mineral composition determined by XRD
11-10-90 ▼ Water level on date shown

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Plant : Triefus
Started : 11-10-90
Finished : 11-10-90

Logged : F. Whippy
Date : 11-10-90
Drawn : F. Whippy
Approved
Sheet 1 of 1

DATA POINT NO 16

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Auger hole

LOCATION Slopes between Hazelwoods Hill and Bass Highway

CASING/HOLE COMPLETION

. No support used

. End of hole : 2·8m (required depth)

CO-ORDINATES — SYSTEM: AMG; E. 430880; N. 5442175

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 67m

penetration (m)	METHOD OF ADVANCING HOLE	ELEVATION (metres)	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C'r (kPa)	φ'r (deg)	NMC %	water
				Silty CLAY; high plasticity, black; trace f sand.	A						F	< PL															
			1	CLAY; medium to high plasticity, olive green; some fine to medium sand.	S_d	38*	CH	75	25	100 / 150			2·31						129	98	24	1				46	
	AS		2	BASALT; extremely to highly weathered, very low strength, light brown. Remould's (in parts) to sandy and gravelly CLAY; high plasticity.	Tb_r						St	M > PL															dry
				colour change to dark brown																							
				End of hole : 2·8m (required depth).																							

Remarks : Site in the middle of a small slump.

METHOD OF ADVANCING HOLE — AS : auger screwing (d : 100mm).

EXPLANATION — NMC : Natural Moisture Content. BWD : Bulk Wet Density. SPD : Soil Particle Density. * : Mineral composition determined by XRD

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox — Logged : F. Whippy

Date : 12·10·90

Plant : Triefus — Drawn : F. Whippy

Started : 12·10·90 — Approved

Finished : 12·10·90 — Sheet 1 of 1

DATA POINT NO 17

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Auger hole

LOCATION Slopes between Hazelwoods Hill and Bass Highway.

CASING/HOLE COMPLETION

. No support used.

. End of hole : 2·9m (required depth)

CO-ORDINATES — SYSTEM: AMG; E. 430915; N. 5442095

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 63m

Penetration 1 2 3	Method of advancing hole	Elevation / Depth (metres)	Geological description (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	Geological symbol	Sample number	Classification (USC metric)	Field tests: Vane shear strength Peak (kPa)	Vane shear strength Residual (kPa)	Penetrometer (kPa)	Consistency / density index	Moisture condition	Laboratory tests: SPD (g/cm³)	BWD (g/cm³)	Mechanical analysis Clay %	Silt %	Sand %	Gravel %	Index tests Liquid limit %	Plasticity index %	Linear shrinkage %	Free swell %	Emerson class No	Shear strength parameters C′ (kPa)	φ′ (deg)	NMC %	Water
	AS	1	SILT ; high plasticity, black (organics); trace fine gravel (basalt frags.)	A						F	M ≫ PL															
	AS		colour change to dark brown with orange-grey mottling; derease in consistency.	S_d	39*	MH			25 50	S	M < LL							168	129	25		3			63	
	ST		CLAY; high plasticity, colour as above.		40*	CH	25 20	20 15	25			2·25		91	6	3		173	136	28		3	6	12	64	
	AS	2	BASALT ; extremely to highly weathered, very low strength, light brown. Remoulds to gravelly CLAY; high plasticity, gravel-fine to medium grained (basalt frags.)	Tb_r		GC CH			75 100	F to St	M > PL															dry
			End of hole : 2·9m (required depth).																							

Remarks : . Site in the middle of a small slump.

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm).

ST : square cross section tube (70×70mm).

EXPLANATION

NMC : Natural Moisture Content.

BWD : Bulk Wet Density.

SPD : Soil Particle Density.

* : Mineral composition determined by XRD

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Trieflus

Started : 12·10·90

Finished : 12·10·90

Logged : F. Whippy

Date : 12·10·90

Drawn : F. Whippy

Approved

Sheet 1 of 1

DATA POINT NO 18

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: Auger hole

LOCATION: Slopes between Hazelwoods Hill and Bass Highway

CASING/HOLE COMPLETION:
- No support used
- End of hole : 4.3m (refusal)

CO-ORDINATES: SYSTEM AMG; E 430985; N 5442025

REDUCED LEVEL: DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 65m

penetration f 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C'r (kPa)	φ'r (deg)	NMC %	water
	AS		1	Silty CLAY; high plasticity, black (organics).	A						F	>PL															
				CLAY; high plasticity, dark brown with grey mottling.		41*						M < LL	2.50						135	103	26		3			51	
			2	colour change to light brown with orange & grey mottling; some fine to medium sand (rock fragments & vesicle infillings).	S_d		CH	65	30	75 / 125	St to VSt	M ≤ PL															dry
			3	same as above with increase in moisture content.								M > PL															
			4	BASALT; extremely to highly weathered, very low strength, light brown. Remoulds to sandy CLAY; fine-medium	T_{b_r}							M < PL															
				End of hole : 4.3m (refusal)																							

Remarks: . Site in the middle of a small slump.

METHOD OF ADVANCING HOLE: AS : auger screwing (d : 100mm).

EXPLANATION: NMC : Natural Moisture Content. BWD : Bulk Wet Density. SPD : Soil Particle Density. * : Mineral composition determined by XRD.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Logged : F. Whippy
Date : 12.10.90
Plant : Triefus
Drawn : F. Whippy
Started : 12.10.90
Approved
Finished : 12.10.90
Sheet 1 of 1

DATA POINT NO 19

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Auger hole

LOCATION Paddock adjacent to North West Model Engineering Society compound – N. Ulverstone

CASING/HOLE COMPLETION
. No support used
. End of hole : 2.7m (refusal)

CO-ORDINATES: SYSTEM AMG; E. 433950; N. 5443330

REDUCED LEVEL: DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 4m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION	DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters c'r (kPa)	φ'r (deg)	NMC %	water
	AS		0	SAND; fine-medium, dark brown, some organics	A							D															
			1	SAND; fine-coarse, light brown; some clay and trace fine gravel (well rounded quartz & chert).	Qm	47	SM				L	M			19	71	10										30.10.90
			2	colour change to light grey-brown, sand dominantly medium size; trace clay.								W															
				No return – poorly graded gravel?			GP																				
				End of hole : 2.7m (refusal).																							

Remarks
. Site on coastal plain.
. water level : 1m ; conductivity : 850μS

METHOD OF ADVANCING HOLE
AS : auger screwing.

EXPLANATION
NMC : Natural Moisture Content.
BWD : Bulk Wet Density.
SPD : Soil Particle Density.
30.10.90 Water level on date shown.

GEOLOGICAL SYMBOL (see text).

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Plant : Triefus
Started : 30.10.90
Finished : 30.10.90
Logged : J. Whippy
Date : 30.10.90
Drawn : J. Whippy
Approved
Sheet 1 of 1

DATA POINT NO 20

BOREHOLE LOG

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: Auger hole

LOCATION: Beside fence behind information board; Frombergs - N. Ulverstone

CASING/HOLE COMPLETION: No support used

. End of hole : 1.5m (refusal)

CO-ORDINATES: SYSTEM AMG; E. 433545; N. 5443115

REDUCED LEVEL: DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 8m

penetration (1 2 3)	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BWD (g/cm³)	Mechanical Analyses: Clay %	Mechanical Analyses: Silt %	Mechanical Analyses: Sand %	Mechanical Analyses: Gravel %	Index Tests: Liquid Limit %	Index Tests: Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C_r' (kPa)	Shear Strength Parameters: ϕ_r' (deg)	NMC %	water
	AS	0.5	SAND; fine to medium, dark brown, organic rich.	A		SP				L																
			SAND; fine to medium, light grey; some fine gravel.																							
		1	Clayey SAND; fine to medium, light brown with dark brown & orange mottling; trace fine gravel (well rounded quartz). Clay - med to high plasticity.	Qm		SC				L to MD	M															dry
		1.5	Gravelly CLAY; high plasticity, light brown, trace fine to medium sand. Gravel - fine to medium, well rounded quartz.			CH				F to St	>PL															
			End of hole : 1.5m (refusal)																							

Remarks: Site towards edge of coastal plain.

METHOD OF ADVANCING HOLE
- AS : auger screwing (d: 100mm)
- T : thin wall tube (d; : 63mm)
- ST : square cross section tube (70x70mm).

EXPLANATION
- NMC : Natural Moisture Content
- BWD : Bulk Wet Density
- SPD : Soil Particle Density
- 27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller: B. Cox
Plant: Triefus
Started: 30.10.90
Finished: 30.10.90

Logged: J. Whippy
Date: 30.10.90
Drawn: J. Whippy
Approved:
Sheet 1 of 1

DATA POINT NO 21

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Slope facing Preston Road - Braids property : Central Ulverstone

CASING/HOLE COMPLETION

. No support used

. End of hole : 4.2m (refusal).

CO-ORDINATES		
	SYSTEM	AMG
	E.	429350
	N.	5441710
REDUCED LEVEL	DATUM	AHD(Tasmania)
	COLLAR GROUND SURFACE	≈ 37m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: c'r (kPa)	φ'r (deg)	NMC %	water
			CLAY; medium - high plasticity, black	A						F																
	AS	1	CLAY; medium - high plasticity, dark brown; trace coarse sand to fine gravel (angular quartz and rock fragments)	Sd	48*	CH	85	25		St	M < PL	2.69						64	29	16		6			27	dry
		2																								
		3	colour change to red - brown																							
		4	End of hole: 4.2m (refusal)																							

Remarks

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm)

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : T. Whippy
	Date : 30.10.90
Plant : Triefus	Drawn : T. Whippy
Started : 30.10.90	Approved :
Finished : 30.10.90	Sheet 1 of 1

DATA POINT NO 22

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Basalt slopes facing Gawler River - Braids property : Central Ulverstone

CASING/HOLE COMPLETION

. No support used

. End of hole : 1.5m (refusal)

CO-ORDINATES — SYSTEM: AMG; E: 428565; N: 5441875

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 32m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C'r (kPa)	φ'r (deg)	NMC %	water
			CLAY; medium to high plasticity, dark brown	A						F																
	AS	1	CLAY; high plasticity, light brown with orange & light grey mottling; some medium sand to fine gravel (rock fragments).	Sd	49*	CH	40	15	75 / 100	F to St	M < PL	2.49						85	58	20		2			39	dry
			BASALT; highly weathered, L strength, brown	Tdr																						
			End of hole : 1.5m (refusal)																							

Remarks

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm)

T : thin wall tube (d : 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD.

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 30.10.90

Finished : 30.10.90

Logged : J. Whippy

Date : 30.10.90

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 23

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Towards bottom of slope facing Gawler River - Braids property : Central Ulverstone.

CASING/HOLE COMPLETION
. No support used
. End of hole : 7m (required depth).

REDUCED CO-ORD LEVEL — SYSTEM: AMG; E. 428590; N. 5441580; DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 16m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BND (g/cm³)	Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C′ (kPa)	Shear Strength Parameters φ′ (deg)	NMC %	water
	AS	1	SAND; fine-medium, light grey; trace clay.	Qa		SP				L	M															
			SILT; medium to high plasticity, light brown; some sand-fine to medium (quartz and rock fragments).		50*	MH	60	25	100 125 125	St	M < PL	2.71						54	23	14		6			26	
		2	Clayey SAND: fine-medium, light brown with grey mottling.			SC				L	M															
			CLAY, medium to high plasticity, light grey brown; some fine to medium sand and trace medium gravel (quartz-subrounded).							St to VSt																
		3	colour change to light brown			CH				F to St	M ≥ PL															30.10.90
		6	colour change to dark brown.							S to F	M > PL															
		7	End of hole : 7m (required depth).																							

Remarks
. Site within alluvium
. water level : 5.92m ; conductivity : 210μS

METHOD OF ADVANCING HOLE
AS : auger screwing (d: 100mm).
T : thin wall tube (d: 63mm).
ST : square cross section tube (70x70mm).

EXPLANATION
NMC : Natural Moisture Content
BWD : Bulk Wet Density
SPD : Soil Particle Density
* : Mineral composition determined by XRD
27.8.90 Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox
Plant : Triefus
Started : 30.10.90
Finished : 30.10.90

Logged : J. Whippy
Date : 30.10.90
Drawn : J. Whippy
Approved :
Sheet 1 of 1

DATA POINT NO 24

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Slope facing Gawler River - Braids property : central Ulverstone

CASING/HOLE COMPLETION

. No support used

. End of hole : 2·8m (required depth).

CO-ORDINATES		
	SYSTEM	AMG
	E	428770
	N	5441280
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 40m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: c'r (kPa)	φ'r (deg)	NMC %	water
				Gravelly CLAY; low-medium plasticity, red-brown; gravel - fine to medium	Pe_W	51*	CL				F to St	M ≤ PL	2·65						43	17	9		6			15	
	AS	1	1	SCHIST; extremely to highly weathered, very low to low strength, light brown. Remoulds to gravelly CLAY; low to medium plasticity. Some quartz veining. Gravel - fine to medium, quartz & rock fragments	Pe_r	52																					dry
			2	End of hole: 2·8m (required depth).																							

Remarks

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm)

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 30.10.90

Finished : 30.10.90

Logged : J. Whippy

Date : 30.10.90

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT No 25

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Nose of ridge facing West Gawler Road - Carters property : Central Ulverstone

CASING/HOLE COMPLETION
. No support used
. End of hole : 1.5m (refusal)

CO-ORDINATES — SYSTEM: AMG; E. 429345; N. 5440920

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 42m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BND (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C′ (kPa)	ϕ′ (deg)	NMC %	water
	AS	0.5	CLAY; medium – high plasticity, dark brown; trace fine sand.	A						F																
	AS	1	Gravelly CLAY; high plasticity, olive green. Gravel – fine to medium grained basalt fragments (slightly weathered to fresh)	T_{bw}	53*	CH			100 100 125	St	M < PL							76	49	19		5			15	dry
			End of hole : 1.5m (refusal).																							

Remarks

METHOD OF ADVANCING HOLE
- AS : auger screwing (d : 100mm)
- T : thin wall tube (d : 63mm)
- ST : square cross section tube (70x70mm)

EXPLANATION
- NMC : Natural Moisture Content
- BWD : Bulk Wet Density
- SPD : Soil Particle Density
- * : Mineral composition determined by XRD
- 27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date : 30 · 10 · 90
Plant : Triefus	Drawn : J. Whippy
Started : 30 · 10 · 90	Approved :
Finished : 30 · 10 · 90	Sheet 1 of 1

DATA POINT NO 26

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Towards head of gully sloping towards West Gawler Road - Carters property : Central Ulverstone

CASING/HOLE COMPLETION : . No support used

. End of hole : 2m (refusal).

CO-ORDINATES		
	SYSTEM	AMG
	E.	429375
	N.	5440905
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR AROUND SURFACE	≃ 40m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BWD (g/cm³)	Mechanical Analysis: Clay %	Mechanical Analysis: Silt %	Mechanical Analysis: Sand %	Mechanical Analysis: Gravel %	Index Tests: Liquid Limit %	Index Tests: Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: c' (kPa)	Shear Strength Parameters: φ' (deg)	NMC %	water
	AS	1	CLAY; medium to high plasticity, black; trace fine sand, organics	A						F	M ≤ PL															
			CLAY; high plasticity, dark brown.	S_d	54*	CH			75	St	M ≤ PL							103	69	18		5			49	
										F	≥ PL															
			Gravelly CLAY; high plasticity, olive green; some medium sand to medium gravel (SW-Fr basalt)	Tb_W						St	M ≤ PL															dry
		2	End of hole : 2m (refusal)																							

Remarks

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm).

T : thin wall tube (d: 63mm).

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* 27.8.90 : Mineral composition determined by XRD

Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date : 30·10·90
Plant : Triefus	Drawn : J. Whippy
Started : 30·10·90	Approved :
Finished : 30·10·90	Sheet 1 of 1

DATA POINT NO 27

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Beside West Gawler Road, in front of property with glasshouses.

CASING/HOLE COMPLETION

. No support used

. End of hole : 2·8m (refusal)

CO-ORDINATES — SYSTEM: AMG; E. 429150; N. 5440615

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 14m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: c′ (kPa)	φ′ (deg)	NMC %	water
	AS		Silty SAND; fine to medium, mid grey			SM				L	M															
	AS		CLAY; high plasticity, olive green with orange mottling; some fine to medium sand.				65	30	75																	
	T	1			55*				75	F	M	2·54	1·84					93	67	21		2			41	
				Qa						to	>														45	
			colour change to blue green with orange-brown mottling			CH			100	St	PL															
	AS	2							150																	30.10.90
			End of hole : 2·8m (refusal)																							

Remarks

. water level : 2·35m ; conductivity : 400μS

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm).

