

**Report on**  
**GEOTECHNICAL STUDY**  
**PROPOSED HERITAGE HILLS STAGE 2**  
**RURAL RESIDENTIAL DEVELOPMENT**  
**LOT 9001 NUNNAGINE CIRCLE, ROELANDS**

**Submitted to:**  
Roelands Development Pty Ltd  
21 Lerici Circle  
BUNBURY WA 6230

[www.galtgeo.com.au](http://www.galtgeo.com.au)  
4/15 Walters Drive  
OSBORNE PARK WA 6017  
T: +61 (8) 6272-0200

## TABLE OF CONTENTS

1. Introduction .....	1
2. Site Description and Proposed Development .....	1
3. Project Objectives .....	1
4. Fieldwork.....	2
5. Laboratory Testing .....	4
5.1 Geotechnical .....	4
5.2 Phosphorous Retention Index.....	4
6. Site Conditions .....	5
6.1 Geology .....	5
6.2 Subsurface Conditions.....	5
6.3 Groundwater .....	6
7. Geotechnical Assessment .....	6
7.1 Preliminary Site Classification .....	6
7.2 Site Preparation .....	7
7.3 Compaction .....	7
7.3.1 General.....	7
7.3.2 Granular Soils .....	8
7.3.3 Clayey Soils .....	9
7.4 Approved Fill .....	9
7.5 Excavation and Slopes .....	9
7.6 Effluent Disposal .....	10
7.7 Phosphorous Retention Index.....	11
7.8 Pavement Design.....	11
7.8.1 In situ Subgrade Design Strength .....	11
7.8.2 Design Traffic Loading .....	11
7.8.3 Pavement Thickness Design .....	12
7.8.4 Subgrade and Road Pavement Construction .....	12

7.8.5	Materials .....	12
8.	Closure .....	13

## TABLES

Table 1: Summary of Tests .....	2
Table 2: Summary of Constant Head Permeability Tests .....	3
Table 3: Summary of Laboratory Test Results .....	4
Table 4: Summary of PRI Laboratory Test Results .....	5
Table 5: Summary of Site Classifications (AS 2870-2011) .....	6
Table 6: Pavement Thickness Design .....	12

## FIGURES

Figure 1: Site and Location Plan

## APPENDICES

APPENDIX A:	SITE PHOTOGRAPHS
APPENDIX B:	TEST PIT REPORTS
APPENDIX C:	DYNAMIC CONE PENETROMETER TEST RESULTS
APPENDIX D:	GEOTECHNICAL LABORATORY TEST RESULTS
APPENDIX E:	PRI LABORATORY TEST RESULTS
APPENDIX F:	UNDERSTANDING YOUR REPORT

## 1. INTRODUCTION

This report presents the outcomes of Galt Geotechnics Pty Ltd's (Galt's) geotechnical study for the proposed Heritage Hills Stage 2 rural residential development at Lot 9001 Nunnagine Circle, Roelands (the "site"). The location of the site relative to the surrounding area is shown on Figure 1, Site and Location Plan.

The study was authorised by George Chaffey on behalf of Roelands Development Pty Ltd in a signed Client Authorisation form dated 20 October 2016.

## 2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The site is irregular in plan with an approximate area of 16.82 ha. The site is bounded by a rural residential subdivision to the west and other rural properties to the other sides. The proposed subdivision plan provided shows the site generally slopes down from the south-east corner to the north-west corner with surface elevations ranging from about RL 130 m to RL 40 m AHD respectively.

At the time of the study, the site was being used as grazing paddocks, and covered in grasses with occasional trees. We also noted rock outcrop at the surface at a number of locations across the elevated eastern part of the site. The approximate locations of rock outcropping at the surface are shown on Figure 1.

A couple of watercourses are present in the north-west part of the site. Historical aerial photography shows that a small dam was present in the south-west corner of the site. This dam appears to have been backfilled sometime between June 2012 and December 2013.

Based on the information provided we understand that the proposed development is to comprise 31 lots with a minimum lot size of 3,031 m<sup>2</sup> and associated roads. We also understand that:

- ✦ sewage effluent disposal is planned to be on-site by infiltration;
- ✦ a residence is proposed on the adjoining site to the east, designated Lot 9 (with a plan area of about 14.68 ha) on the plan; and
- ✦ the proposed residence on Lot 9 is expected to be located in the north-west corner of the lot and will also dispose of sewage effluent on site.

## 3. PROJECT OBJECTIVES

The objectives of our study were to:

- ✦ assess subsurface soil and groundwater conditions across the site including recording the depth of groundwater;
- ✦ provide a preliminary site classification(s) in accordance with AS 2870-2011 "Residential Slabs and Footings";
- ✦ assess the suitability of the soils encountered for use as structural fill;
- ✦ recommend appropriate site preparation procedures including compaction criteria;
- ✦ provide design subgrade California bearing ratio (CBR) values for pavement thickness design of the access roads inclusive of a pavement design; and
- ✦ assess the suitability of the site for on-site disposal of effluent by percolation (in accordance with Department of Health Guidelines and AS 1547-2012) including classification of the soils at the site in accordance with Table 5.1 of the standard.

## 4. FIELDWORK

Fieldwork was carried out on 27 and 28 October 2016 and comprised:

- a site walkover including taking photographs;
- excavation of test pits at about 16 locations (TP01 to TP16), extending to depths varying between 1.6 m and 2.2 m;
- testing with a dynamic cone penetrometer (DCP) adjacent to each test pit, extending to a depth of 1.0 m in each instance;
- constant head permeability testing using a Guelph permeameter at eight locations (TP03, TP04, TP06, TP08, TP11, TP12, TP13 and TP14), at depths varying between about 0.35 m and 0.45 m below ground; and
- collection of samples for inspection and possible laboratory testing.

### General

A geotechnical engineer from Galt positioned the tests, conducted the site walkover, observed the test pitting, logged the materials encountered in the test pits, conducted the penetrometer and permeability testing, and collected samples for inspection and possible laboratory testing.

Photographs of the site are presented in Appendix A, Site Photographs.

Test locations were positioned using a hand-held GPS accurate to about  $\pm 5$  m in the horizontal plane. The approximate test locations are shown on Figure 1, Site and Location Plan.

Details of the tests are summarised in Table 1: Summary of Tests.

**Table 1: Summary of Tests**

Test Name	Test Depth (m)	Depth to Groundwater <sup>1</sup> (m)	Reason for Termination	Stratigraphy <sup>2</sup>
TP01	2.0	GNE	Target depth	Sandy CLAY overlying CLAY
TP02	2.0	GNE	Target depth	Sandy CLAY overlying CLAY
TP03	2.0	GNE	Target depth	Sandy CLAY overlying CLAY
TP04	2.0	GNE <sup>3</sup>	Target depth	Silty SAND/Clayey SAND/Sandy CLAY overlying Sandy CLAY overlying CLAY
TP05	2.0	GNE	Target depth	Sandy CLAY overlying CLAY
TP06	2.0	GNE	Target depth	Sandy CLAY overlying CLAY
TP07	1.8	GNE	Refusal	Sandy CLAY overlying Gravelly CLAY/Clayey GRAVEL overlying WEATHERED ROCK
TP08	2.0	GNE	Target depth	Sandy CLAY overlying CLAY/Sandy CLAY overlying CLAY
TP09	1.8	GNE	Refusal	Sandy CLAY overlying CLAY/Sandy CLAY overlying WEATHERED ROCK
TP10	1.8	GNE	Refusal	Sandy CLAY overlying WEATHERED ROCK
TP11	2.0	GNE	Target depth	Sandy CLAY overlying Sandy CLAY/Gravelly CLAY overlying CLAY

Test Name	Test Depth (m)	Depth to Groundwater <sup>1</sup> (m)	Reason for Termination	Stratigraphy <sup>2</sup>
TP12	2.2	1.8	Target depth	Sandy CLAY overlying Gravelly CLAY overlying Sandy CLAY/Gravelly CLAY
TP13	1.6	GNE	Refusal	Sandy CLAY overlying WEATHERED ROCK
TP14	2.2	1.2	Target depth	Sandy CLAY overlying CLAY
TP15	2.2	GNE	Target depth	Sandy CLAY overlying Gravelly CLAY overlying CLAY
TP16	2.2	GNE	Target depth	Sandy CLAY overlying WEATHERED ROCK

- Notes:**
1. GNE: Groundwater was not encountered at the test locations within the investigated depth.
  2. Slow seepage of groundwater into the test pit occurred at TP12 and TP14.
  3. Water ponding on surface about 10 m from TP04.

### Test Pits

Test pits were excavated using a 4 tonne Hitachi Zaxis 40U excavator equipped with a 600 mm wide toothed and 1200 mm wide batter buckets supplied and operated by BC Coastal Contracting. Test pit reports are presented in Appendix B, Test Pit Reports, along with a list of explanatory notes, abbreviations and the method of soil description used on the reports. Included at the end of each test pit report are photographs of the open pit and the spoil removed from the pit.

### Dynamic Cone Penetrometer Test

Dynamic cone penetrometer (DCP) tests were carried out adjacent to each test pit. The DCP tests were conducted in accordance with AS 1289.6.3.2. DCP blow counts were reported per 100 mm penetration intervals. The DCP test results are presented in Appendix C, Dynamic Cone Penetrometer Test Results.

### Constant Head Permeability Tests

Constant head permeability tests were carried out in accordance with of AS 1547-2012 "On-site Domestic Wastewater Management" using a Guelph permeameter. A summary of the test results are presented in Table 2: Summary of Constant Head Permeability Tests.

**Table 2: Summary of Constant Head Permeability Tests**

Permeability Test <sup>1</sup>	Test Depth (m)	Constant Head of Water in Test (cm)	Depth to Groundwater <sup>2,3</sup> (m)	Soil Type	Hydraulic Conductivity Permeability, k (m/day)
TP03	0.4	24	> 2.0	Sandy CLAY	0.2
TP04	0.4	21	> 2.0	Clayey SAND/ Sandy CLAY	<0.06
TP06	0.4	20	> 2.0	Sandy CLAY	1.3
TP08	0.45	24	> 2.0	Sandy CLAY	1.0
TP11	0.4	20	> 2.0	Sandy CLAY	1.2

Permeability Test <sup>1</sup>	Test Depth (m)	Constant Head of Water in Test (cm)	Depth to Groundwater <sup>2,3</sup> (m)	Soil Type	Hydraulic Conductivity Permeability, k (m/day)
TP12	0.4	18	1.8	Sandy CLAY	0.5
TP13	0.35	20	> 1.6	Sandy CLAY	0.1
TP14	0.4	20	1.2	Sandy CLAY	0.3

**Notes:** 1. Constant head permeability tests were conducted adjacent to the test pit.

## 5. LABORATORY TESTING

### 5.1 Geotechnical

Geotechnical laboratory testing of soil samples were undertaken by Mining and Civil Geotest and Liquid Labs in their NATA-accredited laboratories. The testing composed determination of:

- particle size distribution on 7 samples;
- Atterberg limits and linear shrinkage on 6 samples;
- organic content on 1 sample;
- dry density-moisture content relationship using Modified compactive effort on 3 samples; and
- soaked California bearing ratio (CBR) on 3 remoulded samples.

Laboratory test results along with the test methods followed are presented in Appendix D, Geotechnical Laboratory Test Results and summarised in Table 3: Summary of Laboratory Test Results.

**Table 3: Summary of Laboratory Test Results**

Test Location	Depth (m)	Unified Soils Classification	% Gravel	% Sand	% Fines	LL (%)	PI (%)	LS (%)	Organic Content (%)	MMDD (t/m <sup>3</sup> )	OMC (%)	CBR
TP05	0.3 – 0.5	CI	1	31	68	36	17	7.0	-	1.65	14.8	9
TP05	0.7 – 0.9	CI	5	36	59	33	16	7.0	-	-	-	-
TP08	0.3 – 0.4	CI	6	29	65	-	-	-	9.6	-	-	-
TP09	0.4 – 0.5	CH	2	9	89	62	37	14.5	-	1.50	18.3	1.5
TP10	0.5 – 0.7	CH	11	12	77	51	30	12.0	-	-	-	-
TP12	0.4 – 0.5	CL	9	32	59	28	11	5.5	-	1.78	14.3	9
TP15	0.4 – 0.5	CI	3	46	51	39	16	8.0	-	-	-	-

LL: Liquid Limit  
MC: Moisture Content  
OMC: Optimum Moisture Content  
CBR: California bearing ratio (soaked) of samples remoulded to a dry density ratio of 95% MMDD, 4.5 kg surcharge

PI: Plasticity Index  
MMDD: Maximum Dry Density (using modified compaction energy)  
NO: Not Obtainable

LS: Linear Shrinkage  
NP: Non-Plastic

### 5.2 Phosphorous Retention Index

Phosphorous Retention Index (PRI) testing was undertaken on four soil samples by CSBP's Soil and Plant Analysis Laboratory. The results of the laboratory testing are presented in Appendix E, PRI Laboratory Test Results and are summarised in Table 4: Summary of PRI Laboratory Test Results.