T : thin wall tube (d : 63mm).

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD.

27.8.90 : Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 30·10·90

Finished : 30·10·90

Logged : J. Whippy

Date : 30·10·90

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 28

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Slope west of Gawler River, below Bellwick – South Ulverstone

CASING/HOLE COMPLETION

. No support used

. End of hole : 7m (required depth).

CO-ORDINATES	SYSTEM	AMG
	E	428635
	N	5440535
REDUCED LEVEL	DATUM	AHD(Tasmania)
	COLLAR GROUND SURFACE	≃ 25m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters c'r (kPa)	φ'r (deg)	NMC %	water
				CLAY; low to medium plasticity, dark brown, some fine to medium sand (rock frags).	A		CL					M ≤ PL														
			1	SILT; med. plasticity, orange-brown; clayey, sandy.		56*				50 75	F	>PL	2·61		35	48	17	49	31	12		5			24	
			2	change in consistency								M ≤ PL														
	AS		3	trace fine to medium gravel (angular quartz)	S_d		ML				St															dry
			4									M ≥ PL														
			5																							
			6	increase in gravel content (≃ 10%) – angular quartz and rock fragments (schist); abundant mica flakes.		57*													67	41	13		5			25	
			7	End of hole : 7m (required depth)																						

Remarks

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm)

T : thin wall tube (d : 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 31 · 10 · 90

Finished : 31 · 10 · 90

Logged : J. Whippy

Date :

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 29

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Trevor Street reserve

CASING/HOLE COMPLETION

. No support used

. End of hole : 7m (required depth).

CO-ORDINATES — SYSTEM: AMG; E. 430355; N. 5442390

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 17m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C′ (kPa)	φ′ (deg)	NMC %	water
			GRAVEL; fine to coarse, angular, some sand	F		GW				MD	D															
			Sandy SILT; low-med plasticity, dark brown, some gravel (rock frags).			ML				F	< PL															
		1	CLAY; high plasticity, dark brown with grey and orange mottling; some fine sand.		58*	CH	70	35	100 125 160			2.38						136	105	28		5			43	
		2					70	30	150																	
		3	Sandy CLAY, high plasticity, light brown; sand - fine grained			CH / SC				St to VSt	M > PL															
	AS	4	CLAY; high plasticity, dark brown; some sand - fine to medium grained (zeolites and rock fragments), trace fine gravel (rock fragments - basalt).	Qm		CH																				31.10.90
		5																								
		6			59																					
		7	End of hole : 7m (required depth)																							

Remarks

. Site within coastal plain.

. water level : 4.9m ; conductivity : 850μS.

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm).

T : thin wall tube (d : 63mm).

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 31.10.90

Finished : 31.10.90

Logged : J. Whippy

Date : 31.10.90

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 30

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Beside Westella Drive, just east of Claytons Rivulet

CASING/HOLE COMPLETION

. No support used

. End of hole : 2.8m (refusal)

CO-ORDINATES		
	BYSTEM	AMG
	E.	434495
	N.	5442815
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 6m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency / density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BWD (g/cm³)	LABORATORY TESTS: Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	LABORATORY TESTS: Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	LABORATORY TESTS: Free Swell %	Emerson Class No	LABORATORY TESTS: Shear Strength Parameters c'r (kPa)	φ'r (deg)	NMC %	water
	AS	1	SAND; fine to medium, some clay	A																						
			SAND; fine to medium, brown; trace fine gravel (rounded quartz & rock fragments).		60						D															
		2	colour change to fawn and trace fine to medium gravel (rounded quartz and quartzite).	Qm		SP				L	M															31.10.90
											W															
			End of hole : 2.8m (refusal)																							

Remarks

. Site on coastal plain

. water level : 1.97m ; conductivity : 180 μS

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm)

T : thin wall tube (d : 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 31·10·90

Finished : 31·10·90

Logged : J. Whippy

Date :

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 31

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Beside track to sewerage pond; ≈ 50m from sewerage pond.

CASING/HOLE COMPLETION

. No support used

. End of hole : 5·2m (refusal)

CO-ORDINATES — SYSTEM: AMG; E:; N:

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR GROUND SURFACE:

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C′ (kPa)	φ′ (degs)	NMC %	water
	AS		0	SAND; fine - medium; dark brown; organics	A							M															
				colour change to light brown		G1																					
			1	colour change to blue-grey; some silt, trace fine gravel. Occassional thin (100 - 200 mm) clay to sandy clay layers - high plasticity with moisture content > plastic limit, consistency - stiff to very stiff.	Q_a		SP				L	W															
			2																								
			3																								
			4																								
				CLAY; high plasticity; blue-grey; some fine - medium sand, trace gravel - fine to medium (angular quartz + rock fragments).			CH				VSt	>PL															
			5	SAND; dominantly medium grained; quartz, rock fragments and bivalve (10 - 20mm) shells; trace silt.	Q_m		SP				L	W															
				End of hole : 5·2m (refusal).																							

31.10.90 ▼

Remarks

. Site on Forth River alluvial plain.

. Water level : 0·66 m ; Conductivity : 2100 µS.

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm).

T : thin wall tube (d : 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 31·10·90

Finished : 31·10·90

Logged : J. Whippy

Date : 31·10·90

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 32

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Forth River alluvial plain

CASING/HOLE COMPLETION

. No support used

. End of hole : 7m (required depth).

REDUCED LEVEL CO-ORDINATES		
	SYSTEM	AMG
	E	436410
	N	5441125
	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 3m

penetration f 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BWD (g/cm³)	LABORATORY TESTS: Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	LABORATORY TESTS: Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	LABORATORY TESTS: Free Swell %	Emerson Class No	Shear Strength Parameters: c′ (kPa)	φ′ (deg)	NMC %	water
	AS		1	CLAY; low-medium plasticity, peaty, dark brown.	A	62	CL				S	>PL			30		70										
			2	Silty SAND; fine to medium grained, blue grey; quartz, mica + rock fragments; slight odour (peat)			SM				L																
			3																								
			4		Qa							W															
			5	SAND; dominantly medium to coarse grained; dark grey; quartz and rock fragments; some fine to medium gravel.		63	SW				L to MD				3	52	45									
			6																								
			7	End of hole : 7m (required depth).																							31.10.90

Remarks

. water level : 0.5m ; conductivity : 3,500 µS

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm)

T : thin wall tube (d : 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

27.8.90 Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Trietus

Started : 31.10.90

Finished : 31.10.90

Logged : J. Whippy

Date : 31.10.90.

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 33

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Forth River alluvial plain.

CASING/HOLE COMPLETION

. No support used

. End of hole : 7m (required depth).

CO-ORDINATES — SYSTEM: AMG; E: 436470; N: 5441730

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 3m.

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BND (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C′ (kPa)	Shear Strength Parameters φ′ (deg)	NMC %	water
	AS	0	CLAY; low-medium plasticity; black; organics	A		CL				F	<PL															
			colour change to dark brown, medium-high plasticity; trace fine to medium sand.			CH					>PL															
		1	Silty SAND; dominantly fine to medium grained; blue grey with orange mottling fines content decrease with depth.	Qa	64	SM					M							41	7	2					39	31.10.90 ▼
		2																								
		3	SAND; dominantly medium grained; blue-grey; bivalve shells (10-20mm), quartz + rock fragments; some silt, slight odour. Occassional thin clay bands (100-200mm) - high plasticity with firm to stiff consistency.	Qm		SP				L	W															
		4																								
		5																								
		6																								
		7	End of hole : 7m (required depth).																							

Remarks: . water level : 0.76m ; conductivity : 8,900 μS.

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm).

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 31.10.90

Finished : 31.10.90

Logged : J. Whippy

Date : 31.10.90

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 34

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Basalt ridge between Kimberleys and Stubbs Roads.

CASING/HOLE COMPLETION

. No support used

. End of hole : 7m (required depth).

CO-ORDINATES: BY SYSTEM AMG; E 433855; N 5442160

REDUCED LEVEL: DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 111m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C'r (kPa)	φ'r (deg)	NMC %	water
	AS	1	CLAY; high plasticity; red-brown, trace medium sand (basalt fragments).		65 *		30	15				2.44						94	56	19		6			51	
	T	2	trace fine grained gravel (highly weathered vesicular basalt).		66		45	20		S to F			1.75												48 45	
	AS	3		T_{bw}	67 *	CH					M > PL															
		4	colour change to dark brown.															108	71	20		6			57	
		5																								
		6	colour change to dark brown with red mottling.							St																1.11.90
		7							125																	
			End of hole : 7m (required depth).																							

Remarks: . water level : 6m ; conductivity : 390 μS

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm).

T : thin wall tube (d: 63mm).

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD.

27.8.90 ▼ : Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 1.11.90

Finished : 1.11.90

Logged : J. Whippy

Date : 1.11.90

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 35

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Slope east of Castra Road & past end of Merinda Drive – Boons property.

CASING/HOLE COMPLETION

. No support used

. End of hole : 2.4m (refusal).

CO-ORDINATES		
	SYSTEM	AMG
	E.	433260
	N.	5442190
REDUCED LEVEL	DATUM	AHD(Tasmania)
	COLLAR GROUND SURFACE	≈ 40m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BWD (g/cm³)	LABORATORY TESTS: Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	LABORATORY TESTS: Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	LABORATORY TESTS: Free Swell %	LABORATORY TESTS: Emerson Class No	LABORATORY TESTS: Shear Strength Parameters c' (kPa)	φ' (deg)	LABORATORY TESTS: NMC %	water
	AS		CLAY; high plasticity, dark brown; some fine to medium sand (zeolites & rock fragments).	A						S to F																
	T	1	CLAY; high plasticity; light grey with orange mottling	Sd	68*	CH	90	30	75	F to St	M > PL	2.24	1.73	87	10	3		121	82	23		2	3	10	56 50	
	AS	2	CLAY; high plasticity, dark brown; some fine to medium sand (zeolites and rock fragments).		69*													68	36	17		1	4	27	40	1.11.90
			End of hole : 2.4m (refusal)																							

Remarks

. water level : 2.36m ; conductivity : 220 μS.

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm)

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date : 1.11.90
Plant : Triefus	Drawn : J. Whippy
Started : 1.11.90	Approved :
Finished : 1.11.90	Sheet 1 of 1

DATA POINT NO 36

BOREHOLE LOG

PROJECT : ULVESTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Slope behind Brookvale, Ballingers property - off Castra Road.

CASING/HOLE COMPLETION

. No support used

. End of hole : 5.2m (refusal).

CO-ORDINATES		
	SYSTEM	AMG
	E.	431930
	N.	5441545
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 53m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency / density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BWD (g/cm³)	Mechanical Analyses: Clay %	Mechanical Analyses: Silt %	Mechanical Analyses: Sand %	Mechanical Analyses: Gravel %	Index Tests: Liquid Limit %	Index Tests: Plasticity Index %	Index Tests: Linear Shrinkage %	Free Swell %	Emerson Class No.	Shear Strength Parameters: C'_r (kPa)	Shear Strength Parameters: ϕ'_r (deg.)	NMC %	water
		0	CLAY; high plasticity, dark brown.	A						F	<PL															
			CLAY; high plasticity; red-brown; some fine-medium sand, trace fine gravel; zeolite and highly weathered to slightly weathered basalt frags.		70 *				125													6			52	
		1							150										146	104	28						
									200																		
		2	Colour change to dark brown, increase in gravel content to ≈ 10%.	S_d		CH				St to VSt	M > PL															dry
	AS	3																									
		4																									
					71														78	33	13					53	
		5																									
			End of hole : 5.2m (refusal).																								

Remarks : . Site on basalt slope.

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm)

T : thin wall tube (d; .63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date : 1.11.90
Plant : trefus	Drawn : J. Whippy
Started : 1.11.90	Approved :
Finished : 1.11.90	Sheet 1 of 1

DATA POINT NO 37

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Basalt slope behind dam, French's property - off Castra Road.

CASING/HOLE COMPLETION

. No support used

. End of hole : 3·6m (refusal).

CO-ORDINATES		
REDUCED LEVEL	SYSTEM	AMG
	E	431 250
	N	5440670
	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 100m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: S.P.D. (g/cm³)	B.W.D. (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C' (kPa)	φ' (deg)	N.M.C. %	water
		1	CLAY, medium to high plasticity, dark brown, trace fine to medium sand, organics							F	<PL															
			colour change to red-brown		72*				125		M							92	57	21		6			42	
									150		≥															
									150		PL															
									175																	
		2	colour change to orange-brown.	S_d	73*	CH				St to VSt	M > PL							101	64	21		6			54	dry
		3	End of hole : 3·6m (refusal).																							

Remarks

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm)

T : thin wall tube (d : 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date :
Plant : Triefus	Drawn : J. Whippy
Started : 1·11·90	Approved :
Finished : 1·11·90	Sheet 1 of 1

DATA POINT NO 38

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Foot of slope, G&L Turners property – off Westella Drive.

CASING/HOLE COMPLETION

. No support used

. End of hole : 1·3m (refusal).

CO-ORDINATES		
	SYSTEM	AMG
	E.	434190
	N.	5442620
REDUCED LEVEL	DATUM	AHD(Tasmania)
	COLLAR GROUND SURFACE	≈ 13m

penetration (123)	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters c'r (kPa)	φ'r (deg)	NMC %	water
	AS	0·5	Silty SAND, fine to medium, black, trace fine gravel.	A		SM				L	M															
			Sandy SILT; plasticity, grey-brown. Sand – fine to medium (quartz, mica + rock fragments)	Q_m		ML			150		M															dry
		1	colour change to grey with yellow-orange mottling; trace medium gravel (quartz and highly weathered schist).		74*				175		>			21	28	50	1	36	19	5		1			17	
									200		PL														
			End of hole 1·3m (refusal)																						

Remarks .....

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm).

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date : 1·11·90
Plant : Trietus	Drawn : J. Whippy
Started : 1·11·90	Approved :
Finished : 1·11·90	Sheet 1 of 1

DATA POINT NO. 39

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Beside Claylons Rivulet, Webbs property – off Stubbs Road.

CASING/HOLE COMPLETION

. No support used

. End of hole : 1.7m (refusal).

CO-ORDINATES — SYSTEM: AMG; E. 434415; N. 5442005

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR (GROUND SURFACE): ≈ 12m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C′ (kPa)	φ′ (deg)	NMC %	water
	AS	0	SILT; low to medium plasticity, black, trace fine to medium sand (rock fragments)			ML					M ≤ PL															
		0.5	CLAY; medium to high plasticity, dark brown; some medium to coarse sand (sub round quartz, schist & quartzite)							F to St																
		1	Gravelly CLAY; medium to high plasticity, mid brown. Gravel-fine to medium (quartzite, schist & quartz)	Q_a	* 75	CH					M ≤ PL							63	41	15		5			26	1/11/90 ▼
		1.5	End of hole : 1.7m (refusal)																							

Remarks : . water level : 1.56m ; conductivity : 160 µS

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm)

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm)

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 1 · 11 · 90

Finished : 1 · 11 · 90

Logged : J. Whippy

Date : 1 · 11 · 90

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 40

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Slope west of Claytons Rivulet, Webbs property - off Stubbs Road.

CASING/HOLE COMPLETION

· No support used

· End of hole : 4.5m (refusal).

CO-ORDINATES — SYSTEM: AMG; E. 434095; N. 5441875

REDUCED LEVEL — DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 45m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: c′ (kPa)	φ′ (deg)	NMC %	water
	AS	1	SILT; low plasticity, black; trace f. sand	A		ML					< PL															
			CLAY; medium to high plasticity, dark brown; some fine to medium gravel (rock fragments).	PE w	76*	CH			125 / 175		M > PL							110	78	21		2			48	
		2	SCHIST; completely to highly weathered, very low to low strength	PE r	77*							2.34						128	87	22		1	3	11	57	dry
		3																								
		4	End of hole : 4.5m (refusal)																							

Remarks

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm).

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ : Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 1·11·90

Finished : 1·11·90

Logged : J. Whippy

Date : 1·11·90

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 41

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Basalt ridge at top of Stubbs Road.

CASING/HOLE COMPLETION

· No support used

· End of hole : 7.3m (required depth)

CO-ORDINATES		
	SYSTEM	AMG
	E.	433900
	N.	5440505
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 125m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION	DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C′ (kPa)	Shear Strength Parameters φ′ (deg)	NMC %	water
	AS		1	GRAVEL; dominantly medium size; basalt, quartz, chert - road base.	F		GP				MD	D															
			2	CLAY; high plasticity, red-brown, trace fine to coarse sand (rock fragments).		78*				150 to 200		M < PL							104	65	18		6			41	
			3	colour change to yellow-brown and increase in moisture content; some fine gravel (highly weathered basalt fragments).	Tb_W	79*	CH				St to VSt		2·62						92	49	19		6	2	31	51	dry
			4																								
			5	colour change to dark brown.								M > PL															
			6																								
	T		7	BASALT, extremely weathered, very low strength; yellow-brown with red + blue-grey mottling. Remoulds to high plasticity clay.	Tb_r	80*								1·64					93	44	15					55 57	
				End of hole : 7.3m (required depth).																							

Remarks

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm)

T : thin wall tube (d : 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date : 2·11·90
Plant : Triefus	Drawn : J. Whippy
Started : 2·11·90	Approved :
Finished : 2·11·90	Sheet 1 of 1

DATA POINT NO 42

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Side of old Bass Highway east of Turners Beach Road

CASING/HOLE COMPLETION

· No support used

· End of hole : 1·7m (refusal)

CO-ORDINATES		
	SYSTEM	AMG
	E.	435785
	N.	5442820
REDUCED LEVEL	DATUM	AHD(Tasmania)
	COLLAR GROUND SURFACE	≈ 5m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BWD (g/cm³)	Mechanical Analyses: Clay %	Mechanical Analyses: Silt %	Mechanical Analyses: Sand %	Mechanical Analyses: Gravel %	Index Tests: Liquid Limit %	Index Tests: Plasticity Index %	Index Tests: Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: c′ (kPa)	Shear Strength Parameters: φ′ (deg)	NMC %	water
1	AS	1	SAND; fine-medium, white; some organics GRAVEL; fine to coarse, light brown; some medium to coarse sand; quartz & quartzites – well rounded to sub rounded.	Q_m		SP GW				L	M D																dry
			End of hole : 1·7m (refusal)																								

Remarks

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm)

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm)

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date : 2·11·90
Plant : Triefus	Drawn : J. Whippy
Started : 2·11·90	Approved :
Finished : 2·11·90	Sheet 1 of 1

DATA POINT NO 43

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Western abutment of Leven Bridge

CASING/HOLE COMPLETION

. No support used

. End of hole : 7m (required depth).

CO-ORDINATES		
	SYSTEM	AMG
	E	428600
	N	5442945
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 5m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION	DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BWD (g/cm³)	LABORATORY TESTS: Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	LABORATORY TESTS: Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	LABORATORY TESTS: Free Swell %	Emerson Class No	LABORATORY TESTS: Shear Strength Parameters c' (kPa)	φ' (deg)	NMC %	water
	AS		0	Clayey GRAVEL ; fine to coarse; light brown ; in a low plasticity clay matrix. Gravel consist of angular quartzite, silcrete frags.	F		GC					D															
			1	Silty SAND ; fine to medium grained; dark brown; plant fragments			SM				L	M															
			2	CLAY ; high plasticity ; grey-green with orange mottling; some fine to medium sand-quartz & rock fragments.	Qa																					20.11.90 ▼
			3																								
			4				CH				F to St.	M > PL															
			5	colour change to khaki brown.																							
			6																								
			7	End of hole : 7m (required depth).																							

Remarks . Water level : 2.5m ; conductivity : 440 µS

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm)

T : thin wall tube (d : 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Trietus

Started : 20 . 11 . 90

Finished : 20 . 11 . 90

Logged : J. Whippy

Date : 20 . 11 . 90

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 44

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger

LOCATION : Top of basalt ridge, Johnsons place - off West Gawler Road.

CASING/HOLE COMPLETION

. No support used

. End of hole : 3.4m (required depth).

CO-ORDINATES		
REDUCED LEVEL	SYSTEM	AMG (1:25,000)
	E	42702
	N	544142
	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 100m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C′ (kPa)	Shear Strength Parameters φ′ (deg)	NMC %	water
				CLAY; high plasticity, dark brown, some fine to coarse sand (basalt + zeolite)	A							<PL															
	AS		1	CLAY; high plasticity, orange-brown, trace medium to coarse sand - basalt fragments + zeolites	Tb_w	81		80	25	50 to 100	F to St	M > PL							98	69	25					46	
	T			BASALT; extremely low strength, extremely weathered, fine grained (relict texture preserved) Remoulds to CLAY; high plasticity, dark red - brown, some medium to coarse sand - rock fragments.	Tb_r	82*	CH							1.76					80	41	18		6			39 40	
	AS		2			83													84	44	17		6			38	21.11.90
			3	End of hole : 3.4m (required depth).																							

Remarks

. water level : 2.3m ; conductivity : 94 μS

. High water table probably due to close proximity of site to dam.

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm)

T : thin wall tube (d : 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date : 21.11.90
Plant : Triefus	Drawn : J. Whippy
Started : 21.11.90	Approved :
Finished : 21.11.90	Sheet 1 of 1

DATA POINT NO 45

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Slope facing Gawler River, Johnson's property – off West Gawler Road.

CASING/HOLE COMPLETION

. No support used

. End of hole : 5.8m (refusal)

CO-ORD INATES — SYSTEM: AMG (1:25,000) | E. 42781 | N. 544160

REDUCED LEVEL — DATUM: AHD (Tasmania) | COLLAR GROUND SURFACE: ≈ 53m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C'r (kPa)	φ'r (deg)	NMC %	water
	AS	1	CLAY; high plasticity, dark brown; some medium to coarse sand and fine to medium gravel – basalt fragments	S_d	84	CH				F to St	M < PL															
		2	same as above except for colour change to light brown.		85					F	M ≥ PL							99	61	22					47	
		3			* 86					S	M > PL	2.60						105	69	21		5	4	29	50	21.11.90
		4	CLAY; high plasticity, dark brown; some medium to coarse sand and fine to medium gravel; trace coarse gravel – zeolite and basalt fragments.																							
		5																								
			End of hole : 5.8m (refusal)																							

Remarks

. water level : 3.8m ; conductivity : 110μS

. site towards head of landslide.

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm)

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ : Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 21. 11. 90

Finished : 21. 11. 90

Logged : J. Whippy

Date :

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT NO 46

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Beside railway track, Hilata Street.

CASING/HOLE COMPLETION

. No support used

. End of hole : 7m (required depth).

CO-ORDINATES		
REDUCED LEVEL	SYSTEM	AMG
	E	429835
	N	5442995
	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 10m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C'r (kPa)	φ'r (deg)	NMC %	water
	AS		0	SAND; fine to medium; quartz & organics																						
				colour change to white; quartz			SP					D															
				colour change to dark brown	Q_m																					
			1	colour change to light brown								M														21-11-90
			2	Silty SAND; dominantly fine to medium with some coarse; yellow brown; trace fine gravel – quartz, subround.	Q_a		SM				L	W														
			4	SAND; medium to coarse; blue-grey; quartz & rock fragments.	Q_m		SP																			
			5	CLAY; high plasticity; blue-grey to light grey. (decomposed basalt ?)	Tb_w	87*	CH			100 to 175	F to St	M > PL							134	89	26	5			62	
			7	End of hole : 7m (required depth).																						

Remarks : water level : 1·32m; conductivity : 95μS

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm)

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 21·11·90

Finished : 21·11·90

Logged : J. Whippy

Date :

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT No 47

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Beside railway track – Water Street.

CASING/HOLE COMPLETION : No support used

: End of hole : 7m (required depth).

CO-ORDINATES		
	SYSTEM	AMG
	E	431285
	N	5443665
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≃ 12m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BMD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C'r (kPa)	Shear Strength Parameters φ'r (deg)	NMC %	water
	AS	0	Sandy CLAY; low plasticity, dark brown; sand – fine grained	A		CL				F	D															
			SAND; fine to medium, light grey.								M															
			colour change to light brown.		88									1	3	95	1									
		1			89									1	2	92	5									21.11.90
			SAND; medium to coarse, mid brown, some fine to medium gravel.																							
		2																								
		3				SP				L	W															
				Q_m																						
		4	colour change to grey; grain size dominantly medium.																							
		5																								
		6																								
			Gravelly CLAY; high plasticity, blue-grey; gravel dominantly fine to medium with trace coarse – rock fragments and quartz			CH				F	M > PL															
		7	End of hole : 7m (required depth).																							

Remarks : . water level : 1.6m ; conductivity : 810 μS

METHOD OF ADVANCING HOLE
- AS : auger screwing (d: 100mm)
- T : thin wall tube (d: 63mm)
- ST : square cross section tube (70x70mm).

EXPLANATION
- NMC : Natural Moisture Content
- BWD : Bulk Wet Density
- SPD : Soil Particle Density
- 27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date : 21.11.90
Plant : Triefus	Drawn : J. Whippy
Started : 21.11.90	Approved :
Finished : 21.11.90	Sheet 1 of 1

DATA POINT NO 48

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Haywoods Reserve – Ulverstone District Football Club.

CASING/HOLE COMPLETION

. No support used

. End of hole : 5m (refusal).

CO-ORDINATES		
	SYSTEM	AMG
	E	431810
	N	5442905
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 15m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C'_r (kPa)	ϕ'_r (deg)	NMC %	water
	AS	0	CLAY; low to medium plasticity, dark brown - organics.	A		CL				F																
		1	Sandy CLAY; high plasticity, light brown; sand dominantly fine grained.	Q_a	90*							2·61						68	49	16		5			33	21.11.90
		2	CLAY; high plasticity, grey with red-brown mottling; some fine to medium sand and fine gravel - mica flakes and subrounded quartz.							S to F	M > PL															
		3	CLAY; high plasticity, dark brown with light grey and light brown mottling; some medium to coarse sand and fine to medium gravel – zeolite & basalt rock fragments.	Tb_W		CH																				
		4																								
		5	End of hole 5m (refusal).																							

Remarks : . water level : 1m

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm)

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ : Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Logged : J. Whippy

Date :

Plant : Triefus

Drawn : J. Whippy

Started : 21.11.90

Approved :

Finished : 21.11.90

Sheet 1 of 1

DATA POINT NO 49

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : Slope behind Forth Road - between Jones Creek tributaries

CASING/HOLE COMPLETION

- No support used
- End of hole : 7m (required depth).

CO-ORDINATES		
	SYSTEM	AMG
	E	435400
	N	5440535
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 52m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C′ (kPa)	Shear Strength Parameters φ′ (deg)	NMC %	water
	AS		1	CLAY; medium plasticity; dark brown; some fine sand.	A		CL				F	<PL															
				Clayey SAND; fine to medium, dark grey-brown; some fine to medium gravel - quartz and rock fragments. Can be rolled into thread.		91	SC				L	M															
				Sandy CLAY; high plasticity, light grey-brown with red-orange mottling; sand-fine to medium, trace coarse gravel — quartz & rock fragments.	Ts																					
	T		2	· Sand content decreases with depth. · Slickensides on some fissured surfaces.		92*						F			1.91				65	45	13	6			40 25	
	AS		3	CLAY; high plasticity, dark red brown; trace fine sand - zeolites. Relict planes Mn oxide stained and some slickensided. (extremely weathered to decomposed basalt mixed with sediments due to slope failure)	Sd							M > PL														
	T		4			93*	CH						2.69	1.55					104	67	19	6			46 41	22-11-90
			5								F to St															
	AS		6																							
			7	End of hole : 7m (required depth).																						

Remarks : water level : 4·2m ; conductivity : 150 µS.

METHOD OF ADVANCING HOLE

- AS : auger screwing (d : 100mm)
- T : thin wall tube (d : 63mm)
- ST : square cross section tube (70x70mm).

EXPLANATION

- NMC : Natural Moisture Content
- BWD : Bulk Wet Density
- SPD : Soil Particle Density
- * : Mineral composition determined by XRD
- 27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : J. Whippy
	Date :
Plant : Triefus	Drawn : J. Whippy
Started : 22.11.90	Approved :
Finished : 22.11.90	Sheet 1 of 1.

DATA POINT NO 50

BOREHOLE LOG

PROJECT : ULVERSTONE ENGINEERING GEOLOGY

FEATURE : Auger hole

LOCATION : slope behind Forth Road.

CASING/HOLE COMPLETION

. No support used

. End of hole : 6·1m (required depth)

REDUCED LEVEL — CO-ORDINATES: BYSTEM AMG; E 435470; N 5441910; DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 52m.

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C′r (kPa)	Shear Strength Parameters φ′r (deg)	NMC %	water
	AS	1	CLAY; medium to high plasticity, dark brown; organics	A						F to St	M ≤ PL															
			CLAY; high plasticity, dark red-brown; some medium to coarse sand and trace fine gravel – basalt fragments & quartz (angular)		94												69	49	17					21		
		2	colour change to light red-brown						125 to 200	St	M > PL															
		3		S_d	95*	CH				VSt							129	91	24		6			47		dry
		4	colour change to red-brown with grey mottling																							
		5																								
		6	CLAY; high plasticity, grey																							
			End of hole : 6·1m (required depth).																							

Remarks: . Medium grained, angular quartz sand present through whole profile.

METHOD OF ADVANCING HOLE

AS : auger screwing (d : 100mm)

T : thin wall tube (d; 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* : Mineral composition determined by XRD

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox — Logged : T. Whippy

Date :

Plant : Triefus — Drawn : T. Whippy

Started : 22. 11. 90 — Approved :

Finished : 22. 11. 90 — Sheet 1 of 1

DATA POINT NO 51

BOREHOLE LOG

PROJECT : LANDSLIDE INVESTIGATION – FROMBERGS

FEATURE : Auger hole

LOCATION : Frombergs property – N. Ulverstone

CASING/HOLE COMPLETION

. Open hole piezometer installed (50mm diameter PVC pipe).

. End of hole : 5·4m (refusal)

CO-ORDINATES		
REDUCED LEVEL	SYSTEM	AMG
	E	433505
	N	5442645
	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 35m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION	DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BMD (g/cm³)	LABORATORY TESTS: Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	LABORATORY TESTS: Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	LABORATORY TESTS: Free Swell %	LABORATORY TESTS: Emerson Class No	LABORATORY TESTS: Shear Strength Parameters C′r (kPa)	φ′r (deg)	LABORATORY TESTS: NMC %	water
	AS		1	SILTY CLAY; high plasticity, dark brown some fine to medium sand, organics	A		MH				Fr	M ≤ PL															
			2	Sandy CLAY; high plasticity, brown; sand – fine to medium, some fine to coarse gravel (basalt frags), trace charcoal.																							
			3	colour change to yellow-brown; sand – fine to medium trace coarse.							F to St																
			4	colour change to reddish yellow-brown																							
			5	colour change to yellow-brown	S_d		CH				F	M > PL															
				colour change to mid brown																							
				colour change to greenish brown		104					F to St								114	83	25		1	4	16		12.6.88
				increase in medium to coarse sand content – slightly weathered blue-grey basalt fragments.																							
				End of hole : 5·4m (refusal).																							

Remarks

. Slip surface measured at 4·3m

. water level : 4.90m

METHOD OF ADVANCING HOLE — EXPLANATION — GEOLOGICAL SYMBOL

AS : auger screwing (d : 100mm)

12·5·88 ▼ water level on date shown

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : R. Donaldson
	Date : 10. 5. 88
Plant : Triefus	Drawn : R. Donaldson
Started : 10. 5. 88	Approved : R. Donaldson
Finished : 10. 5. 88	Sheet 1 of 1

DATA POINT NO 52

BOREHOLE LOG

PROJECT : LANDSLIDE INVESTIGATION - FROMBERGS

FEATURE : Auger hole

LOCATION : Frombergs property - N. Ulverstone

CASING/HOLE COMPLETION

. Open hole piezometer installed (50mm diameter PVC pipe)

. End of hole : 7.5m (refusal - bedrock ?)

REDUCED LEVEL / CO-ORDINATES		
	SYSTEM	AMG
	E	433515
	N	5442665
	DATUM	AHD(Tasmania)
	COLLAR GROUND SURFACE	≈ 30m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BND (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters c′ (kPa)	Shear Strength Parameters φ′ (deg)	NMC %	water
	AS		1	Silty CLAY; high plasticity, dark brown, some fine to medium sand, trace charcoal.	A		MH				Fr																dry
			1	Sandy CLAY; high plasticity, yellow-brown with green grey & red brown mottling. Sand - fine to medium, trace coarse sand to fine gravel.							VSt to H	M < PL															
			2	same as above with some sandy clay lensing developed.																							
			3																								
			4	colour change to light brown, lensing not developed.	Sd		CH				F to St	M > PL															
			5	colour change to mid brown																							
			6	colour change to greenish-brown; some coarse sand to fine gravel - highly weathered vesicular blue grey basalt fragments.																							
			7	increase in coarse sand to fine gravel content.																							
				End of hole : 7.5m (refusal - bedrock?)																							