**Table 4: Summary of PRI Laboratory Test Results**

Test Pit	Sample Depth (m)	PRI (mL/g)	Soil Type
TP03	0.5 – 0.6	373.2	Sandy CLAY
TP04	0.5 – 0.6	77.2	Clayey SAND/Sandy CLAY
TP05	0.3 – 0.5	2457.6	Sandy CLAY
TP08	0.3 – 0.4	1358.4	Sandy CLAY
TP09	0.4 – 0.5	3744	Sandy CLAY
TP10	0.5 – 0.7	2945.6	Sandy CLAY
TP11	0.5 – 0.6	595.5	Sandy CLAY
TP12	0.4 – 0.5	782.2	Sandy CLAY
TP13	0.6 – 0.7	2736.7	Sandy CLAY
TP14	0.4 – 0.5	2229.7	Sandy CLAY

## 6. SITE CONDITIONS

### 6.1 Geology

The Bunbury sheet of the 1:250,000 scale Regional Geology series maps indicates that the site is almost entirely underlain by rock described as quartz-feldspar-biotite (garnet) gneiss. The far south east and far north-west corners of the site are shown to be underlain by laterite described as massive or pisolitic and soils of the Guildford Formation including ferruginised limonite layers, respectively.

The findings of the geotechnical study indicate that the subsurface conditions on the site generally comprise clayey sands/sandy clays overlying clayey soils grading to weathered granitic (probably Gneiss) rock with depth.

### 6.2 Subsurface Conditions

We note that there are some variations in the soils corresponding to the surface elevation across the site. However, the subsurface soils can be generalised as a weathered rock profile, with various degrees of weathering observed in the test pits. We have interpreted the generalised subsurface conditions to comprise:

- ✦ TOPSOIL: Clayey SAND/Silty SAND, fine to medium grained, brown, with some roots, with some organics, moist, present from the surface to about 0.2 m to 0.3 m depth; overlying
- ✦ Sandy CLAY (CI): low to medium plasticity, brown/orange, with some gravel, firm to stiff, moist, extending to depths varying between about 0.6 m and the maximum depth investigated of 2.0 m; overlying
- ✦ CLAY/Gravelly CLAY/Sandy CLAY (CI-CH): medium to high plasticity, brown/orange/grey, with some sand and gravel, firm to very stiff, moist, with some rock fragments (slightly weathered) grading into WEATHERED ROCK (recovered as Silty GRAVEL/Clayey GRAVEL), extending to the maximum depth investigated of 2.2 m, causing refusal of the excavator as shallow as 1.6 m depth at some locations.

Weathered rock was generally encountered across the higher elevation parts of the site (along the eastern and south eastern parts of the site). We also noted rock outcrop at the surface at a number of locations across the elevated eastern part of the site.

The individual test pit reports should be referred to for details at each test pit location.



## 6.3 Groundwater

There is currently no publicly available maximum groundwater information for this site, however, given the general topography of the site we would expect the permanent groundwater table to be at many metres' depth.

Groundwater (probable perched water) was encountered in test pits TP12 and TP14, as slow seepage from the sides of the test pits at 1.8 m and 1.2 m, respectively.

Of particular note was that groundwater was not encountered at TP04 to a depth of 2.0 m, however, water was ponding on the surface as close as 10 m to the east of TP04 where reeds etc were present.

Groundwater is likely to influence the proposed development where the elevations of the proposed lots are close to the elevation of the adjacent watercourses, particularly in the lower elevations of the site near TP01 and TP04.

A perched groundwater level is likely to be present on top of the clayey soils following periods of rainfall.

The presence of watercourses, near surface rock and clayey soils at shallow depth suggests that surface runoff and seepage may be expected during wetter times of the year.

## 7. GEOTECHNICAL ASSESSMENT

### 7.1 Preliminary Site Classification

The preliminary site classification is based on AS 2870-2011 "Residential Slabs and Footings" which defines the site classes as given in Table 5, Summary of Site Classifications.

**Table 5: Summary of Site Classifications (AS 2870-2011)**

Class	Description	Characteristic Surface Movement ( $y_s$ )
A	Most sand and rock site with little or no ground movement from moisture change	Not Defined (typically <5 mm)
S	Slightly reactive clay sites with only slight ground movement from moisture changes	0 – 20 mm
M	Moderately reactive clay sites, which may experience moderate ground movements from moisture change	20 – 40 mm
H1	Highly reactive sites, which may experience high ground movements from moisture change	40 – 60 mm
H2	Highly reactive sites, which may experience very high ground movements from moisture change	60 – 75 mm
E	Extremely reactive sites, which may experience extreme ground movements from moisture change	>75 mm
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise	Not Defined

We consider that site classifications of "Class M" and "Class H1" are appropriate provided that the site preparation measures outlined in Section 7.2 are undertaken prior to construction. The appropriate site classification to apply will depend on the subsurface conditions below where residences and structures are proposed.

Improvement of the site to “Class S” is possible with importation and placement of at least 0.7 m (on “Class M” sites) and 1.0 m (on “Class H1” sites) of inert sand (or gravel) fill overlying clayey material. As mentioned above this only applies to areas where residences and structures are proposed.

**Note:** AS 2870 is limited to single to double storey residential structures with normal shallow footings with a maximum bearing pressure of 100 kPa. This must be taken into account by the structural designers.

## 7.2 Site Preparation

The site preparation measures outlined below are aimed at improvement of the portion of each of the rural residential lots where construction of residences and associated structures are planned including on-ground slabs, shallow footings, retaining walls and pavements.

The following site preparation measures must be followed:

- ✦ Demolish and remove all infrastructure associated with farming activities. Remove demolition debris and any other deleterious material from site including building rubble, buried services, water troughs and services related to the old dam (located in the south-west corner of the site that has subsequently been backfilled).
- ✦ Strip vegetation from the site including grubbing out of tree roots.
- ✦ Strip and stockpile topsoil from the site for potential re-use in non-structural applications or for possible blending with clean sand (generally only a thin layer of topsoil was noted at the time of our investigation over the majority of the site). Topsoil strip is only necessary to remove roots. We recommend a 200 mm to 300 mm topsoil strip or as otherwise necessary to remove all roots from the soil.
- ✦ Excavate and shape to grade (where required). All excavated material (including the underlying clayey soils) should only be used for general bulk fill.
- ✦ Moisture condition and compact *in situ* soil in accordance with and to the requirements of Section 7.3. Any wet or soft areas not responding to the compaction should be excavated and replaced with lean mix concrete (for small localised areas) or with approved clayey material (clayey gravel or clayey sand) compacted to the requirements of Section 7.3. Under no circumstances should a free draining granular material be used to backfill depressions in the clay surface as these are likely to fill with water and soften the surrounding clayey soil.

Additional geotechnical studies may be required if conditions vary from that identified in this report.

## 7.3 Compaction

### 7.3.1 General

Over-excavation and replacement of loose/soft materials may be required where the minimum dry density ratio cannot be achieved.

Fill must be placed in horizontal layers of not greater than 0.3 m loose thickness for granular material and 0.2 m loose thickness for cohesive material. Each layer must be compacted by suitable compaction equipment, and carefully controlled to ensure even compaction over the full area and depth of each layer.

Care will need to be taken when compacting in the vicinity of existing services and structures. This is particularly important if vibratory compaction is being carried out. Tynan (1973)<sup>1</sup> provides assistance with the selection of compaction equipment for use adjacent to services.

<sup>1</sup> Tynan (1973) Ground Vibration and Damage Effects on Buildings, Australia Road Research Board, Special Report No. 11.

Large compaction equipment (self-propelled vibrating rollers, etc.) must not be used within 2 m behind retaining walls. Hand compaction plant must be used.

### Test Frequency

After compaction, verify that the required level of compaction has been achieved by testing to a minimum depth of 0.9 m in sandy soils and 0.3 m in clayey soils:

- ☛ on each lift of fill at the rate of 1 test per 500 m<sup>3</sup>;
- ☛ on each lift of fill on a 40 m grid;
- ☛ at each spread footing location;
- ☛ at 10 m centres along strip footings; and
- ☛ on a grid of 15 m centres below on-ground slabs and pavements.

Further to this, we recommend footings be inspected by a geotechnical engineer prior to blinding to ensure that soft spots are not present between test areas.

### 7.3.2 Granular Soils

Approved granular fill must be compacted using suitable compaction equipment to achieve a dry density ratio of at least 95% MMDD (maximum modified dry density) as determined in accordance with AS 1289.5.2.1 at a moisture content within 2% of optimum moisture content (OMC).

Granular fill must be placed in horizontal layers of not greater than 300 mm loose thickness. Each layer must be compacted by suitable compaction equipment, and carefully controlled to ensure even compaction over the full area and depth of each layer.

Where clean sand (<5% gravel, <5% fines) is used as fill, a Perth sand penetrometer (PSP) may be used for compaction control in accordance with AS 1289.6.3.3. The following minimum PSP blow counts may be assumed to correspond to a dry density ratio of 95% MMDD:

- ☛ Depth range 0.0 m to 0.15 m: SET
- ☛ Depth range 0.15 m to 0.45 m: 8 blows
- ☛ Depth range 0.45 m to 0.75 m: 10 blows
- ☛ Depth range 0.75 m to 1.05 m: 12 blows (or 0.75 m to 0.9 m: 6 blows)

If difficulties are experienced recording the required blow counts, a site-specific PSP correlation should be carried out to determine the PSP blow count correlating to a DDR of 95% MMDD. The correlation must:

- ☛ be done on site;
- ☛ use the nuclear density gauge (NDG) to determine density at a minimum of 5 points with varying density to a depth of 300 mm below surface;
- ☛ use a calibrated PSP to determine the PSP blow count from 150 mm to 450 mm at each of the NDG test points; and
- ☛ be plotted on a chart of PSP blow count vs DDR.

If gravel is used as fill, compaction testing must be done using a nuclear density gauge (NDG) in accordance with AS 1289.5.8.1.

### 7.3.3 Clayey Soils

*In situ* clayey material must be moisture conditioned to within 2% of OMC and compacted using suitable compaction equipment to a minimum dry density ratio of 95% SMDD (in accordance with AS 1289.5.1.1.).

A nuclear density gauge should be used for compaction control of clayey soils in accordance with AS 1289.5.8.1.

Surficial clayey soils are likely to soften and become saturated during and following rainfall. This commonly leads to weaving and rutting of the surface when trafficked by earthmoving equipment. It will also be difficult to compact the clayey soil in this condition. Where this occurs, we recommend the following prior to compaction:

- remove the soft saturated clayey soil to waste to expose a competent clay base; or
- wait until the soils have dried to at or near their optimum moisture content for compaction.

We note that regardless of the compaction of clayey soils, they are still likely to perform poorly with regard to strength, rutting, etc. when wet.

The clayey soils on the site will drain poorly when inundated during the wetter times of the year and result in saturated conditions that may inhibit compaction of the soil. To reduce the risk associated with this, we recommend that earthworks are carried out during the summer months when perched water is expected to be limited and are not carried out within 1-2 weeks following heavy rainfall. Shaping of clay subgrade areas must always be done to promote run-off and prevent ponding of water, which will rapidly lead to strength loss in the clayey soils.

If difficulties are encountered during compaction due to water, further advice should be sought from a geotechnical engineer.

### 7.4 Approved Fill

Imported granular fill must comply with the material requirements as stated in AS 3798-2007, "Guidelines on Earthworks for Commercial and Residential Developments". Sand fill must comprise clean sand that is free of organic matter and have a fines content of less than 5%.

The *in situ* clayey material is not considered to be suitable for re-use as inert structural fill, but may be used to make good over-excavations in clayey material.