Remarks

. Slip surface measured at 5.2m

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm).

T : thin wall tube (d: 63mm).

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 11-5-88

Finished : 11-5-88

Logged : R. Donaldson

Date : 11-5-88

Drawn : R. Donaldson

Approved : R. Donaldson

Sheet 1 of 1

DATA POINT NO 53

BOREHOLE LOG

PROJECT : LANDSLIDE INVESTIGATION – FROMBERGS

FEATURE : Auger hole

LOCATION : Frombergs property – N. Ulverstone

CASING/HOLE COMPLETION

· Open hole piezometer installed (50mm diameter PVC pipe)

· End of hole : 8.8m (required depth).

CO-ORDINATES		
	SYSTEM	AMG
	E.	433525
	N.	5442690
REDUCED LEVEL	DATUM	AHD(Tasmania)
	COLLAR	
	GROUND SURFACE	≈ 25m

penetration	METHOD OF ADVANCING HOLE	ELEVATION	DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BND (g/cm³)	LABORATORY TESTS: Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	LABORATORY TESTS: Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	LABORATORY TESTS: Free Swell %	Emerson Class No.	LABORATORY TESTS: Shear Strength Parameters c'r (kPa)	φ'r (deg)	NMC %	water
	AS		0	Sandy SILT; low plasticity, grey-brown, some clay; organics.	A		ML				F	M < PL															
				Sandy CLAY; high plasticity, yellow brown with green-grey mottling. Sand - fine to medium, trace coarse.							VSt to H	M ≈ PL															
			1	CLAY; high plasticity, mid grey with orange-brown mottling; some fine to medium sand.																							
			2	colour change to pockets of dark grey-brown.							St to VSt																
			3																								
			4	Sandy CLAY; high plasticity, light brown; some fine to medium sand and trace coarse sand to fine gravel.	S_d		CH				F to St	M > PL															
			5	colour change to yellow brown																							
			6	colour change to mid brown																							
			7								F																

12.5.88

11.5.88

Remarks

· Slip surface measured at 4.40m

· water levels : 8.04m on 11.5.88 and 6.3m on 12.5.88

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm).

T : thin wall tube (d$_i$: 63mm).

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

27.8.90 Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 11.5.88

Finished : 11.5.88

Logged : R. Donaldson

Date : 11.5.88

Drawn : R. Donaldson

Approved : R. Donaldson

Sheet 1 of 2

DATA POINT No 53

BOREHOLE LOG

PROJECT : LANDSLIDE INVESTIGATION – FROMBERGS

FEATURE : Auger hole

LOCATION : Frombergs property – N. Ulverstone

CASING/HOLE COMPLETION

. Open hole piezometer installed (50mm diameter PVC pipe)

. End of hole 8.8m (required depth).

REDUCED LEVEL	CO-ORDINATES	
	SYSTEM	AMG
	E.	433525
	N.	5442690
DATUM		AHD (Tasmania)
COLLAR GROUND SURFACE		≈ 25m

penetration (m)	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BWD (g/cm³)	LABORATORY TESTS: Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	LABORATORY TESTS: Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters C′ (kPa)	Shear Strength Parameters φ′ (deg)	NMC %	water
			8																								
	AS			colour change to dark brown	S_d		CH				F	M > PL															
				Clayey GRAVEL; fine grained in high plasticity clay matrix; blue-grey and brown; some fine to coarse sand – highly weathered basalt fragments			GC																				
				End of hole : 8.8m (required depth).																							

Remarks

. Slip surface measured at 4.40m

. water levels : 8.04m on 11.5.88 and 6.87m on 12.5.88

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm).

T : thin wall tube (d: 63mm).

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

27.8.90 Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox	Logged : R. Donaldson
	Date : 11.5.88
Plant : Triefus	Drawn : R. Donaldson
Started : 11.5.88	Approved : R. Donaldson
Finished : 11.5.88	Sheet 2 of 2

DATA POINT NO 54

BOREHOLE LOG

PROJECT : LANDSLIDE INVESTIGATION - FROMBERGS

FEATURE : Auger hole

LOCATION : Frombergs property - N. Ulverstone

CASING/HOLE COMPLETION

. Open hole piezometer installed (50mm diameter PVC pipe)

. End of hole : 5.2m (required depth).

CO-ORDINATES		
	SYSTEM	AMG
	E.	433540
	N.	5442710
REDUCED LEVEL	DATUM	AHD(Tasmania)
	COLLAR GROUND SURFACE	≈ 23m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION	DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BND (g/cm³)	LABORATORY TESTS: Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	LABORATORY TESTS: Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	LABORATORY TESTS: Free Swell %	Emerson Class No.	Shear Strength Parameters c′ (kPa)	Shear Strength Parameters φ′ (deg)	NMC %	water
	AS		1	Sandy CLAY; high plasticity, brown; sand- medium to coarse, some fine gravel - extremely weathered basalt fragments and zeolites.			CH				M > PL	S to F															
			2	no return. (well sorted sand ?)	S_d																						
			3																								
			4																								
			5	Sandy CLAY; high plasticity, yellow-brown with blue grey mottling; sand- fine to medium.			CH				St	M > PL															
				End of hole : 5.2m (required depth).																							

11.5.88 ▼ 12.5.88 ▼

Remarks

. water levels : 4.80 m 11.5.88 and 4.71m on 12.5.88

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm).

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm).

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

27.8.90 ▼ Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller : B. Cox

Plant : Triefus

Started : 11.5.88

Finished : 11.5.88

Logged : R. Donaldson

Date : 11.5.88

Drawn : R. Donaldson

Approved : R. Donaldson

Sheet 1 of 1

DATA POINT NO 55

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Sewerage line trench

LOCATION Westland Drive – W. Ulverstone

CASING/HOLE COMPLETION

. Trench 0.9m deep.

CO-ORDINATES		
REDUCED LEVEL	SYSTEM	AMG
	E.	428355
	N.	5444740
	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 7m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BHD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C′ (kPa)	φ′ (deg)	NMC %	Water
			Clayey SAND; fine to medium, dark brown.	A		SC				L	D															
		0.2	SAND; fine to medium, white; quartz rich			SP					M															
	BH	0.4	Sandy CLAY; medium plasticity, dark brown; sand - fine grained and occurring as lenses.	Qm	* 42	CL → CH	55	45	145	St to VSt	M > PL	2.49						47	29	12		2			27	
		0.6					45	24	275																	
		0.8	Sub-horizontal peat layer (15m -m) thick 20cm from top boundary.						375																	

Remarks

METHOD OF ADVANCING HOLE

BH: backhoe bucket

EXPLANATION

GEOLOGICAL SYMBOL (see text)

* Mineral composition determined using X-ray diffraction.

ENGINEERING GEOLOGY SECTION

Driller

Plant

Started

Finished

Logged: F. Whippy

Date: 18.9.90

Drawn: F. Whippy

Approved

Sheet 1 of 1

DATA POINT NO 56

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Road cutting.

LOCATION Opposite D. Marshalls residence, Knights Road – W. Ulverstone

CASING/HOLE COMPLETION

Excavation 0.8m high.

CO-ORDINATES		
REDUCED LEVEL	SYSTEM	AMG
	E	428070
	N	5443470
	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 12m

penetration	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BND (g/cm³)	Mechanical Analysis: Clay %	Mechanical Analysis: Silt %	Mechanical Analysis: Sand %	Mechanical Analysis: Gravel %	Index Tests: Liquid Limit %	Index Tests: Plasticity Index %	Index Tests: Linear Shrinkage %	LABORATORY TESTS: Free Swell %	LABORATORY TESTS: Emerson Class No	Shear Strength Parameters: C'r (kPa)	Shear Strength Parameters: φ'r (deg)	LABORATORY TESTS: NMC %	water
123		metres																								
	B	0.2 0.4 0.6 0.8	CLAY; low plasticity, grey with orange mottling, some fine grained sand.	Q_a	* 44	CL – ML	26	14	275	VSt	M < PL	2.51						27	7	4		2			19	

Remarks

METHOD OF ADVANCING HOLE

B : bulldozer blade

EXPLANATION

GEOLOGICAL SYMBOL (see text)

* Mineral composition determined using X-ray diffraction

ENGINEERING GEOLOGY SECTION

Driller

Plant

Started

Finished

Logged : F. Whippy

Date : 20.9.90

Drawn : F. Whippy

Approved

Sheet 1 of 1

DATA POINT NO 57

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Road cutting

LOCATION Ulverstone Interchange ; ≈350m west of bottom of Kimberleys Road.

CASING/HOLE COMPLETION

CO-ORDINATES		
REDUCED LEVEL	SYSTEM	AMG
	E.	432515
	N.	5442750
	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 25m

Penetration 1 2 3	Method of advancing hole	Elevation / Depth (metres)	Geological description (soil type: plasticity or particle characteristics, colour, secondary and minor components)	Geological symbol	Sample number	Classification (USC metric)	Field tests: Vane shear strength Peak (kPa)	Vane shear strength Residual (kPa)	Penetrometer (kPa)	Consistency / density index	Moisture condition	Laboratory tests: SPD (g/cm³)	BWD (g/cm³)	Mechanical analyses: Clay %	Silt %	Sand %	Gravel %	Index tests: Liquid limit %	Plasticity index %	Linear shrinkage %	Free swell %	Emerson class No	Shear strength parameters: C_r' (kPa)	ϕ_r' (deg)	NMC %	Water
	B		CLAY; high plasticity, red-brown with grey mottling.										1.52												49	
	T		The surface has a dry cracked crust (100–150 mm thick) under which the moisture content is relatively high.		* 45	CH	20	15	75	S to F	M > PL	2.29		79	17	4		134	97	28		1			57	
	B	1	Gullying (up to 1m deep) developed in the material.	TS1																					62	
		2																								
	T		SANDY CLAY; medium to high plasticity, grey with brown mottling. Sand-fine to medium grained. Gullied with dry cracked crust.		* 46	CH – SC	40	20	125	F to St		2.48	1.77	38	15	47		73	54	17		1			24	
	B	3	SAND; fine to medium grained, weakly cemented, quartz rich.			SP				D to VD	D														31	

Remarks

METHOD OF ADVANCING HOLE

B : bulldozer blade

T : thin wall tube (d : 63mm)

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* Mineral composition determined using X-ray diffraction

GEOLOGICAL SYMBOL

(see text)

ENGINEERING GEOLOGY SECTION

Driller

Plant

Started

Finished

Logged : J. Whippy

Date : 21·9·90

Drawn : J. Whippy

Approved

Sheet 1 of 1

DATA POINT Nº 58

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Surface – grab sample

LOCATION SDA church – West Ulverstone

CASING/HOLE COMPLETION

CO-ORDINATES — SYSTEM: AMG; E: 428 440; N: 544 3965

REDUCED LEVEL — DATUM: AHD(Tasmania); COLLAR GROUND SURFACE: ≈ 42m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency / density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BWD (g/cm³)	Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters c'r (kPa)	φ'r (deg)	NMC %	water
			CLAY;	TS	43*	CL												45	24	8		3			22	

Remarks

METHOD OF ADVANCING HOLE

AS : auger screwing (d: 100mm)

T : thin wall tube (d: 63mm)

ST : square cross section tube (70x70mm)

EXPLANATION

NMC : Natural Moisture Content

BWD : Bulk Wet Density

SPD : Soil Particle Density

* 27.8.90 Mineral composition determined by XRD

Water level on date shown.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller :

Plant :

Started :

Finished :

Logged :

Date :

Drawn : J. Whippy

Approved :

Sheet 1 of 1

DATA POINT Nº 59

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Surface – grab sample

LOCATION West Gawler

CASING/HOLE COMPLETION

CO-ORDINATES		
	SYSTEM	AMG
	E	428 260 E
	N	544 1260 N
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR GROUND SURFACE	≈ 45m

penetration	METHOD OF ADVANCING HOLE	ELEVATION (metres)	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BMD (g/cm³)	LABORATORY TESTS: Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	LABORATORY TESTS: Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	LABORATORY TESTS: Free Swell %	LABORATORY TESTS: Emerson Class Nº	LABORATORY TESTS: Shear Strength Parameter C′r (kPa)	Shear Strength Parameter φ′r (deg)	LABORATORY TESTS: NMC %	water
123				CLAY,	S_d	96*	CH						264						94	55	20		6			36	

Remarks

METHOD OF ADVANCING HOLE

EXPLANATION

GEOLOGICAL SYMBOL

* Mineral composition determined by XRD

ENGINEERING GEOLOGY SECTION

Driller	Logged
	Date
Plant	Drawn J. Whippy
Started	Approved
Finished	Sheet 1 of 1

DATA POINT NO 60

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE surface - grab sample

LOCATION Beside South Road - West Ulverstone.

CASING/HOLE COMPLETION

CO-ORDINATES		
REDUCED LEVEL	SYSTEM	AMG
	E.	428120
	N.	5443885
	DATUM	AHD (Tasmania)
	COLLAR AROUND SURFACE	≈ 40m

Penetration 1 2 3	Method of Advancing Hole	Elevation (metres)	Depth	Geological Description (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	Geological Symbol	Sample Number	Classification (USC metric)	Field Tests: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	Consistency density index	moisture condition	Laboratory Tests: SPD (g/cm³)	BMD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameters: C'r (kPa)	φ'r (deg)	NMC %	Water
				CLAY	C_W	97*	CH												65	45	13		6			24	

Remarks

METHOD OF ADVANCING HOLE

EXPLANATION

*: Mineral composition determined by XRD

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller

Plant

Started

Finished

Logged

Date

Drawn Y. Whippy

Approved

Sheet 1 of 1

DATA POINT NO 61

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE Surface – grab sample

LOCATION Reservoir site off Stubbs Road

CASING/HOLE COMPLETION

REDUCED LEVEL CO-ORDINATES		
	SYSTEM	AMG
	E	435030
	N	5441690
	DATUM	AHD (Tasmania)
	COLLAR	
	GROUND SURFACE	≈ 80m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION soil type: plasticity or particle characteristics, colour, secondary and minor components.	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BND (g/cm³)	LABORATORY TESTS: Mechanical Analyses Clay %	Silt %	Sand %	Gravel %	LABORATORY TESTS: Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	LABORATORY TESTS: Free Swell %	Emerson Class No	LABORATORY TESTS: Shear Strength Parameter C'r (kPa)	Ø'r (deg)	N.M.C %	water
				CLAY		98*													89	55	16		6			28	
					Ts	* 103							2·73						92	57	16		6			40	

Remarks

METHOD OF ADVANCING HOLE

EXPLANATION

* Mineral composition determined by XRD.

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller	Logged
	Date
Plant	Drawn J. Whippy
Started	Approved
Finished	Sheet 1 of 1

DATA POINT Nº 62

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE surface – grab sample

LOCATION Top of road cutting, Bass Highway – West Ulverstone

CASING/HOLE COMPLETION

CO-ORDINATES		
	SYSTEM	AMG
	E.	427230
	N.	5443780
REDUCED LEVEL	DATUM	AHD (Tasmania)
	COLLAR AROUND SURFACE	≈ 30m

penetration	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	FIELD TESTS: Vane Shear Strength Residual (kPa)	FIELD TESTS: Penetrometer (kPa)	FIELD TESTS: consistency density index	FIELD TESTS: moisture condition	LABORATORY TESTS: SPD (g/cm³)	LABORATORY TESTS: BND (g/cm³)	Mechanical Analysis: Clay %	Mechanical Analysis: Silt %	Mechanical Analysis: Sand %	Mechanical Analysis: Gravel %	Index Tests: Liquid Limit %	Index Tests: Plasticity Index %	Index Tests: Linear Shrinkage %	Free Swell %	Emerson Class Nº2	Shear Strength Bromtest: C'r (kPa)	Shear Strength Bromtest: φ'r (deg)	NMC %	water
1 2 3		metres	CLAY	PE_W	99*	CH												74	47	14		6				

Remarks

METHOD OF ADVANCING HOLE

EXPLANATION

* Mineral composition determined by XRD

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller

Plant

Started

Finished

Logged

Date

Drawn J. Whippy

Approved

Sheet 1 of 1

DATA POINT Nº 63

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE surface – grab sample

LOCATION West Gawler – Ulverstone South.

CASING/HOLE COMPLETION

CO-ORDINATES		
REDUCED LEVEL	BYSTEM	AMG
	E.	427050
	N.	5442630
	DATUM	AHD (Tasmania)
	COLLAR	
	GROUND SURFACE	≈ 30m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BMD (g/cm³)	Mechanical Analyses: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class Nº	Shear Strength Brameht: C′ (kPa)	ϕ′ (deg)	NMC %	water
					Sd	100	CL												46	43	10		5			19	

Remarks

METHOD OF ADVANCING HOLE

EXPLANATION

*: Mineral composition determined by XRD

GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller

Plant

Started

Finished

Logged

Date

Drawn J. Whippy

Approved

Sheet 1 of 1

DATA POINT No 64

BOREHOLE LOG

PROJECT ULVERSTONE ENGINEERING GEOLOGY

FEATURE surface - grab sample

LOCATION Castra Road

CASING/HOLE COMPLETION

CO-ORDINATES: SYSTEM AMG; E. 431675; N. 5440265

REDUCED LEVEL: DATUM AHD (Tasmania); COLLAR GROUND SURFACE ≈ 53m

penetration 1 2 3	METHOD OF ADVANCING HOLE	ELEVATION metres	DEPTH	GEOLOGICAL DESCRIPTION soil type: plasticity or particle characteristics, colour, secondary and minor components.	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength (kPa) Peak	Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BMD (g/cm³)	Mechanical Analysis: Clay %	Silt %	Sand %	Gravel %	Index Tests: Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameter: C′ (kPa)	φ′ (deg)	NMC %	water
					S_d	101	CH												56	34	13					18	

Remarks

METHOD OF ADVANCING HOLE — EXPLANATION — GEOLOGICAL SYMBOL (see text)

ENGINEERING GEOLOGY SECTION

Driller

Plant

Started

Finished

Logged

Date

Drawn J. Whippy

Approved

Sheet 1 of 1

BOREHOLE LOG

DATA POINT No. 65

PROJECT: ULVERSTONE ENGINEERING GEOLOGY

FEATURE: surface – grab sample

LOCATION: Kimberleys' Road

CASING/HOLE COMPLETION:

CO-ORDINATES: SYSTEM: AMG; E. 432910; N. 5441830

REDUCED LEVEL: DATUM: AHD (Tasmania); COLLAR GROUND SURFACE: ≈ 110m

penetration	METHOD OF ADVANCING HOLE	ELEVATION / DEPTH (metres)	GEOLOGICAL DESCRIPTION (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	GEOLOGICAL SYMBOL	SAMPLE NUMBER	CLASSIFICATION (USC metric)	FIELD TESTS: Vane Shear Strength Peak (kPa)	Vane Shear Strength Residual (kPa)	Penetrometer (kPa)	consistency density index	moisture condition	LABORATORY TESTS: SPD (g/cm³)	BMD (g/cm³)	Mechanical Analysis Clay %	Silt %	Sand %	Gravel %	Index Tests Liquid Limit %	Plasticity Index %	Linear Shrinkage %	Free Swell %	Emerson Class No	Shear Strength Parameter C'r (kPa)	Shear Strength Parameter φ'r (deg)	NMC %	water
123			CLAY	Tb_W	102*							2·37		92	7	1		91	51	19		6			45	

Remarks:

METHOD OF ADVANCING HOLE

EXPLANATION

GEOLOGICAL SYMBOL (see text)

*: Mineral composition determined by XRD

ENGINEERING GEOLOGY SECTION

Driller:

Plant:

Started:

Finished:

Logged:

Date:

Drawn: J. Whippy

Approved:

Sheet 1 of 1

Appendix 2

Summary of laboratory soil testing, data points 1 to 65

Data point	Sample	Depth (m)	USC classification	Geological symbol	LL (%)	PL (%)	PI (%)	LS (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	MC (%)	EN (%)	Soil particle density	Bulk wet density	c'_r (kPa)	$'_r$ (°)
1	1	1.3–1.65	CH	Sd									54			1.77		
	2	1.3–1.65	CH	Sd													4	32
	3	1.65–2.6	CH	Sd	80	31	49	17					44	3	2.37			
2	4	0.4–1.5	SP	Qm						6	94							
3	5	1.3–1.6	CH	Sd	115	29	86	24	70	16	14		47	1	2.26			
	6	1.3–1.6	CH	Sd									44			1.80		
	7	1.7–1.9	CH	Sd	101	30	71	21					45	1			5	15
4	8	2.6–2.8	CH	Sd	108	32	76	24					49	6				
	9	4.5–4.8	CH	Ts	112	33	79	18					45	1	2.36		2	8
	10	6.8–7.3	CH	Ts														
6	11	1.5–1.8	CH	Tbw	69	34	35	16					34	6		1.60		
	12	4.2–6.7	CH	Tbw														
7	14	1.6–2.8	CH	Cr	59	36	23	12					24	6				
	15	4.3–4.6	CH	Cr									24			1.60		
8	16	0.4–1.3	SP	Qm						6	94							
	17	2.8–3.2	CH	PEw														
9	18	0.7–1.6	SP	Qm						4	96							
	19	4.8–7.0	CH	PEw									30	5				
10	20	0.6–1.3	CH	Qm	62	17	45	16					25	5	2.43			
11	21	1.0–2.0	CH	Sd	87	36	51	20					38	6	2.57			
	22	5.1–5.4	CH	Sd									56			1.74		
12	23	0.8–1.0	CH	Sd									41					
	24	1.4–1.7	CH	Sd									50					
	25	1.8–2.0	CH	Sd									52					
	26	2.0–2.2	CH	Sd									52					
	27	2.2–2.5	CH	Sd									53					
	28	3.8–4.1	CH	Sd	148	43	105	29					60	6	2.50			
	29	5.1–5.5	CH	Sd									74			1.64		
13	30	2.6–2.9	CH	Sd	113	41	72	22					38	6				
	31	3.2–3.4	CH	Sd	105	43	62	17					39	3				
	32	3.4–3.65	CH	Sd	98	30	68	21					43	3	2.68		5	21
14	33	2.3–2.8	CH	Tbw	140	42	98	28	78	19	3		64	6	2.56		5	18
	34	1.8–4.3	CH	Tbw									66					
	35	6.9–7.2	CH	Tbw									82			1.56		
15	36	0.8–1.1	CH	Qa	105	24	81	21					32	5	2.53		4	18
	37	2.1–2.9	CH	Qa														
16	38	0.2–1.3	CH	Sd	129	31	98	24					46	1	2.31			
17	39	0.5–1.0	CH	Sd	168	39	129	25					63	3				
	40	1.0–1.25	CH	Sd	173	37		28	91	6	3		64	3	2.25		6	12
18	41	0.2–1.0	CH	Sd	135	32	103	26					51	3	2.50			
19	47	0.2–1.2	SP	Qm						19	71	10						
21	48	0.2–1.0	CH	Sd	64	35	29	16					27	6	2.69			
22	49	0.2–1.3	CH	Sd	85	27	38	20					39	2				
23	50	0.3–1.3	MH	Sd	54	31	23	14					26	6	2.71			
24	51	0–0.4	CL	PEw	43	26	17	9					15	6	2.65		2	15
	52	0.4–2.8		PEr														
25	53	0–0.2	CH	TBw	76	28	48	19					15	5				
26	54	0.3–1.3	CH	Sd	103	34	69	18					49	5				
27	55	1.0–1.3	CH	Qa	93	26		21					34	2	2.54	1.84		
28	56	0.75–1.1	CH	Sd	49	18		12	35	48	17		24	5	2.61			
	57	5.8–6.3	CH	Sd	67	26	41	13					25	5				
29	58	0.6–1.5	CH	Qm	136	27	109	28					43	5	2.38			
	59	5.5–7.0	CH	Qm														
30	60	0.4–1.2	SP	Qm														
31	61	0.4–1.0	SP	Qa														
32	62	0.1–1.0	SM	Qa														
	63	5.0–7.0	SP	Qa														
33	64	0.4–1.0	SM	Qa	41	34	7	2					39					

Data point	Sample	Depth (m)	USC classification	Geological symbol	LL (%)	PL (%)	PI (%)	LS (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	MC (%)	EN (%)	Soil particle density	Bulk wet density	c'$_r$ (kPa)	'$_r$ (°)
34	65	0.3–1.0	CH	Tbw	94	38	56	19					51	6	2.44			
	66	0.5–0.7	CH	Tbw									45			1.75		
	67	3.5–4.5	CH	Tbw	108	37	71	20					57	6				
35	68	0.7–1.0	CH	Sd	121	39	82	23	87	10	3		56	2	2.24	1.73	3	10
	69	1.4–2.4	CH	Sd	68	32	36	17					62	5			4	27
36	70	0.2–1.5	CH	Sd	145	41	104	28					52	6				
	71	4.5–5.2	CH	Sd	78	45	33	13					53					
37	72	0.3–1.0	CH	Sd	92	35	57	21					42	6				
	73	1.5–3.6	CH	Sd	101	37	64	21					54	6				
38	74	0.8–1.3	ML	Qm	36	17	19	5	21	28	50	1	17	1				
39	75	0.8–1.7	CH	Qa	63	22	41	15					26	5				
40	76	0.7–1.2	CH	Sd	110	32	78	21					48	2				
	77	1.2–1.6		PEr	128	41	87	22					57	1	2.34		3	11
41	78	0.4 –1.0	CH	Tbw	104	39	65	18					41	6				
	79	2.5–3.3	CH	Tbw	92	43	49	19					51	6	2.62		2	31
	80	7.0–7.3	CH	Tbr	93	49	44	15					35			1.64		
44	81	0.3–1.4	CH	Tbw	98	29	69	25					46	6			4	30
	82		CH	Tbr	80	39	41	18					37	6		1.76		
	83		CH	Tbr	84	40	44	17					38	6				
45	84	1.0–1.2	CH	Sd														
	85	1.4–2.5	CH	Sd	99	38	61	22					47					
	86	3.0–3.5	CH	Sd	105	36	69	21					50	5	2.60		4	29
46	87	5.0–7.0	CH	Tbw?	134	45	89	26					62	5				
47	88	0.4–1.0	SP	Qm					1	3	95	1						
	89	1.0–1.6	SP	Qm					1	2	92	5						
48	90	0.3–1.3	CH	Qa	69	19	49	16					33	5	2.61			
49	91	0.2–0.8	SC															
	92	1.6–1.9	CH	Ts	103	25	78	20					32	6		1.91		
	93	3.4–3.7	CH	Sd	104	37	67	19					41	6	2.69	1.55		
50	94	0.7–1.0	CH	Sd	69	20	49	17					21					
	95	3.2–3.6	CH	Sd	129	38	91	24					47	6				
51	104	4.3–5.2	CH	Sd										1			4	16
55	42	0.3–0.9	CL-CH	Qm	47	18	29	12					27	2	2.49			
56	44	0–0.8	CL-ML	Qa	27	20	7	4					19	2	2.51			
57	45	0–2.0	CH	Tbw	134	37	97	28	79	17	4		62	1	2.29	1.52		
	46	2.0–3.0	CH	Tbw	73	19	54	17	38	15	47		31	1	2.50	1.77		
58	43			Ts	45	21	24	8					22	3				
59	96		CH	Sd	94	39	55	20					36	6	2.64			
60	97		CH	Cw	65	20	45	13					24	6				
61	98		CH	Ts	89	34	55	16					28	6				
	103		CH	Ts	92	35	57	16					40	6	2.73			
62	99		CH	PEw	74	27	47	14					Dry	6			2	15
63	100		CH	Sd	46	23	23	10					19	5				
64	101		CH	Sd	56	22	34	13					18					
65	102		CH	Tbw	91	40	51	19					45	6	2.37			

Notes:
Data point numbers 1–54 are auger holes; 55 trench; 56–57 existing excavations, 58–65 surface grab samples
c'$_r$ is residual cohesion in kilopascals, '$_r$ is residual angle of friction in degrees
Soil particle density and Bulk wet density are in g/cm^3

LL = liquid limit; PL = plastic limit; PI = plasticity index; LS = linear shrinkage

Geological symbols:
Qa = Alluvium; Qm = Coastal plain deposits; Sd = Slope deposit (transported soils)
Tbw = Residual soil — basalt parent rock; Tsi = Intra-basaltic sediments; Tbr = Basalt bedrock; Ts = Sub-basaltic sediments
Cw = Residual soil — Cambrian parent rock; Cr = Cambrian bedrock
PEw = Residual soil — Precambrian parent rock; PEr = Precambrian bedrock
r includes extremely weathered material (original rock fabric preserved)

Appendix 3

Details of data points 66 to 157

Site ID	Location	AMG (E)	AMG (N)	Reference	Depth (m) Start	Depth (m) End	Description	USC	Remarks
66	Clara Street, West Ulverstone	428970	5444340	UR74/3	0.00	1.20	red soil sandy clay		
					1.20	3.00	weathered basalt, plastic layers		
					3.00	3.40	yellow sand, wet		
67	Clara Street, West Ulverstone	429020	5444350	UR74/3	0.00	0.18	red soil		
					1.80	1.95	grey claying sand		
					1.95	3.00	red soil, sandstone		
68	Clara Street, West Ulverstone	429040	5444280	UR74/3	1.00	2.40	red soil, basalt boulders		
					2.40	3.00	white quartz sand		
69	Clara Street, West Ulverstone	428950	5444450	UR74/3	1.00	1.20	red soil		
					1.20	1.35	brown organic soil		
					1.35	1.50	red soil		
					1.50	1.65	grey plastic clay		
					1.65	3.30	brown clay, shear surface		
70	Clara Street, West Ulverstone	428920	5444330	UR 74/3	0.00	3.00	red soil		
71	Clara Street, West Ulverstone	428890	5444480	UR 74/3	0.00	1.80	red soil		
					1.80	2.10	grey plastic clay, sandy		
					2.10	3.00	brown plastic clay, sheared		
72	Clara Street, West Ulverstone	428830	5444460	UR74/3	0.00	1.00	brown soil		
					1.00	2.10	weathered basalt		
73	Clara Street, West Ulverstone	428820	5444500	UR74/3	0.00	3.00	brown soil, plastic, fissured, sheared		
74	Castra Road, Ulverstone	432120	5441460	U 1989	0.00	0.50	grey brown soil		
					0.50	1.40	red brown clay, fissured		
					1.40	2.50	red brown and grey clay, igneous texture		
					2.50	2.80	red brown and grey clay, basalt		
75	Castra Road, Ulverstone	432110	5441410	U 1989	0.00	0.50	grey brown soil, fractured		
					0.50	1.10	red clay, fissured		
					1.10	2.80	grey brown and reddish clay, igneous texture		
76	Castra Road, Ulverstone	432130	5441410	U 1989	0.00	0.50	grey brown soil		
					0.50	2.00	brown clay, fractured and fissured		
					2.00	2.90	red brown clay, igneous texture		
77	Clayton	433200	5443290	U 1989	0.00	0.30	black sandy loam		
					0.30	0.90	grey black sand, basalt or dolerite boulders		
					0.90	1.50	brown clay, basalt or dolerite rock		
					1.50	2.70	fawn grey clay, basalt or dolerite boulders		
78	Clayton	433220	5443430	U 1990	0.00	0.30	blue grey sand		
					0.30	1.00	light grey sand		
					1.00	2.40	brown grey sand, coarse, WT 1.4		
79	Clayton	433340	5443440	U 1990	0.00	0.30	brown loam		
					0.30	1.40	brown clayey loam, basalt or dolerite boulders		
					1.40		basalt or dolerite layer, very hard		
80	Clayton	433510	5443430	U 1990	0.00	0.40	grey sand, fine grained		
					0.40	1.50	brown sand, some gravel		
					1.50	2.00	grey, brown sand, coarser gravel		
					2.00	3.00	grey brown sand, gravel, wet, WT 2.0		
81	Clayton	433510	5443430	U 1990	0.00	0.40	black loam, beach gravel		
					0.40	0.90	brown sand, beach gravel		
					0.90	1.30	light brown sand, beach gravel		
					1.30	1.90	dark grey brown sand, beach gravel		
					1.90	2.30	grey brown sand, beach gravel, wet, WT 2.1		
82	Clayton	433810	5443460	U 1989	0.00	0.30	grey brown sand, beach gravel		
					0.30	0.50	black clayey sand		
					0.50	0.80	grey clayey sand		
					0.80	1.60	light grey clayey sand		
					1.60	2.80	grey sand		
					2.80	3.00	grey sand wet		
					3.00	3.50	grey sand, some rounded gravel, WT 2.8		
83	Clayton	433970	5443430	U 1989	0.00	0.60	light grey sand		
					0.60	0.90	brown clayey sand		
					0.90	1.90	brown clay		
					1.90	2.50	brown and black clay, some gravel, WT 2–2.4		
84	Clayton	434070	5443320	U 1989	0.00	1.00	light grey sand		
					1.00	2.00	brown clayey sand		
					2.00	2.50	black / green clay, some gravel, WT 1.8		