Any organic-rich sand or sand containing significant proportions of fines (material less than 0.075 mm in size) must not be used as fill without further treatment.

Where doubt exists, a geotechnical engineer must be engaged to inspect and approve the use of potential fill materials.

### 7.5 Excavation and Slopes

Based on the soil profile encountered, we consider that shallow excavations (up to about 1.5 m) on site will generally be achievable using conventional earthmoving equipment (i.e. with a 15 tonne tracked excavator or larger). Most of the test pits (excavated with a 4 tonne excavator fitted with a toothed bucket) extended to more than 2.0 m depth. However, refusal occurred in four test pits at depths of between 1.6 m and 1.8 m. Rock was noted at the surface across the elevated eastern part of the site. A rock breaker or similar is likely to be required to initially break up and loosen the rock material if it needs to be excavated.

Care must be exercised in such excavations and appropriate safety measures adopted where necessary, particularly in the vicinity of existing structures and infrastructure.

For excavations at least 1 m above the perched groundwater level, slopes must be no steeper than:

- ☞ 1V:2H for temporary slopes and 1V:3H for permanent slopes in sand; and
- ☞ 1V:1H for temporary slopes and 1V:2H for permanent slopes in clay.

Even at these slope angles erosion and rilling may occur. Where steeper slopes are required, temporary or permanent slope retention must be employed.

Temporary slopes of 1V:2H in sand and 1V:1H in clay require the following:

- ☞ No surcharge (machinery, stockpiles, etc) is present at the crest of the slope.
- ☞ The maximum slope height is 2 m.
- ☞ No groundwater seepage is identified.

Surcharges (such as from structures, plant and soil stockpiles) must not be placed at or close to the crest of unsupported excavations.

Dewatering would probably not be required as the groundwater is expected to be relatively deep. Localised shallow perched water may, however, occur during the wet season. Where inflow does occur, excavations should be shaped such that water is directed to a sump from which it can be pumped.

The stability of open excavations must be carefully assessed by the contractor during construction. A geotechnical engineer must be consulted where there is any doubt regarding the stability or safety of unsupported excavations.

## 7.6 Effluent Disposal

Constant-head permeameter tests were carried out at eight locations across the site. The results of the permeameter tests are presented in Section 4. The permeameter testing was undertaken between depths of 0.35 m to 0.45 m.

The measured permeability of the clayey soil generally in the top 0.5 m of the soil profile ranged between <0.06 m/day and 1.3 m/day (about  $<6 \times 10^{-7}$  m/s to  $1 \times 10^{-5}$  m/s).

The soils have been classified in accordance with Table 5.1 of AS 1547-2012. In general, the sandy clays in the top 0.5 m of the soil profile across the site are classed as Soil Category 5.

The Soil Category may be improved if the surface is raised with the placement of clean inert cohesionless structural fill, with the effluent disposal system placed within the structural fill. The disposal system must also take into account the presence of the perched groundwater at shallow depth (particularly on clayey soils following periods of rainfall).

Based on the results of the permeameter tests, we consider the clayey soils at the top of the soil profile are not suitable for conventional effluent disposal systems (i.e. septic tank and leach drain).

A nutrient removal system for Phosphorus and Nitrogen is required for each lot. Alternative effluent disposal systems (i.e. Aerobic Treatment Units (ATU's) and Alternative Treatment Systems (ATS's)) may be considered. The alternative on-site effluent disposal system must be designed to comply with the Department of Health, local government (Shire of Harvey) and the Code of Practice for Onsite Sewerage Management. The alternative on-site effluent disposal system shall be approved by the Department of Health WA and be capable of removing greater than 80% of Total Phosphorus and Total Nitrogen.

The suitability of the appropriate land application system must be addressed by the designer, and designed in accordance with all relevant Acts, Codes, Standards and industry best practices. The on-site sewage system must be designed by an appropriate professional (Onsite System Designer) and installed by an appropriate system installer.

## 7.7 Phosphorous Retention Index

The Phosphorous Retention Index (PRI) measured in the laboratory on 10 soil samples ranged from 77.2 mL/g to 3744 mL/g.

We understand that the PRI indicates the capacity of the soil to adsorb phosphorous from sewage effluent. The values recorded indicate the *in situ* soils are readily able to absorb phosphorous. The overall capacity is, however, dependant on the permeability and thickness of the strata through which the effluent flows, noting that it is more likely that effluent disposal would be done in imported sand fill rather than the *in situ* clayey soils. Therefore, only ATU's or ATS's capable of removing Phosphorus shall be utilised for development.

## 7.8 Pavement Design

### 7.8.1 *In situ* Subgrade Design Strength

Where design of flexible pavements is undertaken, a subgrade California bearing ratio (CBR) of 8% may be assumed for pavement thickness design where at least 0.5 m of compacted imported approved sand fill is present over clayey soils. This CBR value assumes that the site preparation requirements outlined in Section 7.2 have been carried out on the pavement subgrade.

Where the pavement is directly underlain by clayey subgrade, we consider a subgrade CBR of 3% can be adopted for pavement thickness design. This value assumes that appropriate subgrade preparation procedures are conducted and that the clayey subgrade is kept dry. If the subgrade cannot be maintained dry at all times, a design CBR of 2% would be applicable.

Due to the plastic nature of the underlying clayey material, roads must be designed such that saturation of the subgrade is avoided. The clay subgrade must be shaped to allow water to run off and we recommend the use of subsoil drains to take water away from the road subgrade.

### 7.8.2 Design Traffic Loading

The following design traffic loading has been assumed. This should be reviewed by the Civil Engineer to ensure that it meets with their requirements:

Design traffic loading	$4 \times 10^3$ ESA's
Percentage of heavy vehicles:	3%
Design life of pavement:	20 years

The access road is to be trafficable in all weather conditions. It is assumed that no oversize farm/construction vehicles will travel on the road other than during construction and occasionally throughout the life of the pavement (i.e. the maximum single axle load is 9 tonnes).

### 7.8.3 Pavement Thickness Design

The pavement thickness design has been based on the Main Roads Engineering Note 9: Procedure for the Design of Flexible Pavements and is given in Table 6: Pavement Thickness Design.

**Table 6: Pavement Thickness Design**

Subgrade Unit	Design CBR	Minimum Total Pavement Thickness (mm)
Sand fill overlying clayey soils	8	250#

**Note:** # The thickness provided is the minimum thickness required for a subgrade CBR of 8%. The pavement must include a minimum compacted thickness of 150 mm of base course grade material.

Minimum total pavement thicknesses can be provided for other design CBR values if required.

The above design is based on the following assumptions:

- Adequate surface drainage is provided such that no long-term ponding of water will occur adjacent to the access road.
- Road shoulders shall be at least 1 m wide to limit the risk of saturation of the pavement layers. The road shoulders are not intended for trafficking.

### 7.8.4 Subgrade and Road Pavement Construction

The following subgrade preparation measures must be followed:

- Remove surface vegetation and strip topsoil along the proposed access road alignment. The topsoil strip must be sufficiently thick to remove all shallow roots (around 200 mm depth should be sufficient).
- Shape and/or excavate to subgrade level and grade exposed surface to drain to sides of alignment.
- Proof compact exposed subgrade to achieve the level of compaction specified in Section 7.3 to at least 0.3 m below subgrade level. Prior to compaction, the moisture content of the exposed subgrade should be adjusted to within 2% of optimum moisture content.
- Areas that do not respond to compaction (i.e. areas that rut or heave under compaction) will require removal and replacement with approved compacted fill.

We understand that the proposed access road elevation will generally follow the existing topography, requiring minimal bulk earthworks (i.e. minimal cut/fill).

### 7.8.5 Materials

#### 7.8.5.1 Base Course and Sub-base

The Base Course and Sub-base materials must conform to the requirements of Main Roads WA Specification (MRWA) 501: Pavements.

Alternatively, lateritic Base Course and Sub-base material may be used, provided that the material conforms to the requirements for an Lt6 (lateritic gravel) as defined in Tables 14 and 15 of the Main Roads WA guide<sup>2</sup>.

<sup>2</sup> Main Roads Western Australia (2002): A Guide to the Selection and Use of Naturally Occurring Materials as Base and Subbase in Roads in Western Australia, p 60 and 61.

#### 7.8.5.2 Selected Fill

Lateritic clayey/sandy gravel to build up the road embankments to the underside of the pavement formation should meet the following criteria:

☞ Maximum particle size:	100 mm
☞ Maximum fines content (<0.075 mm):	20 %
☞ Maximum plasticity index:	16 %
☞ Minimum CBR at 95% MMDD:	10 %

#### 7.8.5.3 Seal

We understand that there are not specific road design guidelines produced by the Shire of Harvey. In other rural communities the preferred wearing course (rural roads and intersections) is 30 mm asphalt on a primer seal.

However, the minimum specified standard for rural access roads (other than intersections) is either:

- ☞ Two coat emulsion seal with 10 mm and 7 mm basalt aggregate; or
- ☞ Hot bitumen prime with 5 mm metal aggregate and seal coat with 10 mm basalt aggregate.

### 8. CLOSURE

We draw your attention to Appendix F of this report, "Understanding your Report". The information provided within is intended to inform you as to what your realistic expectations of this report should be. Guidance is also provided on how to minimise risks associated with groundworks for this project. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

#### GALT GEOTECHNICS PTY LTD



Blake Luff CPEng  
Geotechnical Engineer



Fred Davenport CPEng  
Geotechnical Engineer

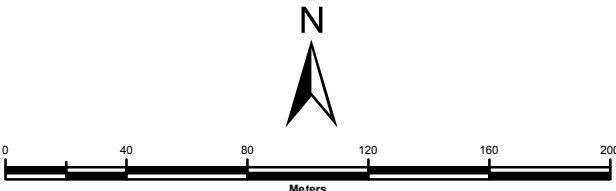
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Legend

- Site Boundary
- Water Ponding on Surface
- Test Pit
- Rock Outcropping at the Surface



	SCALE	1:2,500	(A3)
	DRAWN	PIR	
	DATE DRAWN	20/12/2016	
	CHECKED	BL	
	DATE CHECKED	20/12/2016	
	PROJECTION	GDA 1994 MGA Zone 50	

Galt Geotechnics Pty Ltd  
ACN : 138 490 865  
Tel : +61 (0)8 6272-0200  
Address : Unit 4, 15 Walters Drive  
Osborne Park WA 6017

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CLIENT	ROELANDS DEVELOPMENT PTY LTD		
PROJECT	GEOTECHNICAL STUDY PROPOSED RURAL RESIDENTIAL DEVELOPMENT		
LOCATION	LOT 9001 NUNNAGINE CIRCLE, ROELANDS		
TITLE	SITE & LOCATION PLAN		
Job No	J1601231	Fig No	FIGURE 1
		Rev	A



## Appendix A: Site Photographs



**Photograph 1: Looking south across the site from near TP03**



**Photograph 2: Looking north across the site from near TP07**



**Photograph 3: Looking at the area where water is ponding at the surface adjacent to TP04**



**Photograph 4: Looking north across the site from near TP12**





**Photograph 5: Looking north from near TP14**



**Photograph 6: Looking north-west across the site from near TP13**





**Photograph 7: View of typical rock outcropping at the surface**



**Photograph 8: Looking north across the site from near TP06**





**Photograph 9: Looking south across the site from near TP11**



**Photograph 10: Looking south-east across the site from near TP12**

## Appendix B: Test Pit Reports



# EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS



## METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HMLC	HMLC Core Barrel	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

## SUPPORT

T Timbering

## PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

## WATER

▶	Water Inflow	▼	Water Level
◀	Water Loss (complete)		
◁	Water Loss (partial)		

## SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

## ROCK CORE RECOVERY

$$\text{TCR} = \text{Total Core Recovery (\%)} = \frac{\text{CRL}}{\text{TCL}} \times 100$$

$$\text{SCR} = \text{Solid Core Recovery (\%)} = \frac{\text{CCR}}{\text{TCL}} \times 100$$

$$\text{RQD} = \text{Rock Quality Designation (\%)} = \frac{\text{ALC} > 100}{\text{TCL}} \times 100$$