Site ID	Location	AMG (E)	AMG (N)	Reference	Depth (m) Start	Depth (m) End	Description	USC	Remarks
85	Ulverstone, Civic Centre	430460	5443410	U 1979	0.00	1.20	sand and rubble		
					1.20	2.00	gritty sand, hard pan		
					2.00	3.00	dark yellow sand, WT 2.0		
86	Ulverstone, Civic Centre	430480	5443470	MR 1981	0.00	0.80	grey sand	SP	6 pits
					0.80	2.00	dark brown sand, some cemented	SP-SM	
					2.00	2.40	sand, WT 2.0	SP	
87	Ulverstone, High School	430360	5442670	MR 1969	0.00	0.25	grey gravel, quartzite		
					0.25	0.60	grey sand		
					0.60		sandy clay over weathered quartzite pebbles, WT 0.6		
88	Ulverstone, High School	430370	5442720	MR 1969	0.00	0.25	grey gravel, quartzite		
					0.25	0.30	black sandy loam		
					0.30	0.60	grey sand		
					0.60	2.10	dark grey to black clay, some gravel		
					2.10	2.40	black gravel in sand WT 2.0		
89	Lovett Street, Ulverstone, Fire Station	429800	5442490	DC 1990	0.00	0.25	grey topsoil		
					0.25	0.60	sandy loam		
					0.60	1.60	yellow grey clay, plastic		
					1.60	3.00	grey sand, wet		
90	Lovett Street, Ulverstone, Fire Station	429790	5442520	DC 1990	0.00	0.40	grey topsoil		
					0.40	1.80	grey clay, firm		
					1.80	2.70	grey sand, wet		
91	Lovett Street, Ulverstone, Fire Station	429820	5442550		0.00	0.45	loaming topsoil		
					0.45	1.60	grey?, softer with depth		
					1.60	2.80	grey sand, wet		
92	Lovett Street, Ulverstone, Fire Station	429770	5442550	DC 1990	0.00	0.35	grey topsoil		
					0.35	1.50	grey clay, firm		
					1.50	2.70	grey wet sand		
93	Lovett Street, Ulverstone, Fire Station	429770	5442480	DC 1990	0.00	0.35	topsoil		
					0.35	1.70	grey yellow clay, firm		
					1.70	2.80	grey yellow sand, wet		
94	Short Street, Ulverstone	429550	5442640	MR 1982	0.00	0.43	black loaming sand	SP	6 pits
					0.43	0.90	white sand		
					0.90	1.05	yellow orange sand		
					1.05	1.60	yellow orange sand, some iron cemented		
					1.60	1.90	yellow sand		
95	East Ulverstone, Primary School	431990	5443520	MR 1979	0.00	0.20	grey broen sand	SP	3 pits
					0.20	0.60	brown silty sand, quartzite and basalt boulders	SM	
					0.60	1.10	brown gravelly clay (basalt boulders)	GC	
					1.10	1.70	orange brown highly weathered basalt (clayey)		
96	South Road, West Ulverstone, Drill Hole 2	427690	5443740	MR 1976	0.00	0.40	black green clay, sandy	CH	3 pits
					0.40	1.40	blue grey clay, some coarse sand	CH	3 DH
					1.40	3.50	brown grey clay, some rock fragments	CH	
					3.50	6.00	brown grey weathered		
					6.00	13.00	brown and grey		
97	Leven River Bridge, Ulverstone	428830	5442680	MR 1976	0.00	1.50	water	SP	
					1.50	14.50	grey sand, black grey silty sand	ML	
					14.50	17.35	gravel with silty sand, some clay	GP	
97	Leven River Bridge, Ulverstone	428830	5442680	MR 1976	0.00	1.50	water		
					1.50	2.50	gravel, fine grained	GP	
					2.50	12.00	grey sand, shell and fragments	SP-SC	
					12.00	16.65	grey black silt	MH	
					16.65	18.95	brown silty sand, pebbles and gravel	SC-GP	
98	Leven River Bridge, Ulverstone	428830	5442680	MR 1976	0.00	1.50	water		
					1.50	7.00	grey sand, some shells	SP-SC	
					7.00	9.30	yellow sand, some clay seams	SC	
					9.30	17.18	grey silt	MH	
					17.18	19.20	river shingles with silt and sand	GP	
					17.18	29.60	orange brown clay with gravel, some sand	GP-SC	
99	Leven River Bridge, Ulverstone (Pier 3)	428830	5544268		0.00	3.60	water		
					3.60	9.10	sand, fine gravel, silt yellow clay bands	SP-ML	
					9.10	17.10	grey silt	ML-MH	
					17.10	18.55	fine grained, silty and sandy	GP	
					18.55	22.64	river mined with sandy and clay fines		
					22.64	25.68	clay, friable, stiff, schist pebbles		
					25.68	27.40	pebbly clay		
					27.40	28.92	coarse gravel		
					28.92	31.50	brown quartzite, hard		

Site ID	Location	AMG (E)	AMG (N)	Reference	Depth (m) Start	Depth (m) End	Description	USC	Remarks
100	Leven River Bridge, Ulverstone (Pier 4)	428830	5544268		0.00	3.85	water		
					3.85	8.80	sand, fine gravel shells	GP-SC	
					8.80	16.05	grey silt, shells	MH	
					16.05	18.25	shingle, some schist material	GP	
					18.25	27.10	yellow quartzite with laterite in top section		
101	Leven River Bridge, Ulverstone (Pier 5)	428830	5544268		0.00	3.80	water		
					3.80	10.00	gravel, (water worm), silt sand, shells	GP-SC	
					10.00	17.20	grey silt soft	MH	
					17.20	50.00	yellow quartzite bonds laterite material		
102	Leven River Bridge, Ulverstone A (W)	428750	5442750		0.0	6.38	brown sand, shells		
					6.38	15.50	grey sand, some silt	SP	
					15.50	18.20	sand, pebbles, shells	SP-GP	
					18.20	20.18	green clayey gravel	GP	
					20.18	21.10	green sand gravel	GW	
					21.10	23.20	green grey clayey sand		
					23.20	26.20	grey sand with pebbles (volcanic, quartzite)		
103	Ulverstone Bypass, Masons Creek	429320	5442420	MR	0.00	1.50	clayey sand (clay sparse)		
					1.50	4.00	clayey sand		
					4.00	6.50	sandy clay/rock?		
104	Ulverstone Bypass, Masons Creek	429350	5442420	MR	0.00	0.15	sand		
					0.15	4.30	sand, some clay		
					4.30	6.50	sandy clay/rock?		
105	Ulverstone Bypass, Masons Creek	429370	5442430	MR	0.00	0.30	sand		
					0.30	3.40	sand, some clay		
					3.40	5.40	sandy clay		
					5.40	6.60	sandy clay (wet)/rock?		
106	Ulverstone Bypass, Preston Road	429790	5442280	MR 1976	0.00	0.80	black and orange sand	SC	
					0.80	1.14	orange sandy clay	CL	
					0.80	5.45	yellow, grey, green sand	SP-SC	
					5.45	17.00	black, grey brown, brown clay		
							quartzite pebble at 10 m	OL, CH	
					17.00	20.30	green, white black grey clay with quartzite fragments		
107	Ulverstone Bypass, Preston Road	429790	5442280		0.00	6.00	black grey yellow sand and clayey sand, some gravel	SC, CH	
					6.00	8.40	black grey silt some gravel organic	OL	
					8.40	12.60	green, brown black clay with pebbles quartzite, basalt	CH	
					12.60	13.80	grey basalt cobbles, green brown tuff at end		
					13.80	16.00	grey green phyllite		
108	Ulverstone Bypass, Preston Road	429750	5442280		0.00	12.00	without sampling		
					12.00	16.50	grey yellow phyllite with quartzite bands		
109	Ulverstone Bypass	430940	5441970		0.00	0.60	brown clayey gravel (basalt)	CL	
					0.60	0.80	grey clay	CH	
					0.80	3.50	gravel, rounded basalt fragments		
110	Ulverstone Bypass	430940	5441970		0.00	0.40	brown clayey gravel (basalt)	CL	
					0.40	1.20	green grey clay some pebbles	CH	
					1.20	1.50	basalt slightly weathered		
111	Ulverstone Bypass	430940	5441970		0.00	0.30	brown clayey gravel (basalt)	CL	
					0.30	0.80	yellow clay plastic	CH	
					0.80	5.10	brownish tuff, plastic		
112	Ulverstone Bypass	430940	5441970		0.00	1.00	black, yellow clay plastic	CL-CH	
					1.00	2.20	yellow clay plastic, some basalt fragments	CH	
					2.20	3.90	red brown grey pyroclastic rock		
					3.90	5.80	yellow brown pyroclastic particles absent		
					5.80	8.00	fragments		
113	Ulverstone Bypass	430940	5441970		0.00	0.40	black clay, rock fragments	CL	
					0.40	0.80	orange clay plastic	CH	
					0.80	4.30	pyroclastic		
114	Ulverstone Bypass	430940	5441970		0.00	0.60	grey clay plastic	CL	
					0.60	1.20	brown clay plastic	CL	
					1.20	5.10	basalt, less weathered with depth, rippable		
115	Ulverstone Bypass	430940	5441970		0.00	1.10	black clay plastic, rock fragments	CL	
					1.10	1.60	basalt, weathering decreases with depth, rippable		
116	Ulverstone Bypass	430940	5441970		0.00	0.50	black clay plastic, some rock fragments	CH	
					0.50	1.00	brown clay, plastic	CH	
					1.00	2.80	basalt, weathering decreases with depth		
117	Ulverstone Bypass	430940	5441970		0.00	0.50	black clay, plastic, pebbles	CH	
					0.50	1.60	orange clay plastic, rock fragments	CH	
					1.60	3.20	basalt variable weathering		

Site ID	Location	AMG (E)	AMG (N)	Reference	Depth (m) Start	Depth (m) End	Description	USC	Remarks
118	Ulverstone Bypass	430940	5441970		0.00	0.40	black clay, plastic, rock fragments	CH	
					0.40	0.80	orange yellow to brown clay, plastic	CH	
					0.80	1.70	basalt/variable weathering		
119	Ulverstone Bypass, Castra Main Road	431990	5442290	MR 1977	0.00	0.45	topsoil		
					0.45	0.90	orange yellow silty sand	CL	
					0.90	1.23	gravel, rounded pebbles	GP	
					1.23	6.00	orange yellow clay (weathered basalt)	CH	
					6.00	15.50	basalt variable weathered		
					15.50	17.90	pyroclastic-agglomerate, tuff with sand and clay		
					17.90	22.50	basalt, weathered at top		
120	Ulverstone Bypass, Castra Main Road	431990	5442290		0.00	0.30	topsoil		
					0.30	1.23	red brown sandy clay	CL	
					1.23	2.50	grey brown gravel, clayey, quartz pebbles	GC	
					2.50	15.58	grey brown clay (weathered basalt)	CH	
					15.58	15.85	sandy clay, subangular quartz		
					15.85	17.30	basalt and clay		
					17.30	20.27	basalt, clay filled vesicles		
121	Ulverstone Bypass, Castra Main Road	431990	5442290		0.00	0.30	topsoil		
					0.30	1.60	brown clayey sand	CH	
					1.60	2.00	gravel (quartz)	GP	
					2.00	4.78	yellow clay, some gravel (basalt fragments) weathered basalt		
					4.78	14.20	basalt completely weathered green brown		
					14.20	19.13	basalt, blue grey with vesicles		
122	Ulverstone Bypass, Forth Road Underpass	432580	5442960		0.00	0.60	clayey gravel (basalt fragments)	GC	
					0.60	2.25	dark blue to black clay organic, plastic	CH	
					2.25	2.80	basalt deeply weathered		
123	Ulverstone Bypass, Forth Road Underpass	432580	5442960		0.00	1.00	clayey gravel (basalt fragments)	GC	
					1.00	2.50	blue green plastic clay. quartzite fragments at base		
					2.50	3.70	brown grey basalt, weathered		
124	Ulverstone Bypass Forth Road Underpass	432580	5442960		0.00	0.90	clayey gravel (basalt fragments)		
					0.90	1.60	dark blue to black clay, organic		
					1.60	2.90	grey sand		
					2.90	3.60	brown basalt, highly weathered		
125	Ulverstone Bypass Forth Road Underpass	432580	5442960		0.00	1.30	clayey gravel (basalt fragments)		
					1.30	2.60	grey silty sand		
					2.60	3.80	brown-orange basalt, highly weathered		
126	Ulverstone Bypass Forth Road Underpass	432580	5442960		0.00	0.60	brown clayey gravel (basalt fragments)		
					0.60	1.00	blue grey clay, plastic	CH	
					1.00	2.40	brown grey silty clay, some sand and pebbles, medium plasticity	OH-MH	
					2.40	3.20	brown basalt, highly weathered		
127	Ulverstone Bypass Forth Road Underpass	432580	5442960		0.00	0.60	clayey gravel (basalt fragments)	GC	
					0.60	2.00	dark grey-brown clay, occasional fragments basalt and quartzite plastic	CH	
					2.00	3.00	grey brown basalt, moderately weathered		
128	Ulverstone Bypass Forth Road Underpass	432580	544PQR0		0.00	1.00	clayey gravel (basalt fragments)	GC	
					1.00	2.20	silty sand, quartz boulders	SP	
					2.20	3.60	brown basalt, highly weathered		
129	Ulverstone Bypass Forth Road Underpass	432580	5442960		0.00	0.70	clayey gravel (basalt fragments)	GC	
					0.70	1.50	blue black clay, organic, plastic	OH	
					1.50	2.80	grey sand	SP	
					2.80	4.00	yellow brown basalt, highly weathered		
130	Ulverstone Bypass Forth Interchange `	432580	5442960		0.00	1.60	grey topsoil, brown to grey clayey sand	SC	
					1.60	3.20	brown green clay plastic	CH	
					3.20	5.70	clayey gravel, medium plasticity, basalt fragments (weathered basalt)	GC	
					5.70	11.30	brown yellow-green grey basalt weathering decreases with depth		
					11.30	12.70	grey blue basalt, slightly weathered		
131	Ulverstone Bypass, Forth Interchange	432580	5442960		0.00	0.15	grey sandy clay topsoil	CL	
					0.15	2.00	orange grey silty clay, low to medium plasticity		
					2.00	4.40	brown grey gravelly clay (weathered basalt?) medium plasticity	GC	
					4.40	12.83	yellow brown to blue grey basalt		
132	Ulverstone Bypass Forth Interchange	432580	5442960		0.00	0.15	grey sandy clay topsoil	SC	
					0.15	2.00	orange grey clayey silt medium plasticity	SC-CL	
					2.00	2.90	grey sand, some clay	SP	
					2.90	6.00	brown orange clayey silt medium plasticity (weathered basalt?)	SC-CL	
					6.00	8.50	clayey silt with basalt fragments (highly weathered)	GC	
					8.50	16.45	brown to green grey basalt and/or pyroclastic bedded?		

Site ID	Location	AMG (E)	AMG (N)	Reference	Depth (m) Start	Depth (m) End	Description	USC	Remarks
133	Ulverstone Bypass, Forth Interchange	432580	5442960		0.00	0.20	grey sandy clay topsoil	SC	
		432580	5442960		0.20	1.60	grey silty clay medium to low plasticity	SC-CL	
					1.60	5.75	brown orange clay, basalt fragments increases with depth (highly weathered basalt)	CH-GC	
					5.75	6.90	green grey basalt/pyroclastic		
					6.90	10.97	blue grey basalt		
134	Bass Highway, Claytons Rivulet	434470	5442900		0.00	0.45	loamy topsoil	SC-CL	
					0.45	1.90	red brown to brown clay (silty) friable	CL-CH	
					1.90	2.70	yellow brown to brown green sandy clay, friable	SC-CL	
135	Bass Highway, Claytons Rivulet,	434470	5442900		0.00	0.40	loamy topsoil friable	SC-CL	
					0.40	1.75	brown clayey sand, silty, sandy clay, friable-semi friable		
					1.75	2.75	blue grey sand (quartz)	SC	
136	Bass Highway, Claytons Rivulet	434470	5442900		0.00	0.40	loamy topsoil	SC-CL	
					0.40	2.90	red brown silty and sandy clay friable	CL-CH	
137	Bass Highway, Forth River	436700	5442570		0.00	2.80	brown sandy gravel in sand	GP-GL	
					2.80	7.45	greyish olive sand (quartz) some rock and shell fragments	SP	
					7.45	8.40	grey gravelly sand some wood	SP-GP	
					8.40	11.45	dark olive grey sandy silt (quartz and rock fragments), some shells increasing at base		
138	Bass Highway, Forth River	436610	5442570		0.00	10.15	light to medium grey sand, some silt, shells, wood fragments, occasional gravel fragments	SM	
139	Bass Highway, Forth River	436700	5442570		0.00	0.45	water		
					0.45	3.20	grey sand (quartz) some pebbles	SW	
					3.20	6.87	cobbles and gravel, some clay and sand towards base	GP	
					6.87	7.32	grey brown clay, silty	CH	
140	Bass Highway, Forth River	436800	5442570		0.00	1.05	clayey gravel, silty clay (rounded quartzite fragments)	GC	
					1.05	1.20	light yellow sand, poorly graded	SP	
141	Bass Highway, Forth Bridge	436840	5442570	MR 1983	0.00	0.80	sandy gravel (rounded quartzite fragments) in black and grey sand	GW	
					0.80	1.90	gravel (quartzite fragments becoming lower with depth, sand	GP-GW	
142	Bass Highway, Forth Bridge	436870	5442570		0.00	1.80	sandy gravel (rounded quartzite fragments) in black light grey, orange brown sand	GW	
143	Bass Highway, Forth Bridge	436910	5442570		0.00	0.05	silt, organic	OL	
					0.05	1.10	yellow grey sand (quartz)	SP	
					1.10	1.60	white to grey sandy gravel (quartzite fragments)	GW	
144	Bass Highway, Forth Bridge	436910	5442570		0.00	0.05	dark brown silty clay, organic	OM	
					0.05	1.70	light brown to grey yellow sand (quartz)	SM-SP	
145	Bass Highway, Forth Bridge	436980	5441250		0.00	0.45	dark grey to black sand (quartz) changing to grey	SP	
					0.45	1.90	gravel (quartzite fragments), roots to 0.9 m	GW	
146	Bass Highway, Forth Bridge	436980	5442590		0.00	1.00	clayey gravel (rounded quartzite fragments) in silty clay, organic	GC	
147	Bass Highway, Forth Bridge	436980	5442590		0.00	0.80	clayey gravel (rounded quartzite fragments) in silty clay, organic	GC	
148	Bass Highway, Forth River Bridge	437110	5442650		0.00	0.45	water		
					0.45	6.23	cobbles sand gravel rounded quartzite basalt fragments	GP	
					6.23	9.87	brown and grey basalt, vesicular		
					9.87	14.24	brown red grey tuff? Low specific gravity		
					14.24	14.82	brown sand, basalt pebbles		
					14.82	15.27	gravel, quartzite fragments		
149	Bass Highway, Forth River Bridge	437110	5442650		0.00	3.80	water		
					3.80	5.80	dark green grey to white sand (quartz, rock and shell fragments)	SW-SP	
					5.80	8.00	gravel (quartz and schist fragments), some rounding, shells	GW-GP	
					8.00	8.20	sand	SW	
					8.20	10.50	gravel	GW-GP	
					10.50	12.50	sand with shingle layers (quartzite and schist fragments	SP	
					12.50	13.00	gravel (quartzite and schist fragments), rounded in silty gravel		
					13.00	15.20	yellow-brown clay some quartzite pebbles, rounded	MH	
					15.20	16.70	white-grey sand, some pebble layers	SP	

Site ID	Location	AMG (E)	AMG (N)	Reference	Depth (m) Start	Depth (m) End	Description	USC	Remarks
150	Bass Highway, Forth River Bridge	437110	5442650		0.00	3.50	water		
					3.50	5.75	sand, quartz and rock fragments, some pebble layers	SW	
					5.75	7.95	gravel, subrounded quartzite, schist, basalt fragments	GW	
					7.95	10.50	grey brown gravelly silt quartzite and rock fragments	GM	
					10.50	14.80	red brown clay plastic quartzite pebbles at top but mostly weathered basalt	CH	
					14.80	16.00	white gravel, quartzite fragments, sand	GW	
					16.00	16.45	white sand (quartz)	SP	
151	Bass Highway, Forth River Bridge	437110	5442650	MR 1982	0.00	3.80	silty sand and clay	MH-CL	
				MR 1982	3.80	5.70	brown to grey sandy clay some gravel fragments (quartzite basalt)	CL	
					5.70	8.00	gravel and shingle quartz and rock fragments	GP	
					8.00	12.81	red grey-yellow clay (entirely weathered basalt)	GC-CH	
					12.81	15.04	brown-red grey tuff?		
					15.04	15.40	gravelly sand (quartzite fragments)		
152–157	Bass Highway, Forth River Bridge	437110	5442680		0.00	2.00	sand, silt, river gravel		
					3.70	12.54	gravel, silt and sandy clay		

All grid references are AGD66 datum

References:

UR Unpublished Report, Tasmania Department of Mines
U Ulverstone Municipal Council
MR Department of Main Roads
DC Department of Construction

USC Unified Soil Classification System

Appendix 4

Summary of X-ray diffraction results

Sample No.	3	5	7	8	9	11	14	19	20	21	28	30	32	33	36	38
Clay fraction (%)																
Serpentine																
Talc																
Stevensite																
Montmorillonite	20	35	20	5	40			10	50	80	5	15	20	45	15	85
Halloysite	75	60		80		65	45		50		90	80	65	45	75	15
Kaolinite					30			55								
Goethite	5	5		15		10	5			10	5	5	15	10	10	
Illite					30		45									
Quartz							5									
Hematite						10				10						
Mica								35								
Gibbsite						10										
Vermiculite						5										
Lepidocrocite																
Whole sample(%)																
Lepidocrocite																
Anatase																
Stevensite																
Montmorillonite	20	25	10	2	40			5	25		5		10	35	10	65
Halloysite	60	50	45	70		45	25		20	70	75	70	40	40	45	15
Kaolinite					25			30								
Goethite	2	5	10	15		10	5			5	10	10	10	5	5	2
Illite					25		25									
Quartz		10	25	5	10	25	45	45	55	10		5	15	2	35	2
Hematite						10				10	5			5		
Ilmenite		5	5	5						5	5	2	15	2	5	5
Feldspar		5	5									2	10		2	10
Magnetite	5			5						5		10		10		2
Pyroxene	10															
Apatite	5															
Gibbsite						10										
Mica								20								
Vermiculite						2										
Talc																
Serpentine																
Chlorite																
Geological symbol	Sd	Sd	Sd	Sd	Ts	Tbw	Cr	PEw	Qm	Sd	Sd	Sd	Sd	Tbw	Qa	Sd

Geological symbols

Qa	Alluvium
Qm	Coastal plain deposits
Sd	Slope deposit (transported soils)
Tbw	Residual soil — basalt parent rock
Tsi	Intra-basaltic sediments
Tbr	Basalt bedrock
Ts	Sub-basaltic sediments
Cw	Residual soil — Cambrian parent rock
Cr	Cambrian bedrock
PEw	Residual soil — Precambrian parent rock
PEr	Precambrian bedrock

r includes extremely weathered material (original rock fabric preserved)

Sample No.	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**48**	**49**	**50**	**51**	**53**	**54**	**55**	**56**
Clay fraction (%)																
Serpentine																
Talc																
Stevensite																55
Montmorillonite		85	85	40	40	20	50	50	75	55			90	85	70	
Halloysite		15	15	60			45	50		45	70		10	15		
Kaolinite					55	50						70			20	30
Goethite						10	5				30	10			5	10
Illite						10									5	
Quartz						10										
Hematite									15			5				
Mica																
Gibbsite									10			5				
Vermiculite												10				
Lepidocrocite																
Whole sample(%)																
Lepidocrocite																
Anatase																
Stevensite																15
Montmorillonite	65	75	65	15	20	5	40	20		40			65	45	50	
Halloysite	15	15	15	20			40	20	35	30	35			10		
Kaolinite					30	10						25			10	10
Goethite	2		2			2	15	5	2		15	5		2	10	5
Illite						2									5	
Quartz	5	2	2	65	45	80		50	35		45	55			25	70
Hematite									15							
Ilmenite	5	5	5				5	2	5	2			2	10		
Feldspar	5	5	10					2	2	20			15	20	2	
Magnetite			2						2					15		
Pyroxene										10			20			
Apatite																
Gibbsite					2				2			2				
Mica					5							10				
Vermiculite												5				2
Talc																
Serpentine																
Chlorite																
Geological symbol	Sd	Sd	Sd	Qm	Ts	Qs	Tsi	Tsi	Sd	Sd	Qa	PEw	Tbw	Sd	Qa	Sd

Sample No.	57	58	65	67	68	69	70	72	73	74	75	76	77	78	79	80
Clay fraction (%)																
Serpentine												10	15			
Talc												5	5			
Stevensite																
Montmorillonite		60			40	45						80	75			
Halloysite		30	60	80	60	50	85	65	85		60				85	90
Kaolinite										25						
Goethite		5	10	20		5	10	5	15	5	10	5			15	10
Illite										70	15					
Quartz																
Hematite			20				5	20								
Mica																
Gibbsite			10					10			5					
Vermiculite											10					
Lepidocrocite		5														
Whole sample(%)																
Lepidocrocite		2														
Anatase																
Stevensite																
Montmorillonite		50			40	40						60	60	5		
Halloysite		20	55	65	55	40	80	55	70		25			70	75	85
Kaolinite	15									5						
Goethite	5	5	10	15	2	2	10	5	15	2	5	10	5	10	15	5
Illite											5					
Quartz	50	25	5	2	2	2		10	2	75	50	2	2	2		
Hematite			25				5	20								
Ilmenite								2	5	2				2	2	5
Feldspar						5										
Magnetite				15		10	5	2	10				2	10	10	5
Pyroxene																
Apatite																
Gibbsite			5	2				5		2	2					
Mica	30									15	10					
Vermiculite											2					
Talc												2	2			
Serpentine												20	30			
Chlorite												5				
Geological symbol	Sd	Qm	Tbw	Tbw	Sd	Sd	Sd	Sd	Sd	Qm	Qa	PEw	PEr	Tbw	Tbw	Tbr

Sample No.	**82**	**86**	**87**	**90**	**92**	**93**	**95**	**96**	**97**	**98**	**99**	**100**	**102**	**103**
Clay fraction (%)														
Serpentine														
Talc														
Stevensite														
Montmorillonite			35	35			10					5		
Halloysite	75	85	60	40		90	75	85		10			75	
Kaolinite										80		40		55
Goethite	10	5	5	15		10	15	15		10	5	5	5	40
Illite											95			
Quartz												10		
Hematite	5	10										10	10	
Mica												25		5
Gibbsite	10											5	10	
Vermiculite														
Lepidocrocite				10										
Whole sample(%)														
Lepidocrocite				5										
Anatase														
Stevensite														
Montmorillonite			30	15			5		10					
Halloysite	65	70	60	20	55	70	60	60					75	
Kaolinite									25	70		20		45
Goethite	15	2	5	5		15	20	20	10	2	2	2	5	30
Illite											50			
Quartz	10	10	2	45	40	15	10	5	45	20	45	45	2	20
Hematite	5	2										5	15	
Ilmenite			5	2	5	2	5	2		5				2
Feldspar			2		2									
Magnetite		15		2				10				5		
Pyroxene														
Apatite														
Gibbsite	5	2						2				2	5	
Mica				5					10	5		15		5
Vermiculite														
Talc														
Serpentine														
Chlorite														
Geological symbol	Tbi	Sd	Tbw	Qa	Tsi	Sd	Sd	Sd	Cw	Ts	PEw	Sd	Tbw	

APPENDIX 5

Details of water bores (data points 159 to 200)

Site ID	Location	AMG (E)	AMG (N)	Date drilled	DWS (m)	SWL (m)	TD (m)	Output (l/min)	Salinity (mg/l)	Driller's logs (m)
159	Turners Beach	435420	5442070	26/06/1963			30.5			0–6.1 sand, 6.1–9.1 gravel, 9.1–12 clay 12.2–30.5 black schist
160	Turners Beach	435420	5442070	08/07/1963	11.6		13.7	7.6	13.3	0–7.6 sand, 7.6–9.8 sand and pebbles, 9.8–13.7 coarse gravel
161	Gawler	429700	5440820	21/02/1979	12.1–29	10.7	33.5	75.8		0–0.6 grey loam, 0.6–6.1 clay, 6.1–33.5 siltstone
162	Turners Beach	436110	5442380	17/04/1979			64			0–5.5 sand and gravel, 5.5–6.7 clay, 6.7–12.8 shingle, 12.8–51.8 sand and gravel 51.8–64 sand
163	Turners Beach	436110	5441920	27/04/1979	7.6–9.1	1.8	106.7	455		0–1.8 topsoil, 1.8–5.5 sand, 5.5–6.1 basalt, 6.1–18.3 shingle and gravel, 18.3–106.7 sand, clay and gravel
164	Turners Beach	435360	5442390	01/07/1963	10.7		12.5	22.7	320	0–0.46 sand, 4.6–12.5 gravel
165	Ulverstone	427290	5443410	09/03/1978	10.7	4.4	34.8	22.7		0–1.2 conglomerate, 1.2–7.9 clay, 7.9–34.8 hard mudstone
166	Ulverstone	4332950	5443050	15/09/1978	12.2–21.3	6.1	24.4	75.8		0–0.3 topsoil, 0.3–3.7 clay, 3.7–12.2 loose basalt, 12.2–21.3 sand and gravel, 21.3–24.4 quartzite
167	Turners Beach	435260	5442390	24/09/1965			13.1			0–0.6 sandy soil, 0.6–6.1 sand, 6.1–13.1 graphitic schist
168	Turners Beach	435310	5442390	27/09/1965	5.5		13.1	45.5	325	0–0.3 soil, 0.3–4.0 sand, 4.0–8.8 sand and rounded gravel, 8.8–13.1 graphitic schist
169	Turners Beach	435395	5442500	21/08/1979	6.1–9.8	4.6	9.8	34.1	9.8	0–6.1 sand, 6.1–9.8 gravel
170	Ulverstone	433140	5444620	14/02/1978	16.8–30.5		33.5	91		0–0.3 topsoil, 0.3–12.2 clay, 12.2–14.9 clay and boulders, 14.9–32 basalt, 32–33.5 schist
171	Turners Beach	435530	5441800	10/07/1963	11.6		13.7	19	320	0–4.6 sand, 4.6–8.2 sand, clay, some pebbles 8.2–11.6 clay. 11.6–12.2 coarse gravel, 12.2–13.7 fine gravel
172	Turners Beach	435810	5441790	15/10/1982	6.1–15.7	3.1	74.7	227		0–0.3 topsoil, 0.3–3.1 clay, 3.1–45.7 gravel and sand, 45.7–74.7 schist
173	Ulverstone	433190	5442160	16/02/1979			38.1			0–0.3 topsoil, 0.3–16.8 clay, 16.8–24.4 decomposed basalt, 24.4 –38.1 slate
174	Ulverstone	433080	5441920	17/02/1979			61			0–0.3 topsoil, 0.3–15.2 clay, 15.2–29 decomposed basalt, 29–61 slate
175	Ulverstone	428510	5443820	08/03/1978	6.1, 33.5	4.0	36.6	26.5		0–0.3 topsoil, 0.3–5.5 clay, 5.5–6.1 gravel, 6.1–33.5 soft quartzite, 33.5–38.1 quartzite
176	Ulverstone	430200	5442600	13/08/1979	2.1, 5.5		6.1	36.4		0–6.1 sand
178	Turners Beach	435450	5442390	23/09/1965	12.2		16.3	37.9	260	0–0.5 sandy clay, 0.5–0.8 sand, 0.8–9.1 sand and silt, 9.1–16.3 sand and rounded gravel
179	Ulverstone	427890	5444520	28/10/1982	13.7–27.4	12.2	61	37.9		0–0.3 topsoil, 0.3–12.2 clay, 12.2–27.4 basalt, 27.4–61 schist
180	Ulverstone	433510	5442640	16/02/1983	6.1, 27.4	3.1	54.9	60.6		0–0.3 topsoil, 0.3–12.2 brown clay, 12.2–27.4 basalt, clay, 27.4–53.4 basalt 53.4–54.9 quartz gravel
181	Ulverstone	433400	5442650	18/03/1983	6.1, 27.4		51.9	91		0–0.3 topsoil, 0.3–12.2 clay, 12.2–27.4 decomposed basalt, 27.4–47.3 basalt, 47.3–51.9 schist
182	Ulverstone	432890	5442780	18/02/1983			15.2			0–0.3 topsoil, 0.3–15.2 loose basalt
183	Ulverstone	432510	5442500	19/02/1983			9.1			0–0.3 topsoil, 0.3–9.1 loose basalt
184	Ulverstone	432310	5442440	19/02/1983	0.3–45.7		85.7	22.7		0–0.3 topsoil, 0.3–12.2 loose basalt, 12.2–18.3 clay, 18.3–70.8 basalt, 70.8–85.4 quartz gravel
185	Ulverstone	427280	5445210	13/05/1983	18.3–27.4	3.7	29.3	227		0–1.2 topsoil, 1.2–9.1 clay, 9.1–12.2 clay, shingle, 12.2–29.3 basalt