TCL Length of Core Run

CRL Recovered Length of Core

CCR Total Length of Cylindrical Pieces of Core Recovered

ALC>100 Total Length of Axial Lengths of Core Greater than 100 mm Long

# METHOD OF SOIL DESCRIPTION BOREHOLE AND TEST PIT REPORTS



## GRAPHIC LOG & UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) SYMBOLS

Graphic	USCS	Soil Name	Graphic	USCS	Soil Name
		FILL (various types)		SM	Silty SAND
		COBBLES		ML	SILT (low liquid limit)
		BOULDERS		MH	SILT (high liquid limit)
	GP	GRAVEL (poorly graded)		CL	CLAY (low plasticity)
	GW	GRAVEL (well graded)		CI	CLAY (medium plasticity)
	GC	Clayey GRAVEL		CH	CLAY (high plasticity)
	SP	SAND (poorly graded)		OL	Organic SILT (low liquid limit)
	SW	SAND (well graded)		OH	Organic SILT (high liquid limit)
	SC	Clayey SAND		Pt	PEAT

## RESISTANCE TO EXCAVATION

Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

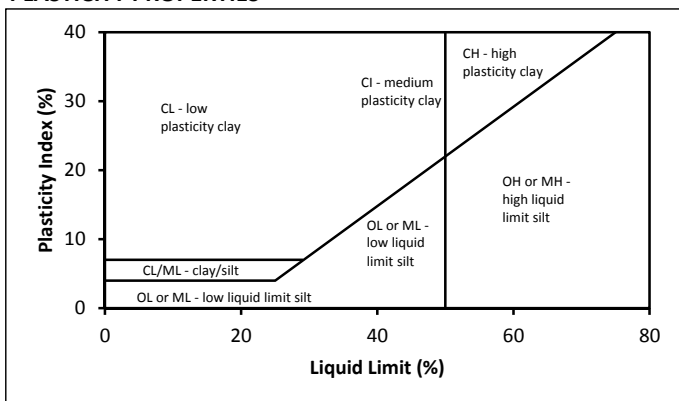
## SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-1993, Appendix A. Material properties are assessed in the field by visual/tactile methods in combination with field testing techniques (where used).

## PARTICLE SIZE

Soil Name	Particle Size (mm)
BOULDERS	>200
COBBLES	63 to 200
GRAVEL	Coarse 20 to 63
	Medium 6 to 20
	Fine 2 to 6
SAND	Coarse 0.6 to 2.0
	Medium 0.2 to 0.6
	Fine 0.075 to 0.2
FINES	SILT 0.002 to 0.075
	CLAY <0.002

## PLASTICITY PROPERTIES



## MOISTURE CONDITION

AS1726-1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

## CONSISTENCY AND DENSITY

AS1726-1993 and HB160-2006

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N"	DCP blows per 100 mm	Symbol	Term	Density Index (%)	SPT "N"	DCP blows per 100 mm	PSP Blows per 300 mm
VS	Very Soft	0 to 12	0 to 2	<1	VL	Very Loose	<15	0 to 4	<1	0 to 2
S	Soft	12 to 25	2 to 4	<1	L	Loose	15 to 35	4 to 10	1 to 2	2 to 6
F	Firm	25 to 50	4 to 8	1 to 2	MD	Medium Dense	35 to 65	10 to 30	2 to 3	6 to 8
St	Stiff	50 to 100	8 to 15	3 to 4	D	Dense	65 to 85	30 to 50	4 to 8	8 to 15
VSt	Very Stiff	100 to 200	15 to 30	5 to 10	VD	Very Dense	>85	>50	>8	>15
H	Hard	>200	>30	>10						

Note: PSP correlations only valid to 450 mm depth

Consistency and density may also be inferred from excavation performance and material behaviour.

# ROCK STRENGTH, WEATHERING AND DEFECTS



## STRENGTH

SYMBOL	STRENGTH	PLI, $I_{s(50)}$	Typical UCS	TYPICAL DESCRIPTORS
EL	Extremely Low	$\leq 0.03$	$\leq 0.7$	Easily remoulded by hand to form a soil
VL	Very Low	0.03-0.1	0.7-2.4	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; too hard to cut triaxial samples by hand. Pieces up to 30 mm thick can be broken by finger pressure
L	Low	0.1-0.3	2.4-7	Easily scored with a knife; indentations 1-3 mm show in the specimen with firm blows of the pick point; has dull thud under hammer. A piece of core 150 mm long x 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling
M	Medium	0.3-1.0	7-24	Readily scored with a knife; a piece of core 150 mm long x 50 mm diameter can be broken by hand with difficulty
H	High	1.0-3.0	24-70	A piece of core 150 mm long x 50 mm diameter cannot be broken by hand but can be broken by a pick with a single blow; rock rings under hammer
VH	Very High	3.0-10.0	70-240	Hand specimen breaks with pick after more than 1 blow; rock rings under hammer
EH	Extremely High	$\geq 10.0$	$\geq 240$	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer

PLI: Point Load Index (MPa)

UCS: Uniaxial Compressive Strength (MPa)

**Note:** Rock strength is defined in accordance with PLI. The relationship between PLI and UCS varies depending on rock type, weathering, etc. UCS is typically  $24 \times I_{s(50)}$  (may range from  $10-30 \times I_{s(50)}$  but possibly lower for carbonate rocks)

## WEATHERING

SYMBOL	TERM	TYPICAL DESCRIPTORS
RS	Residual Soil	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; the soil has not been significantly transported.
EW	Extremely Weathered	The rock has weathered to such an extent that it has 'soil' properties i.e. it either disintegrates or can be remoulded in water. Fabric of original rock still evident.
HW	Highly Weathered	Rock strength is changed by weathering. The whole of the rock mass is discoloured, usually by iron staining or bleaching such that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to deposition of weathering products in pores.
MW	Moderately Weathered	The whole of the rock mass is discoloured, usually by iron staining or bleaching such that the colour of the original rock is not recognisable.
SW	Slightly Weathered	Rock is slightly discoloured but shows little or no change of strength from fresh rock
Fr	Fresh	Rock shows no sign of decomposition or staining

**Note:** The terms HW and MW are not used by AS 1726. The standard uses the term Distinctly Weathered instead to cover this range of weathering.


## ROCK DEFECTS

SYMBOL	DESCRIPTION	COATING / INFILLING		ROUGHNESS		PLANARITY	
J	Joint	Cn	Clean	Sl	Slickensided	Pl	Planar
B	Bedding	St	Stained	Sm	Smooth	Cr	Curved
F	Foliation	Vn	Veneer	Ro	Rough	Un	Undulating
C	Contact	Ct	Coating	VR	Very rough	St	Stepped
Cl	Cleavage					Ir	Irregular
SZ	Shear Zone						
V	Vein						
IS	Infilled seam						
DI	Drilling induced break						

## CORE RUN DETAILS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
TCR	Total Core Recovery	RQD	Rock Quality Designation	TOR	Top of Run
SCR	Solid Core Recovery			BOR	Bottom of Run

<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP01-01)				TOPSOIL: Clayey SAND/Silty SAND, brown, with some organics, with some roots	M	F - St		
			CI				Sandy CLAY: low to medium plasticity, brown becoming brown/orange, trace roots						
			CI / CH				Clayey SAND/Sandy CLAY: medium to high plasticity, orange/brown/grey, trace gravel, trace roots						
			CI / CH				Sandy CLAY/Gravelly CLAY: medium to high plasticity, orange/brown/grey, gravel is weathered rock						
			CI / CH				CLAY: medium to high plasticity, orange/brown/grey, with some sand and gravel						
	F		2.0						Hole terminated at 2.00 m Target depth Groundwater not encountered				

## Sketch & Other Observations



**Comments:**

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions



<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
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Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP02-01)				TOPSOIL: Clayey SAND/Silty SAND, brown, with some organics, with some roots	M	F - St	
	F						CI	Sandy CLAY: low to medium plasticity, red/brown, trace organics, trace roots				
							CI	Sandy CLAY: low to medium plasticity, orange/brown/grey, with some gravel				
							CI / CH	Sandy CLAY: medium to high plasticity, orange/brown/grey, trace gravel				
							CI / CH	CLAY: medium to high plasticity, orange/brown/red/grey, with some sand, trace gravel				
						Hole terminated at 2.00 m Target depth Groundwater not encountered						


## Sketch & Other Observations



**Comments:**

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP03-01)		CI	TOPSOIL: Clayey SAND/Silty SAND, brown, with some organics, with some roots	M	F - St		
	0.5		Sandy CLAY: low to medium plasticity, orange/brown, with some gravel ----- Grading into Sandy CLAY									
	1.0		Sandy CLAY: medium to high plasticity, orange/brown/grey, with some gravel ----- Grading into CLAY									
	1.5		CLAY: medium to high plasticity, orange/brown/grey, trace gravel									
	2.0		Hole terminated at 2.00 m Target depth Groundwater not encountered									

## Sketch & Other Observations



**Comments:**

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions



**Job Number:** J1601231  
**Client:** Roelands Development Pty Ltd  
**Project:** Proposed Rural Residential Development  
**Location:** Roelands

**Contractor:** BC Coastal  
**Machine:** Hitachi 4T exc.  
**Operator:** Ben  
**Bucket:** 600 mm toothed and 1200 mm batter  
**Date:** 27/10/2016  
**Logged:** BL  
**Checked Date:** 16/12/2016  
**Checked By:** FAD

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0						TOPSOIL: Clayey SAND/Silty SAND brown, with some organics, with some roots	M	F - St		Water ponding on surface 10 m to the east.
							Silty SAND/Clayey SAND/ Sandy CLAY: fine to medium grained, grey mottled brown						
	0.5		B(TP04-01)			SM / SC	Sandy CLAY: medium to high plasticity, orange/brown/grey						
	1.0					CI / CH	CLAY: medium to high plasticity, orange/brown, trace sand and gravel						
	F			1.5	B(TP04-02)			CI / CH					
			2.0						Hole terminated at 2.00 m Target depth Groundwater not encountered				




## Sketch & Other Observations



**Comments:**

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0						TOPSOIL: Clayey SAND/Silty SAND, brown, with some organics, with some roots		F - St		
			B(TP05-01)				CI	Sandy CLAY: low to medium plasticity, brown, with some organics					
								Sandy CLAY: medium plasticity, orange/brown mottled grey, fine to medium grained sand, with some gravel					
			B(TP05-02)				CI	Decreasing gravel content					
							CI / CH	CLAY: medium to high plasticity, grey/brown with dark grey veins, trace gravel					
	F		1.0						M				
			1.5								St		
			2.0						Hole terminated at 2.00 m Target depth Groundwater not encountered				

## Sketch & Other Observations




Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions



<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description								
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS		
E	E		0.0						TOPSOIL: Clayey SAND/Silty SAND, brown, with some organics, with some roots, with some gravel		F - St	M			
	F								CI					Sandy CLAY: low to medium plasticity, red/brown, trace gravel	
			B(TP06-01)												Sandy CLAY: medium to high plasticity, orange/brown/red, trace gravel
														CI / CH	Becoming orange/red/brown, no gravel
	H		B(TP06-02)											CI / CH	CLAY: medium to high plasticity, grey mottled red/brown, with fragments of rock (highly weathered)
					Increasing rock fragments (slightly weathered), becoming WEATHERED ROCK										
			2.0						Hole terminated at 2.00 m Target depth Groundwater not encountered						

## Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E			0.0						TOPSOIL: Clayey SAND/Silty SAND, brown, with some organics, with some roots, with some gravel			
	H								Sandy CLAY: medium to high plasticity, red/brown, with some gravel			
			0.5		B(TP07-01)			Cl / CH		M	St	
	F							Cl / CH	Gravelly CLAY/Clayey GRAVEL: medium to high plasticity, red/brown			
			1.0						WEATHERED ROCK: recovered as Clayey GRAVEL/Silty GRAVEL, grey/brown/dark grey, with fragments of rock (slightly weathered to highly weathered)			
	H		1.5									
	VH											
			2.0						Hole terminated at 1.80 m Refusal Groundwater not encountered			

## Sketch & Other Observations




**Comments:**

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions



<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP08-01)		CI	TOPSOIL: Peaty SAND/Clayey SAND, brown, with organics, trace roots				
			Sandy CLAY with organics: low to medium plasticity, brown, with some rock									
	F		CI / CH				CLAY/Sandy CLAY: medium to high plasticity, brown/orange/grey, trace roots					
							Grading into CLAY					
			CI / CH				CLAY: medium to high plasticity, grey/brown/dark grey, with some sand and gravel					
		Hole terminated at 2.00 m Target depth Groundwater not encountered										