Site ID	Location	AMG (E)	AMG (N)	Date Drilled	DWS (m)	SWL (m)	TD (m)	Output (l/min)	Salinity (mg/l)	Driller's logs (m)
186	West Gawler	427280	5441200	08/01/1984			71.4			0–0.3 topsoil, 0.3–1.2 clay, 1.2–36.6 basalt, 36.6–48.7 clay, 48.7–88.3 basalt, 88.3–91.4 quartzite
187	West Gawler	428700	5440860	10/04/1984	48.1	11.6	57.8	15.2		0–0.3 topsoil, 0.3–48.1 mudstone, 48.1–57.8 shale
188	Ulverstone	432610	5442640	12/11/1984	15.2, 27.4	9.1	30.4	30.3		0–0.6 topsoil, 0.6–9.1 clay, 9.1–15.2 loose basalt, 15.2–30.4 basalt
189	Ulverstone	432800	5442640	13/11/1984	9.1–30.4	6.1	32.9	91		0–0.6 topsoil, 0.6–10.7 clay, 10.7–18.3 decomposed basalt, 18.3–32.9 basalt
190	Ulverstone	432500	5442600	10/12/1984	21.3–27.4	12.2	27.4	37.9		0–0.3 topsoil, 0.3–21.3 clay, 21.3–27.4 decomposed rock
191	Ulverstone	427580	5444430	12/02/1985	61	30.5	67.1	19		0–0.3 topsoil, 0.3–6.1 clay, 6.1–67.1 mudstone
192	Ulverstone	426890	5444500	10/02/1988	25.9	9.1	30.4	45.5		0–0.3 topsoil, 0.3–7.0 soft mudstone, 7.0–30.4 mudstone
193	Ulverstone	429200	5442700	1986			72			
194	West Ulverstone	427990	5444830			0.45				
195	West Ulverstone	427080	5445200			12.97				
196	West Ulverstone	427500	5445350			11.3			630	
197	East Ulverstone	432970	5442800			0				
198	West Ulverstone	428090	5443790			6.4			105	
199	Castra Road	431970	5441430	01/12/1988	39.6	13.72	42.7	106	130	0–1.8 soil, clay, boulder, 1.8–15.2 clay 15.2–16.8 soft mudstone, 16.8–34.1 mudstone, 34.1–39.6 red and brown clay, 34.6–42.7 bluestone
200	Castra Road	432120	5441350	03/12/1988	21	4.51	27.4	114	350	0–3.1 white sand, 3.1–27.4 sandstone

Water bore localities have not all been field checked and may be only approximate in some cases. All grid references are AGD66 datum.

DWS Depth water struck
SWL Standing water level
TD Total depth of hole

APPENDIX 6

Log of diamond drill hole, Ulverstone

Hole drilled: December 1990
Location: Von Bibras Road, AMG reference 430 400 mE, 5 441 500 mN (data point 158)

From (m)	*To (m)*	*Recovery (m)*	*Description*
0	1.1	0.98	Red brown clay (thin zone at beginning with roots).
1.1	1.7	0.56	Light brown and red mottled clay, sandy texture (igneous).
1.7	2.5	0.53	As above.
2.5	4.0	1.1	Reddish brown clay, igneous texture becoming firmer.
4.0	5.5	0.70	As above, some remnant jointing, black lining on joints.
5.5	7.0	1.40	Light brown to pink clay, sandy texture (igneous), jointing visible.
7.0	8.5	1.57	As above except for 0.1 m of unweathered basalt at 0.43 m from start of run.
8.5	10.0	0.94	Pinkish clay, igneous texture, one 40 mm piece of unweathered basalt.
10.0	11.5	1.43	0.4 m of above (pinkish clay), 0.1 m grey clay with igneous texture, 0.35 m brown clay with igneous texture and white speckles, followed by grey weathered basalt.
11.5	13	1.04	Grey and brown clay, igneous texture.
13	14.5	1.48	Light grey brown clayey material (weathered basalt), zones with white spots (vesicle fillings).
14.5	16.0	1.48	As above.
16.0	17.5	1.34	As above, some zones with cream-coloured seams (weathered secondary mineral?) and networks.
17.5	19.0	1.46	As above with cream coloured seams and networks.
19.0	20.5	1.65	As above with some darker grey zones, large weathered vesicle fillings in centre of run.
20.5	22.0	1.5	Slightly darker grey brown weathered basalt (clay with igneous texture), 60 mm section of unweathered basalt at 21.2 m.
22.0	23.5	1.45	Light grey-brown deeply weathered basalt, joints becoming visible (clay with igneous texture), one 60 mm zone of unweathered basalt in the middle of run.
23.5	25.0	1.14	Dark grey very weathered basalt, weathered vesicle fillings, some unfilled vesicles.
25.0	26.5	1.42	Dark grey very weathered basalt, some zones are less weathered, white vesicle fillings.
26.5	28.0	1.42	Mid to dark grey weathered basalt zones of fine-grained greenish material at beginning of run, possible thin sedimentary layer at 27.5 m.
28.0	29.5	1.52	First half of run mid grey and brown tuff, breccia or basalt with xenoliths. Final half is dark grey to black weathered basalt with white vesicle fillings and occasional white seams.
29.5	31.0	1.44	Dark grey to black basalt, slightly weathered, vesicles common in some zones (up to 10 mm across).
31.0	32.5	1.60	As above, less vesicles, final 0.15 m light grey green sediments (fine).
32.5	34.0	1.52	0.88 m light grey fine-grained sediments (or tuff?) followed by light grey to brown deeply weathered basalt or tuff/breccia, zones of vesicles.
34.0	35.5	1.48	Brown to grey basalt, deeply weathered for first 0.6 m (zones with vesicles) followed by grey basalt, little weathering, some vesicles.
35.5	37.0	1.48	Dark grey to black massive basalt, little weathering, occasional vesicles, 3–4 joints, weathered zeolite on joint surfaces.
37.0	38.5	1.5	As above (basalt), 4–5 joints.
38.5	40.0	1.36	As above, thick white seams on joints.
40.0	41.5	1.52	Dark grey vesicular basalt, more weathered than above, vesicles mainly open some filled, 0.18 m of brown weathered basalt in middle of run.
41.5	43.0	1.31	Dark grey vesicular basalt, weathered vesicles partially filled, brown weathered zone in middle of run.
43.0	44.5	1.55	Dark grey to black basalt, slightly weathered, occasional vesicles (filled), 8–10 joints.
44.5	46.0	1.28	As above, less vesicles, 6–8 joints.
46.0	47.5	1.26	Brown and grey more weathered basalt, some vesicles (filled).
47.5	49.0	1.52	Brown weathered basalt, some fine-grained brown zones (sediments for weathered zeolite?) in a deeply weathered section.

From (m)	*To (m)*	*Recovery (m)*	*Description*
49.0	50.5	1.55	Brown weathered basalt with vesicles (filled and weathered).
50.5	52.0	1.50	Dark grey, less weathered basalt (brown as above for first 50 mm at beginning), variable concentration of vesicles.
52.0	53.5	1.50	Dark grey to black massive basalt, minor weathering on joints, occasional filled vesicles.
53.5	55.0	1.48	As above, 3–4 joints.
55.0	56.5	1.55	As above, 2–3 joints.
56.5	58.0	1.54	As above, 2–3 joints.
58.0	59.5	1.46	As above, few vesicles.
59.5	61.0	1.63	As above, few vesicles.
61.0	62.5	1.50	As above for first part, final 0.45 m is more weathered and vesicular, a few joints.
62.5	64.0	1.50	Dark grey to black slightly weathered basalt, vesicular, zone of zeolite across core at 63.8 m.
64.0	65.5	1.50	Dark grey to black weathered basalt, vesicles becoming less common.
65.5	67.0	1.48	As above, few vesicles, slightly weathered basalt.
67.0	68.5	1.50	As above, final half has filled vesicles (white), basalt slightly to moderately weathered.
68.5	70.0	1.52	Variably weathered basalt with vesicles, less weathered at end.
70.0	71.5	1.55	Slightly weathered basalt, occasional vesicles, fractured in parts.
71.5	73.0	1.55	Dark grey-black basalt, fractured, 40 mm weathered basalt at end.
73.0	74.5	1.45	Fractured basalt, occasional unfilled vesicle
74.5	76.0	1.48	As above, less fractures.
76.0	77.5	1.48	Fractured basalt, dark grey to black, occasional unfilled vesicles.
77.5	79.0	1.43	As above, less fractured.
79.0	80.5	1.49	As above for first part, final 0.66 m is vesicular, weathered and fractured basalt.
80.5	82.0	1.45	0.8 m vesicular and weathered basalt, becomes less weathered but still slight to moderate weathering in the basalt (dark grey black, filled vesicles common at end).
82.0	83.5	1.4?	Dark grey-black vesicular weathered basalt, white vesicle fillings.
83.5	85.0	1.45	Dark grey-black basalt, slight to moderate weathering, vesicles variable in concentration, some filled, some unfilled.
85.0	86.5	1.40	First 20–30 mm scoriaceous basalt, then light brown grey gravelly zone for 20–30 mm followed by 80–100 mm of sandy material then becoming finer grained (light brown and grey mudstone/siltstone).
86.5	88.0	1.5?	Light brown-grey sediments, broken 0.55 m fine-grained followed by sandy and silty sediments. Final material may be tuff?
88.0			END OF HOLE

Vesicle infill at 42 m was determined as chabazite (by XRD)

Palynology of clay sample at 87 m indicates a probable middle Eocene age

Whole sample XRD at 87 m gave 45% kaolinite, 30% quartz, 15% montmorillonite, 10% mica and 2% gibbsite

APPENDIX 7

Palynology report — Ulverstone diamond drill hole. Sample 87 m depth (Palynology Number P1045)

by S. M. Forsyth

The microflora contains several species that begin their ranges within the *Malvacipollis diversus* Zone. These include *Ischyosporites gremius*, *Meaupreaidites elegansiformis*, *Proteacidites pachypolus*, *Kuylisporites waterbolkii* and *Foveotriletes balteus*. According to Partridge (1973) the last three species first appear in the Bass Basin in the Upper *Malvacipollis diversus* Zone. *Santalumidites cainozoicus* appears first within the Upper *M. diversus* Zone and *Nothofagidites asperus* within the overlying *Proteacidites asperopolus* Zone.

Species which appear first in the *Nothofagidites asperus* Zone are not common but include *Polycingulatisporites simplex* or *Quintinia*-type pollen, *Foveotriletes palaequetrus*, *Rugulatisporites trophus* and probably *Matonisporites ornamentalis*. *Nothofagidites falcatus* may be present.

An upper age limit is suggested by the common occurrence of *Stereisporites* (*Tripunctisporis*) sp., which in the Bass Basin ceased to be common above the Middle *Nothofagidites asperus* Zone but extends into the *Proteacidites tuberculatus* Zone. *Ischyosporites gremius* and *Proteacidites pachypolus* do not range above the *Nothofagidites asperus* Zone and *Santalumidites cainozoicus* does not range into the Upper *N. asperus* Zone. Within the Bass Basin *Rugulatisporites trophus* similarly does not range into the Upper *N. asperus* Zone and *Polycingulatisporites esobalteus* terminates within the Middle *N. asperus* Zone.

No quantitative work has been carried out but qualitatively the microflora appear to post-date the reversal of the *Haloragacidites harrisii*/*Nothofagidites* spp. ratio, which occurs at or below the boundary between *Proteacidites asperopolus* Zone and the *Nothofagidites asperus* Zone.

Assuming no facies effects, the microflora appear to be of younger aspect than those of the Tamar region.

In the Tamar the undifferentiated Upper *M. diversus* Zone–*Proteacidites asperopolus* Zone contains abundant dinoflagellates, more common to abundant *Proteacidites pachypolus* occurrences and probably lacks *Santalumidites cainozoicus*. The Ulverstone microflora is of older aspect than *Nothofagidites asperus* Zone occurrences reported from the Longford Basin (Matthews, 1983), which lack *P. pachypolus* and probable Upper *N. asperus* Zone microfloras from the lower part of the largely volcanic sequence of the Hellyer region (Brown and Forsyth, 1984; Baillie, 1987*a, b, c*; Baillie and Green, 1988, 1990) and Corinna–Lower Pieman area (Morgan, 1987). *Proteacidites pachypolus* is a component of *Nothofagidites asperus* Zone microfloras west of Ross (Forsyth, 1989*a*) and near Avoca.

Overall the microflora can best be correlated with an interval close to the P*roteacidites asperopolus* Zone/*Nothofagidites asperus* Zone boundary. An interval within the *N. asperus* Zone is indicated but the rarity of *N. asperus* Zone indicators and absence of others suggest that the interval is very certainly older than Upper *N. asperus* Zone. Following Partridge (1976), the microflora is of Eocene, most probably Middle Eocene age.

The strata at 87 m depth in the Ulverstone bore are significantly older than sub-basalt strata near Sheffield (Forsyth, 1989*b*), the Wesley Vale Sand (Cromer, 1980) and some strata interbedded? with basalt along the line of the new Howth–Penguin highway. Morgan (letter 23 February 1987) noted that lower *N. asperus* Zone strata underlay the Thirlstane Basalt in Olivers bore. Strata underlying basalt near Selbourne is probably older than that at Ulverstone.

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APPENDIX 8

The petrology of some basalt samples, Ulverstone diamond drill hole

by R. S. Bottrill

Two rock samples from the Ulverstone diamond-drill hole were submitted by W. L. Matthews for mineralogical examination.

Sample — 21.3 m

In hand specimen this sample is rather massive, dark grey and fine grained, a typical basalt. Some amygdular-type patches of clay minerals are present, and fine white spots probably represent feldspars.

In thin section the sample is basaltic in composition, with a hypocrystalline (i.e. semi-glassy) texture. The coarsest phase is olivine (~15%), as euhedral to subhedral phenocrysts to 0.5 mm, partly altered to 'iddingsite'. The groundmass is largely fine plagioclase (~25%; ~$An_{40–50}$), as non-orientated laths. Interstitial to these minerals are very fine grained pyroxenes (titaniferous augite; euhedral–anhedral; ~25%), olivine (anhedral; ~5%), glass (dark brown; ~25%) and opaque minerals (magnetite?; dendritic; ~5%) in an intersertal to intergranular texture.

A few vesicles are present, now filled with clay minerals. Alteration is abundant, ~5–10%, mostly of olivine, but also of the groundmass (excluding plagioclase).

Sample — 74.5m

In hand specimen this sample is rather massive, black and fine grained, another typical basalt. It appears relatively fresh but some patches of clay minerals are present, and olivine phenocrysts to a few millimetres are also present.

In thin section the sample is basaltic in composition, with a holocrystalline (i.e. fully crystalline) texture. The coarsest phase is olivine (~10%), as euhedral to subhedral phenocrysts to ~2 mm, partly altered to 'iddingsite'. The groundmass is largely composed of fine plagioclase (~65%; ~$An_{40–50}$), as flow-lineated laths. Interstitial to these minerals are very fine grained pyroxenes (titaniferous augite; euhedral–anhedral; ~20%), olivine (anhedral; ~3%), and opaques (magnetite?; dendritic, ~5%) in an intergranular texture.

No vesicles were observed. Alteration is abundant, ~5–10%, mostly of olivine, but also of the groundmass (excluding plagioclase).

Discussion

The two basalt samples are probably similar in bulk composition and co-genetic, but differ in texture. The sample from 21.3 m probably formed nearer the top of a flow, cooling rather rapidly, while the sample from 74.5 m appears to have cooled more slowly, crystallising fully.