## Sketch & Other Observations




**Comments:**

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

**Job Number:** J1601231  
**Client:** Roelands Development Pty Ltd  
**Project:** Proposed Rural Residential Development  
**Location:** Roelands

**Contractor:** BC Coastal  
**Machine:** Hitachi 4T exc.  
**Operator:** Ben  
**Bucket:** 600 mm toothed and 1200 mm batter  
**Date:** 27/10/2016  
**Logged:** BL  
**Checked Date:** 16/12/2016  
**Checked By:** FAD

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION		MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0				CI / CH	TOPSOIL: Clayey SAND/Silty SAND, fine to medium grained, brown, with some organics and roots	M	St	Rock outcrops nearby		
			Sandy CLAY: medium to high plasticity, red/brown, trace gravel										
	F		CLAY/Sandy CLAY: medium to high plasticity, orange/red/brown, trace gravel										
	H		WEATHERED ROCK: recovered as Silty GRAVEL/Clayey GRAVEL, grey/dark grey, with fragments of rock (slightly weathered)										
	VH		Increasing rock fragments (slightly weathered)										
			2.0					Hole terminated at 1.80 m Refusal Groundwater not encountered					

## Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions



**Job Number:** J1601231  
**Client:** Roelands Development Pty Ltd  
**Project:** Proposed Rural Residential Development  
**Location:** Roelands

**Contractor:** BC Coastal  
**Machine:** Hitachi 4T exc.  
**Operator:** Ben  
**Bucket:** 600 mm toothed and 1200 mm batter  
**Date:** 27/10/2016  
**Logged:** BL  
**Checked Date:** 16/12/2016  
**Checked By:** FAD

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					TOPSOIL: Clayey SAND/Silty SAND, fine to medium grained, brown, with some organics, with some roots			Rock outcrops nearby
	F		0.5		B(TP10-01)		CI / CH	Sandy CLAY: medium to high plasticity, red/brown, trace gravel	M	F - St	
	H		1.0					WEATHERED ROCK: recovered as Silty GRAVEL/Clayey GRAVEL, grey/brown/dark grey, with fragments of rock (slightly weathered to highly weathered)			
			1.5		B(TP10-02)			Increasing rock fragments (slightly weathered)			
	VH		2.0					Hole terminated at 1.80 m Refusal Groundwater not encountered			

## Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

**Job Number:** J1601231  
**Client:** Roelands Development Pty Ltd  
**Project:** Proposed Rural Residential Development  
**Location:** Roelands

**Contractor:** BC Coastal  
**Machine:** Hitachi 4T exc.  
**Operator:** Ben  
**Bucket:** 600 mm toothed and 1200 mm batter  
**Date:** 27/10/2016  
**Logged:** BL  
**Checked Date:** 16/12/2016  
**Checked By:** FAD

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0						TOPSOIL: Clayey SAND/Silty SAND, fine to medium grained, brown, with some organics, with some roots		
			0.5		B(TP11-01)				Sandy CLAY: medium to high plasticity, brown/red, trace roots		
			1.0		B(TP11-02)			CI / CH	Becoming red/brown, trace gravel, no roots	M	F - St
			1.5					CI / CH	Sandy CLAY/Gravelly CLAY: medium to high plasticity, orange/red/brown		
			2.0		B(TP11-03)			CI / CH	CLAY: medium to high plasticity, grey/brown		
									Hole terminated at 2.00 m Target depth Groundwater not encountered		

## Sketch & Other Observations




**Comments:**

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions



<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	Slow seepage	0.0						TOPSOIL: Clayey SAND/Silty SAND, fine to medium grained, brown, with some organics, with some roots	M	F - St	
	F		B(TP12-01)			CI	Sandy CLAY: low to medium plasticity, brown, trace organics and roots					
						CI	Sandy CLAY: low to medium plasticity, brown/orange					
						CI / CH	Gravelly CLAY: medium to high plasticity, brown/orange, with fragments of rock up to 100 mm diameter					
	H		B(TP12-02)			CI / CH	Sandy CLAY/Gravelly CLAY: medium to high plasticity, orange/brown, with fragments of rock (slightly weathered to highly weathered)	VSt - H				
									Hole terminated at 2.20 m Target depth Groundwater slow seepage at 1.8 m			

## Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION		MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP13-01)			CI	TOPSOIL: Clayey SAND/Silty SAND, brown, with some organics, with some roots	M	F - St	Rock outcrop nearby	
	F						Sandy CLAY: low to medium plasticity, orange/brown, with some gravel						
							Sandy CLAY: low to medium plasticity, red/brown, with some gravel						
							Sandy CLAY: medium to high plasticity, orange/brown, with some gravel						
							CI / CH		Increasing gravel content and rock fragments (highly weathered)				
VH		WEATHERED ROCK: recovered as Silty GRAVEL/Clayey GRAVEL, grey/brown/dark grey, with fragments of rock (Slightly weathered to highly weathered)											
			2.0						Hole terminated at 1.60 m Refusal on rock Groundwater not encountered				

## Sketch & Other Observations






**Comments:**

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions



<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	Very slow seepage	0.0						TOPSOIL: Clayey SAND/Silty SAND, fine to medium grained, brown, with some fines, with some roots			Roots to 0.5 m.
			0.5		B(TP14-01)		CI	Sandy CLAY: low to medium plasticity, brown/red, trace roots				
	1.0		B(TP14-02)				CI / CH	Sandy CLAY: medium to high plasticity, orange/brown, with some gravel	F - St	M		
	1.5							Increasing gravel content				
	2.0				CLAY: medium to high plasticity, orange/brown mottled grey	St						
									Hole terminated at 2.20 m Target depth Groundwater very slow seepage at 1.2 m			

## Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0						TOPSOIL: Clayey SAND/Silty SAND, fine to medium grained, brown, with some organics, with some roots	M	F - St	Root at 0.7 m, 30 mm diameter
	F		B(TP15-01)				CI	Sandy CLAY/Clayey SAND: low to medium plasticity, brown, trace organics, trace roots				
							CI	Sandy CLAY: low to medium plasticity, brown/grey				
			B(TP15-02)				CI / CH	Gravelly CLAY: medium to high plasticity, orange/brown mottled grey, with fragments of rock (slightly weathered)				
								Decreasing gravel content				
				CH	CLAY: medium to high plasticity, grey mottled orange/brown mottled grey	VSt						
								Hole terminated at 2.20 m Target depth Groundwater not encountered				

## Sketch & Other Observations




**Comments:**

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions



<b>Job Number:</b> J1601231	<b>Contractor:</b> BC Coastal	<b>Date:</b> 27/10/2016
<b>Client:</b> Roelands Development Pty Ltd	<b>Machine:</b> Hitachi 4T exc.	<b>Logged:</b> BL
<b>Project:</b> Proposed Rural Residential Development	<b>Operator:</b> Ben	<b>Checked Date:</b> 16/12/2016
<b>Location:</b> Roelands	<b>Bucket:</b> 600 mm toothed and 1200 mm batter	<b>Checked By:</b> FAD

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					TOPSOIL: Clayey SAND/Silty SAND, fine to medium grained, brown, with some organics and roots	M	F - St	
	F		0.5			CI	Sandy CLAY: low to medium plasticity, red/brown, trace gravel	D			
							Sandy CLAY: medium to high plasticity, red/brown, trace gravel				
						CI / CH	Becoming orange/red/brown, with some gravel				
	H		2.0				WEATHERED ROCK: recovered as Silty GRAVEL/Clayey GRAVEL, grey/brown/dark grey, with fragments of rock (slightly weathered to highly weathered)		St		
								Hole terminated at 2.20 m Target depth Groundwater not encountered			

## Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

## Appendix C: Dynamic Cone Penetrometer Test Results

**DYNAMIC CONE PENETROMETER FIELD TEST DATA**  
(AS 1289.6.3.2)

**Client:** Roelands Development Pty Ltd  
**Project:** Proposed Rural Residential Development  
**Location:** Lot 9001 Nunnagine Circle, Roelands

**Job No:** J1601231  
**Date:** 27/10/2016  
**Engineer:** BL



Test No:	TP01	TP02	TP03	TP04	TP05	TP06	TP07	TP08	TP09
Location:	TP01	TP02	TP03	TP04	TP05	TP06	TP07	TP08	TP09
Depth (mm)	No of Penetrometer Blows per 100 mm Depth Interval								
0-100	-	1	1	1	1	1	1	-	1
100-200	1	2	1	1	2	3	4	1	5
200-300	1	1	2	1	1	3	4	1	5
300-400	1	2	1	1	1	3	4	2	4
400-500	1	1	2	1	2	2	4	1	5
500-600	1	2	1	2	1	2	3	1	4
600-700	2	1	2	1	2	2	3	2	4
700-800	2	2	2	2	2	2	4	3	3
800-900	3	3	2	2	2	2	3	2	3
900-1000	3	3	2	2	2	3	4	2	3
1000-1100									
1100-1200									
1200-1300									
1300-1400									
1400-1500									
1500-1600									
1600-1700									
1700-1800									
1800-1900									

Test No:	TP10	TP11	TP12	TP13	TP14	TP15	TP16		
Location:	TP10	TP11	TP12	TP13	TP14	TP15	TP16		
Depth (mm)	No of Penetrometer Blows per 100 mm Depth Interval								
0-100	2	1	1	2	1	1	1		
100-200	2	2	2	2	1	2	3		
200-300	2	2	1	3	2	1	1		
300-400	2	1	1	2	1	2	3		
400-500	3	1	1	3	1	1	3		
500-600	3	1	1	4	1	2	2		
600-700	3	1	2	3	1	1	2		
700-800	4	1	2	3	1	1	2		
800-900	6	1	2	3	1	1	2		
900-1000	6	2	2	4	2	2	2		
1000-1100									
1100-1200									
1200-1300									
1300-1400									
1400-1500									
1500-1600									
1600-1700									
1700-1800									

Dynamic Cone Penetrometer tests done in accordance with AS 1289.6.3.2

HB: Hammer bounce (refusal)

0 = Penetration due to hammer weight only

R: Refusal

## Appendix D: Geotechnical Laboratory Test Results



**Maximum Dry Density (AS 1289.5.2.1) &  
California Bearing Ratio (AS 1289.6.1.1)  
Test Report**

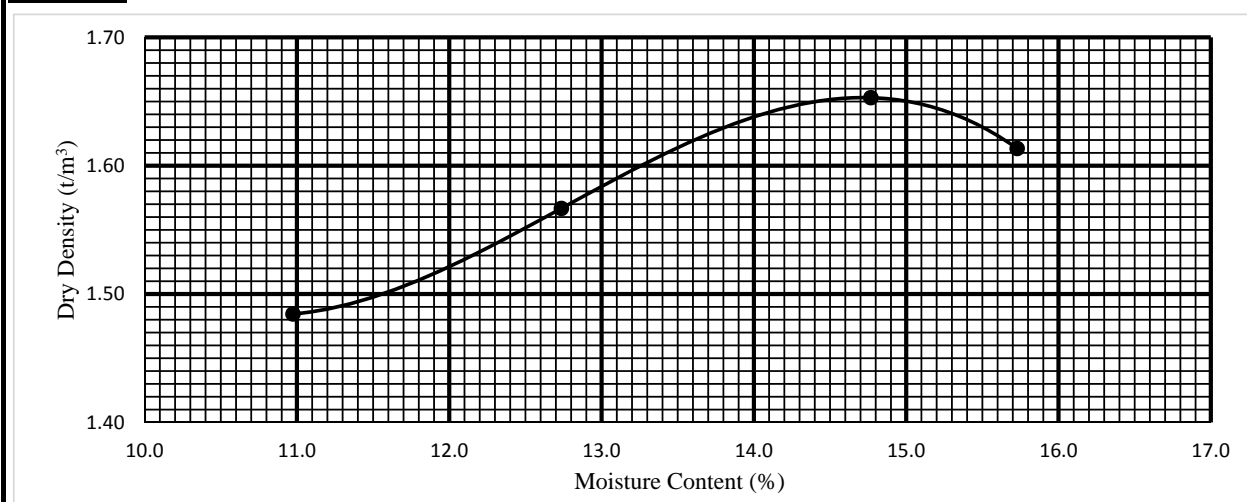


**Mining & Civil  
Geotest Pty Ltd**

**9 Lerista Court, Bibra Lake WA 6164  
Ph: (08) 9418 1873 Mob: 0412 427 245  
Email: craig@mcgeotest.com.au**

<b>Client:</b>	Roelands Development Pty Ltd	<b>Job No:</b>	60083
<b>Project:</b>	Proposed Rural Residential Development	<b>Sample No:</b>	P16/3625
<b>Location:</b>	Lot 9001 Nunnagine Circle, Roelands	<b>Issued Date:</b>	14-Nov-16
<b>Sample ID:</b>	TP05 0.3-0.5	<b>Report No:</b>	60083-P16/3625
Maximum Dry Density t/m <sup>3</sup>	1.65	<b>Conditions at Test</b>	
Optimum Moisture Content %:	14.8	Soaking Period (Days)	4
Desired Conditions: MDD/OMC	95/100	Surcharge (kg)	4.5
Retained on 19.0mm %	0	Entire Moisture Content %	23.6
<b>Compactive Effort</b>		Entire Moisture Ratio %	159.5
Mass of hammer kg	4.9	Top 30mm Moisture Content %	23.7
Number of layers	5	Top 30mm Moisture Ratio %	160.0
Number of blows/layer	15	Swell %	1.0
<b>Conditions after Compaction</b>		C.B.R. at 2.5 mm Penetration %	9
Dry Density t/m <sup>3</sup>	1.56	<b>Conditions after Soaking</b>	
Moisture Content %	15.2	Dry Density t/m <sup>3</sup>	1.55
Density Ratio %	94.5	Moisture Content %	23.1
Moisture Ratio %	102.5	Dry Density Ratio %	94.0
Soaked / Unsoaked	Soaked	Moisture Ratio %	156.5

**Comments:**



Client Address: 4/15 Walters Drive, Osborne Park WA 6017



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Craig Hugo

# Particle Size Distribution & Plasticity Index tests



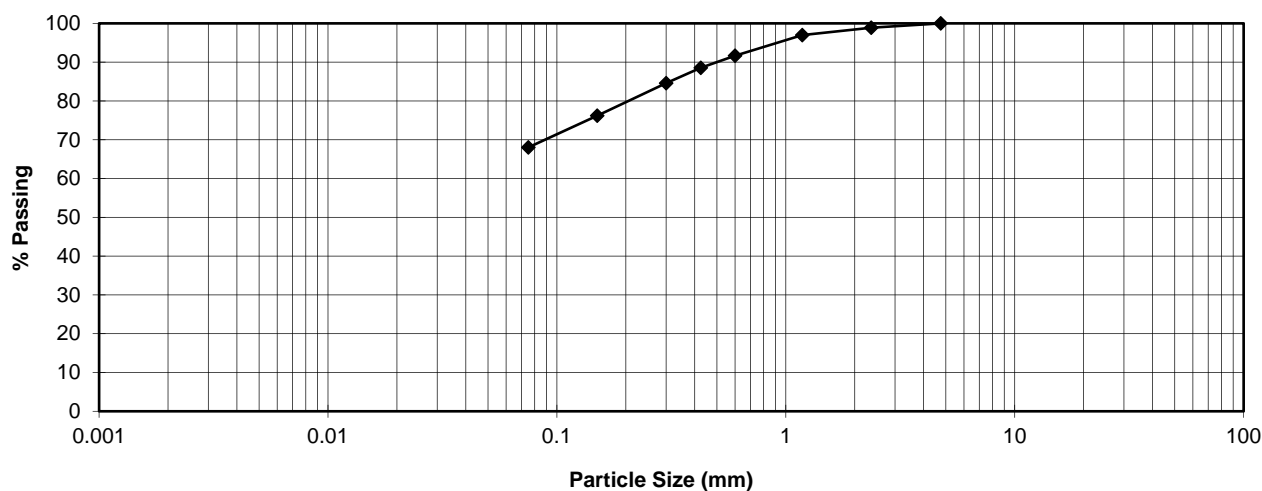
**Mining & Civil  
Geotest Pty Ltd**

9 Lerista Court, Bibra Lake WA 6164  
Ph: (08) 9418 1873 Mob: 0412 427 245  
Email: craig@mcgeotest.com.au

Job No: 60083  
Report No: 60083-P16/3625  
Sample No: P16/3625  
Issue Date: 16-Nov-16

Client: Roelands Development Pty Ltd  
Project: Proposed Rural Residential Development  
Location: Lot 9001 Nunnagine Circle, Roelands

Sample Details: TP05  
Sample Depth (m): 0.3-0.5



## SIEVE ANALYSIS AS1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	99
1.18	97
0.600	92
0.425	89
0.300	85
0.150	76
0.075	68

## Plasticity index tests

### AS 1289

Liquid Limit 3.9.2	36	%
Plastic Limit 3.2.1	19	%
Plasticity Index 3.3.1	17	%
Linear Shrinkage 3.4.1	7.0	%

Cracked

Curled

Client Address: 4/15 Walters Dr, Osborne Park WA 6017  
Notes:

Sampling Procedure: Tested as received



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Craig Hugo

# Organic Content of Soils

## ASTM: D 2974-07a Test Method C



**Mining & Civil  
Geotest Pty Ltd**

**9 Lerista Court, Bibra Lake WA 6164**  
**Ph: (08) 9418 1873 Mob: 0412 427 245**  
**Email: craig@mcgeotest.com.au**

**Job No:** 60083  
**Report No:** 60083-P16/3624  
**Sample No:** P16/3624  
**Issue Date:** 16-Nov-16

**Client:** Roelands Development Pty Ltd  
**Project:** Proposed Rural Residential Development  
**Location:** Lot 9001 Nunnagine Circle, Roelands

**Date Tested:** 14-Nov-16  
**Tested By:** P.S  
**Checked:** C.H

Sample Number	Sample Identification	Ash Content (%)	Organic Content (%)
P16/3624	TP08 0.3-0.4	90.4	9.6

Client Address: 4/15 Walters Drive, Osborne Park WA 6017

Sampling Procedure: Tested as received

Notes: Samples oven dried prior to test

Furnace temperature 440°

Approved signature

Craig Hugo

## Particle Size Distribution



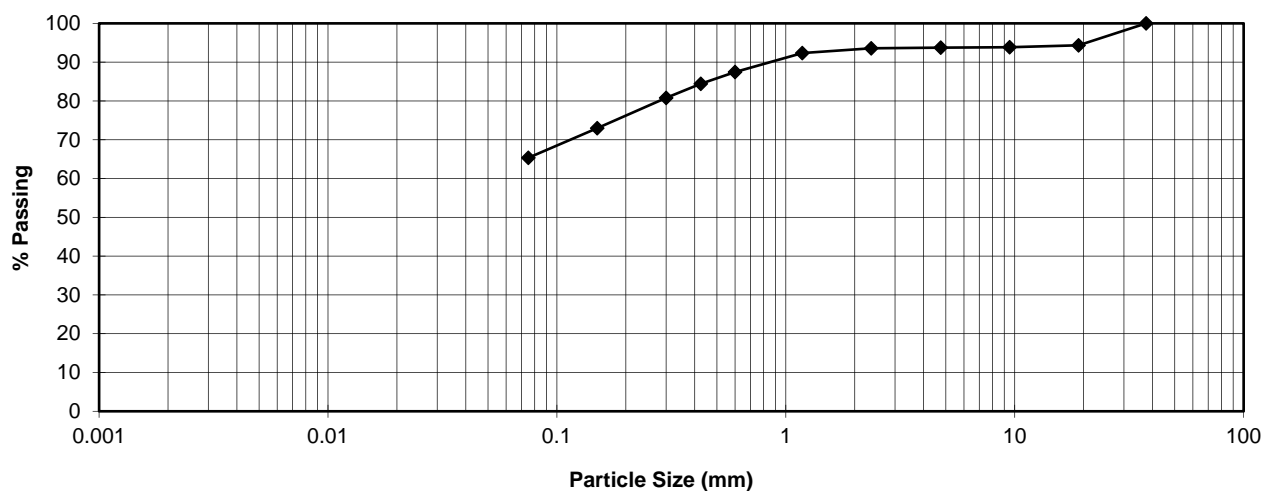
**Mining & Civil  
Geotest Pty Ltd**

9 Lerista Court, Bibra Lake WA 6164  
Ph: (08) 9418 1873 Mob: 0412 427 245  
Email: [craig@mcgeotest.com.au](mailto:craig@mcgeotest.com.au)

**Job No:** 60083  
**Report No:** 60083-P16/3624  
**Sample No:** P16/3624  
**Issue Date:** 16-Nov-16

**Client:** Roelands Development Pty Ltd  
**Project:** Proposed Rural Residential Development  
**Location:** Lot 9001 Nunnagine Circle, Roelands

**Sample Details** TP08  
**Sample Depth (m)** 0.3-0.4



### SIEVE ANALYSIS AS1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	100
19.0	94
9.5	94
4.75	94
2.36	94
1.18	92
0.600	87
0.425	84
0.300	81
0.150	73
0.075	65

Client Address: 4/15 Walters Drive, Osborne Park WA 6017  
Notes:

Sampling Procedure: Tested as received



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Craig Hugo

**Maximum Dry Density (AS 1289.5.2.1) &  
California Bearing Ratio (AS 1289.6.1.1)  
Test Report**

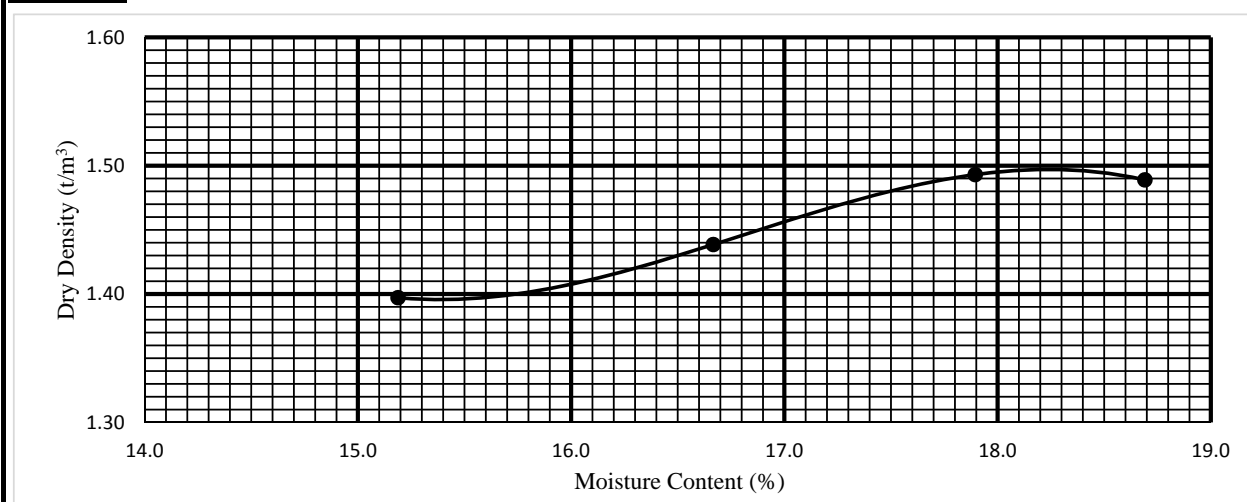


**Mining & Civil  
Geotest Pty Ltd**

**9 Lerista Court, Bibra Lake WA 6164  
Ph: (08) 9418 1873 Mob: 0412 427 245  
Email: craig@mcgeotest.com.au**

<b>Client:</b>	Roelands Development Pty Ltd	<b>Job No:</b>	60083
<b>Project:</b>	Proposed Rural Residential Development	<b>Sample No:</b>	P16/3622
<b>Location:</b>	Lot 9001 Nunnagine Circle, Roelands	<b>Issued Date:</b>	14-Nov-16
<b>Sample ID:</b>	TP09 0.4-0.5	<b>Report No:</b>	60083-P16/3622
Maximum Dry Density t/m <sup>3</sup>	1.50	<b>Conditions at Test</b>	
Optimum Moisture Content %:	18.3	Soaking Period (Days)	4
Desired Conditions: MDD/OMC	95/100	Surcharge (kg)	4.5
Retained on 19.0mm %	0	Entire Moisture Content %	35.4
<b>Compactive Effort</b>		Entire Moisture Ratio %	193.5
Mass of hammer kg	4.9	Top 30mm Moisture Content %	37.8
Number of layers	5	Top 30mm Moisture Ratio %	207.0
Number of blows/layer	15	Swell %	4.0
<b>Conditions after Compaction</b>		C.B.R. at 2.5 mm Penetration %	1.5
Dry Density t/m <sup>3</sup>	1.43	<b>Conditions after Soaking</b>	
Moisture Content %	17.9	Dry Density t/m <sup>3</sup>	1.37
Density Ratio %	95.5	Moisture Content %	32.0
Moisture Ratio %	98.0	Dry Density Ratio %	91.5
Soaked / Unsoaked	Soaked	Moisture Ratio %	175.0

**Comments:**



Client Address: 4/15 Walters Drive, Osborne Park WA 6017



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Approved Signature

Craig Hugo

# Particle Size Distribution & Plasticity Index tests



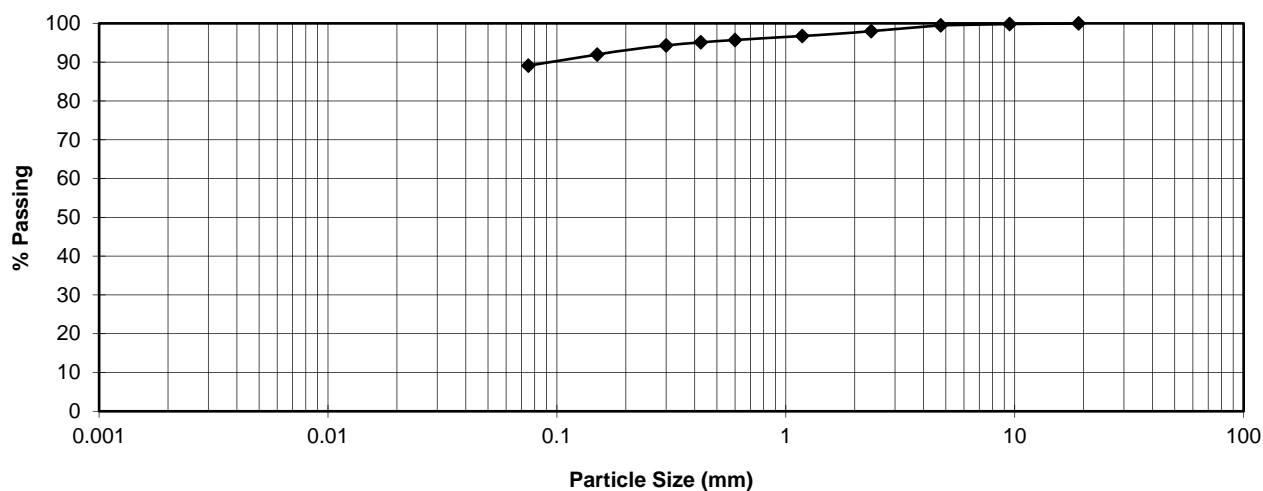
**Mining & Civil  
Geotest Pty Ltd**

9 Lerista Court, Bibra Lake WA 6164  
Ph: (08) 9418 1873 Mob: 0412 427 245  
Email: [craig@mcgeotest.com.au](mailto:craig@mcgeotest.com.au)

Job No: 60083  
Report No: 60083-P16/3622  
Sample No: P16/3622  
Issue Date: 16-Nov-16

Client: Roelands Development Pty Ltd  
Project: Proposed Rural Residential Development  
Location: Lot 9001 Nunnagine Circle, Roelands

Sample Details: TP09  
Sample Depth (m): 0.4-0.5



## SIEVE ANALYSIS AS1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	100
4.75	99
2.36	98
1.18	97
0.600	96
0.425	95
0.300	94
0.150	92
0.075	89

## Plasticity index tests

### AS 1289

Liquid Limit 3.9.2	62	%
Plastic Limit 3.2.1	25	%
Plasticity Index 3.3.1	37	%
Linear Shrinkage 3.4.1	14.5	%

Cracked ☐

Curled ☐

Client Address: 4/15 Walters Dr, Osborne Park WA 6017  
Notes:

Sampling Procedure: Tested as received



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Craig Hugo



**Maximum Dry Density (AS 1289.5.2.1) &  
California Bearing Ratio (AS 1289.6.1.1)  
Test Report**

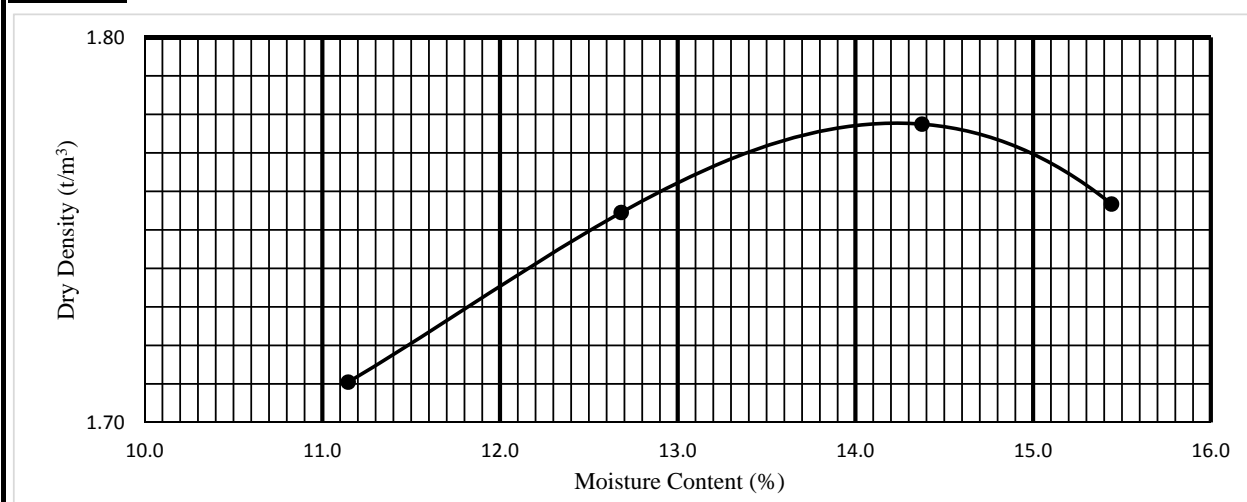


**Mining & Civil  
Geotest Pty Ltd**

**9 Lerista Court, Bibra Lake WA 6164  
Ph: (08) 9418 1873 Mob: 0412 427 245  
Email: craig@mcgeotest.com.au**

<b>Client:</b>	Roelands Development Pty Ltd	<b>Job No:</b>	60083
<b>Project:</b>	Proposed Rural Residential Development	<b>Sample No:</b>	P16/3618
<b>Location:</b>	Lot 9001 Nunnagine Circle, Roelands	<b>Issued Date:</b>	14-Nov-16
<b>Sample ID:</b>	TP12 0.4-0.5	<b>Report No:</b>	60083-P16/3618
Maximum Dry Density t/m <sup>3</sup>	1.78	<b>Conditions at Test</b>	
Optimum Moisture Content %:	14.3	Soaking Period (Days)	4
Desired Conditions: MDD/OMC	95/100	Surcharge (kg)	4.5
Retained on 19.0mm %	0	Entire Moisture Content %	17.6
<b>Compactive Effort</b>		Entire Moisture Ratio %	123.0
Mass of hammer kg	4.9	Top 30mm Moisture Content %	19.8
Number of layers	5	Top 30mm Moisture Ratio %	138.0
Number of blows/layer	15	Swell %	0.0
<b>Conditions after Compaction</b>		C.B.R. at 2.5 mm Penetration %	9
Dry Density t/m <sup>3</sup>	1.69	<b>Conditions after Soaking</b>	
Moisture Content %	14.3	Dry Density t/m <sup>3</sup>	1.69
Density Ratio %	95.0	Moisture Content %	19.7
Moisture Ratio %	100.0	Dry Density Ratio %	94.5
Soaked / Unsoaked	Soaked	Moisture Ratio %	137.5

**Comments:**



Client Address: 4/15 Walters Drive, Osborne Park WA 6017



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Craig Hugo

# Particle Size Distribution & Plasticity Index tests



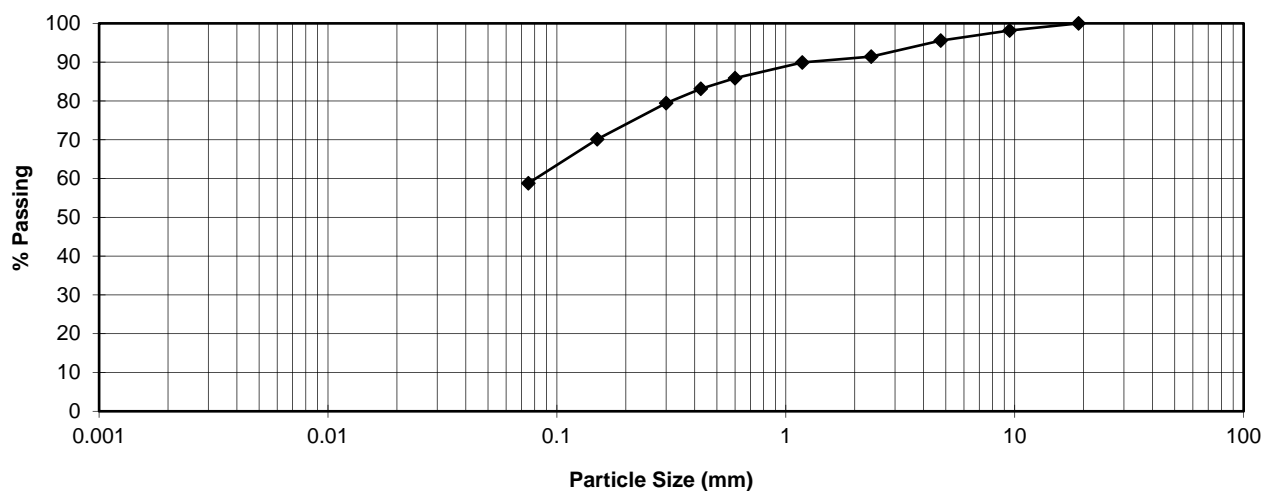
**Mining & Civil  
Geotest Pty Ltd**

9 Lerista Court, Bibra Lake WA 6164  
Ph: (08) 9418 1873 Mob: 0412 427 245  
Email: craig@mcgeotest.com.au

Job No: 60083  
Report No: 60083-P16/3618  
Sample No: P16/3618  
Issue Date: 16-Nov-16

Client: Roelands Development Pty Ltd  
Project: Proposed Rural Residential Development  
Location: Lot 9001 Nunnagine Circle, Roelands

Sample Details: TP12  
Sample Depth (m): 0.4-0.5



## SIEVE ANALYSIS AS1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	98
4.75	96
2.36	91
1.18	90
0.600	86
0.425	83
0.300	79
0.150	70
0.075	59

## Plasticity index tests

### AS 1289

Liquid Limit 3.9.2	28	%
Plastic Limit 3.2.1	17	%
Plasticity Index 3.3.1	11	%
Linear Shrinkage 3.4.1	5.5	%

Cracked

☐

Curled

☒

Client Address: 4/15 Walters Dr, Osborne Park WA 6017  
Notes:

Sampling Procedure: Tested as received



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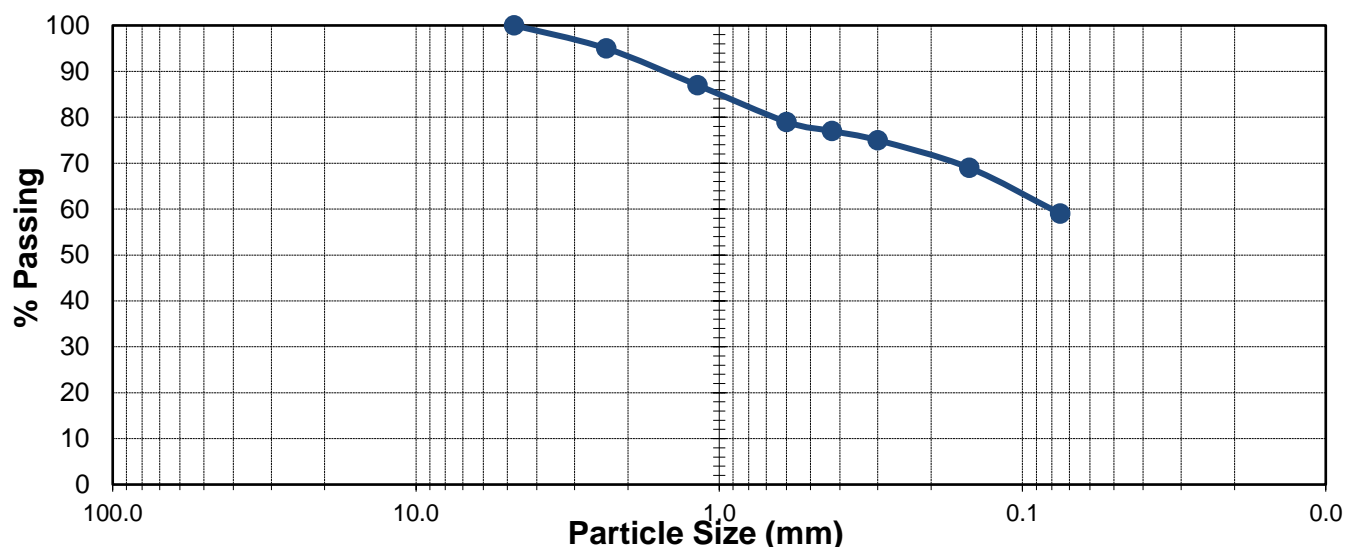
Approved signature

Craig Hugo



## Particle Size Distribution & Atterberg Limits Test Report

<b>Client:</b>	Galt Geotechnics	<b>Ticket No:</b>	S227
<b>Project:</b>	Proposed Rural Residential Development (J1601231)	<b>Report No:</b>	LL16/753 _1
<b>Location:</b>	Lot 9001 Nunnagine Circle, Roelands	<b>Sample No:</b>	LL16/753
<b>Sample ID:</b>	TP05 0.7 - 0.9m	<b>Issue Date:</b>	16-December-2016
<b>Sampling Procedure:</b> Tested as Received			



### SIEVE ANALYSIS

Sieve Size (mm)

75.0

37.5

19.0

9.5

4.75

2.36

1.18

0.600

0.425

0.300

0.150

0.075

### AS 1289.3.6.1

% Passing

100

95

87

79

77

75

69

59

### Atterberg Limits Tests

AS 1289

Liquid Limit 3.1.1

33 %

Plastic Limit 3.2.1

17 %

Plasticity Index 3.3.1

16 %

Linear Shrinkage 3.4.1

7.0 %

Cracked



Curled



**Client Address:** 4/15 Walters Dr, Osborne Park WA 6017

**Comments:**



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**Approved Signature:**

**Name:** Matt van Herk

**Function:** Laboratory Manager

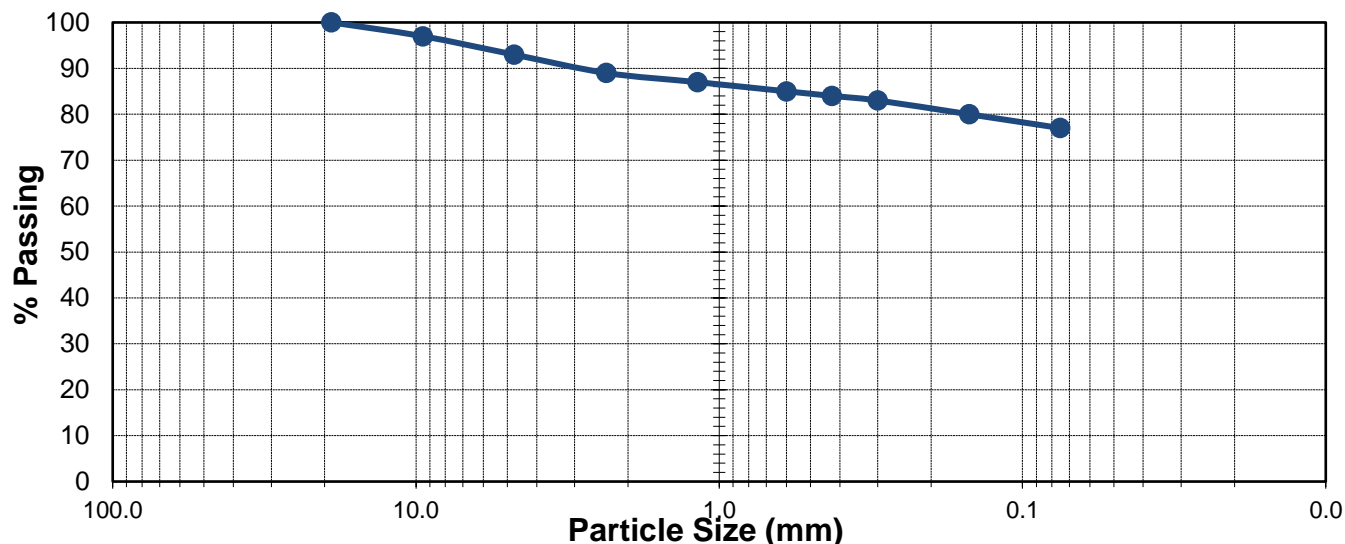
**Date:** 16-December-2016





## Particle Size Distribution & Atterberg Limits Test Report

<b>Client:</b>	Galt Geotechnics	<b>Ticket No:</b>	S227
<b>Project:</b>	Proposed Rural Residential Development (J1601231)	<b>Report No:</b>	LL16/754 _1
<b>Location:</b>	Lot 9001 Nunnagine Circle, Roelands	<b>Sample No:</b>	LL16/754
<b>Sample ID:</b>	TP10 0.5 - 0.7m	<b>Issue Date:</b>	16-December-2016
<b>Sampling Procedure:</b> Tested as Received			



### SIEVE ANALYSIS

Sieve Size (mm)

75.0

37.5

19.0

9.5

4.75

2.36

1.18

0.600

0.425

0.300

0.150

0.075

### AS 1289.3.6.1

% Passing

100

97

93

89

87

85

84

83

80

77

### Atterberg Limits Tests

AS 1289

Liquid Limit 3.1.1

51 %

Plastic Limit 3.2.1

21 %

Plasticity Index 3.3.1

30 %

Linear Shrinkage 3.4.1

12.0 %

Cracked



Curled



**Client Address:** 4/15 Walters Dr, Osborne Park WA 6017

**Comments:**



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**Approved Signature:**

**Name:** Matt van Herk

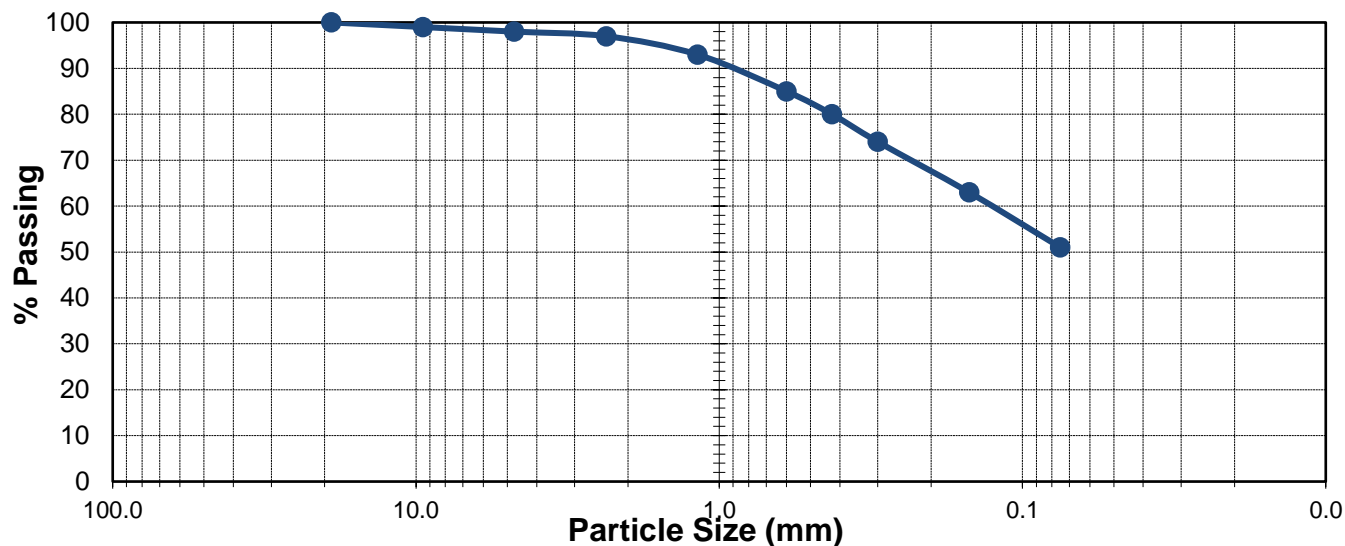
**Function:** Laboratory Manager

**Date:** 16-December-2016



## Particle Size Distribution & Atterberg Limits Test Report

<b>Client:</b>	Galt Geotechnics	<b>Ticket No:</b>	S227
<b>Project:</b>	Proposed Rural Residential Development (J1601231)	<b>Report No:</b>	LL16/755 _1
<b>Location:</b>	Lot 9001 Nunnagine Circle, Roelands	<b>Sample No:</b>	LL16/755
<b>Sample ID:</b>	TP15 0.4 - 0.5m	<b>Issue Date:</b>	16-December-2016
<b>Sampling Procedure:</b> Tested as Received			



### SIEVE ANALYSIS

Sieve Size (mm)

75.0

37.5

19.0

9.5

4.75

2.36

1.18

0.600

0.425

0.300

0.150

0.075

### AS 1289.3.6.1

% Passing

100

99

98

97

93

85

80

74

63

51

### Atterberg Limits Tests

AS 1289

Liquid Limit 3.1.1

39

%

Plastic Limit 3.2.1

23

%

Plasticity Index 3.3.1

16

%

Linear Shrinkage 3.4.1

8.0

%

Cracked

☐

Curled

☒

**Client Address:** 4/15 Walters Dr, Osborne Park WA 6017

**Comments:**



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**Approved Signature:**

**Name:** Matt van Herk

**Function:** Laboratory Manager

**Date:** 16-December-2016

## Appendix E: PRI Laboratory Test Results





## ANALYSIS REPORT

Generated: 16/11/2016 8:26:49 AM

Lab No	3TS16094	3TS16095	3TS16096	3TS16103	3TS16104	3TS16105	3TS16106	3TS16107
Name	P16/3617	P16/3618	P16/3619	P16/3620	P16/3621	P16/3622	P16/3623	P16/3624
Code	TP14 0.4-05	TP12 0.4-0.5	TP13 0.6-0.7	TP10 0.5-0.7	TP11 0.5-0.6	TP09 0.4-0.5	TP04 0.5-0.6	TP08 0.3-0.4
Customer	Roelands Development Pty Ltd	Roelands Development Pty Ltd	Roelands Development Pty Ltd	Roelands Development Pty Ltd	Roelands Development Pty Ltd	Roelands Development Pty Ltd	Roelands Development Pty Ltd	Roelands Development Pty Ltd
Depth	0-10	0-10	0-10	0-10	0-10	0-10	0-10	0-10
Phosphorus Retention Index	2229.7	782.2	2736.7	2945.6	595.5	3744.0	77.2	1358.4



Lab No	3TS16108
Name	P16/3625
Code	TP05 0.3-0.5
Customer	Roelands Development Pty Ltd
Depth	0-10
Phosphorus Retention Index	2457.6

89866  
Mining & Civil Geotest Pty Ltd



Soil & Plant Analysis Laboratory

## ANALYSIS REPORT

Generated: 16/11/2016 3:42:44 PM

Lab No	3VS16058
Name	P16/3626
Code	TP03 0.5-0.6
Customer	Roelands Development Pty Ltd
Depth	0-10
Phosphorus Retention Index	373.2



## Appendix F: Understanding your Report

# UNDERSTANDING YOUR REPORT

GALT FORM PMP11 Rev2

## 1. EXPECTATIONS OF THE REPORT

This document has been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

## 2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- ✦ the project objectives as we understood them and as described in this report;
- ✦ the specific site mentioned in this report; and
- ✦ the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- ✦ the report was not written for you;
- ✦ the report was not written for the site specific to your development;
- ✦ the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- ✦ the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

### 3. SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

### 4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

### 5. CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

### 6. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

### 7. ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

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