SOIL SURVEYS

PROJECT NO. 116-18467

JUNE 2016

PIONEER FORTUNE PTY LTD

BROADSCALE GEOTECHNICAL INVESTIGATION

PROPOSED RESIDENTIAL COMMUNITY DEVELOPMENT

WYATT ROAD

UNDULLAH

Soil Surveys Engineering Pty Limited
Specialists in Applied Geotechnics
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Gold Coast Office
Job No: 116-18467
Ref: 1-18467, 2016-05-31, BR VER 1
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28th June, 2016

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ATTENTION: MICHAEL LEPELAAR

Dear Sir,

RE: BROADSCALE GEOTECHNICAL INVESTIGATION – PROPOSED RESIDENTIAL COMMUNITY DEVELOPMENT - WYATT ROAD, UNDULLAH

Enclosed is a copy of our report for the above project dated June 2016. An electronic copy of the report has been issued.

Should you have any queries regarding this report, please do not hesitate to contact Peter Elkington at our Gold Coast office.

Yours faithfully,

P. ELKINGTON (RPEQ 7226)

for and on behalf of

SOIL SURVEYS ENGINEERING PTY LIMITED

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Appendices

1.0 INTRODUCTION

This report presents the results of the broadscale geotechnical investigation carried out by Soil Surveys Engineering Pty Limited on the 25th, 26th and 30th May, 2016 for the Proposed Residential Community Development at Wyatt Road, Undullah.

The objectives of this investigation were to assess subsurface conditions at the site in accordance with the Scope of Services detailed in Section 2.0.

2.0 SCOPE OF GEOTECHNICAL SERVICES

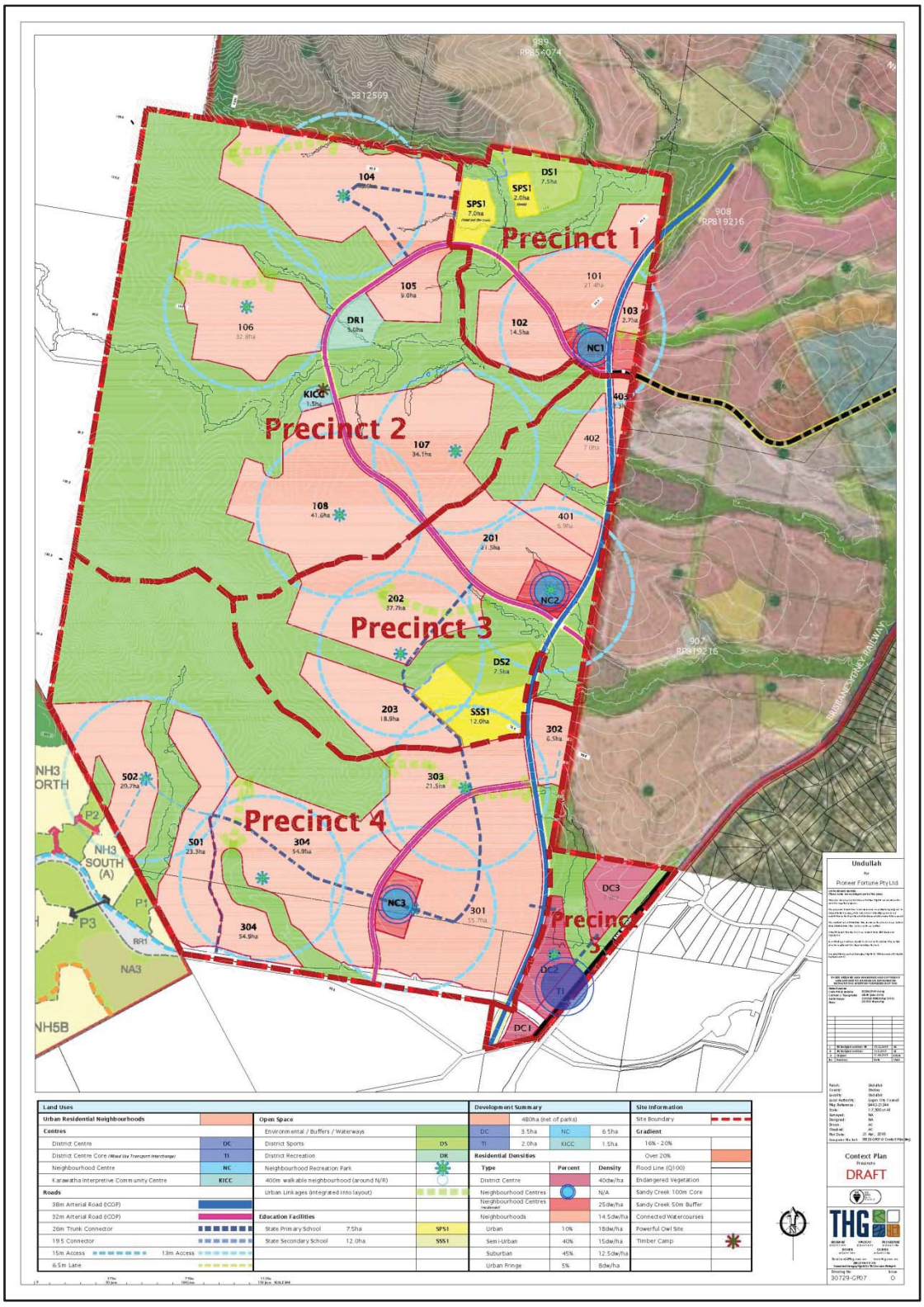
The scope of geotechnical services provided by Soil Surveys Engineering Pty Limited was directed towards evaluating the following items as detailed in our proposal 1-18476, 2016-05-05, PR VER 1 dated 5th May, 2016:

- Investigation of the subsurface profile at the proposed subdivision and the pavement area by drilling, sampling and insitu testing with 7 boreholes and 15 test pits.
- Laboratory testing on selected samples to assess the reactive nature, strength and dispersive nature of the subsurface material.
- Engineering analysis of site investigation and laboratory test results to preliminarily evaluate:-
  - Trafficability and site preparation considerations
  - Earthworks considerations
  - Soil Dispersive parameters
  - Pavement considerations
  - Site management recommendations

3.0 PROPOSED DEVELOPMENT

It is understood the proposed development is to consist of the development of a Masterplan and community of up to 7,500 houses spread over 20 residential areas. Refer Figure 1.

Details of the development are unknown at this stage but are generally expected to consist of the significant bulk earthworks across the site.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Pioneer Fortune Pty Ltd
Context Plan
DRAFT
THG
Land Uses
Urban Residential Neighbourhoods
Centres
District Centre
District Centre Core
Neighbourhood Centre
Karawatha Interpretive Community Centre
Roads
38m Arterial Road (EDP)
32m Arterial Road (EDP)
26m Trunk Connector
19.5 Connector
15m Access
13m Access
6.5m Lane
Open Space
Environmental / Buffers / Waterways
District Sports
District Recreation
Neighbourhood Recreation Park
400m walkable neighbourhood (around N/R)
Urban Linkages (integrated into layout)
Education Facilities
State Primary School 7.5ha
State Secondary School 12.0ha
Development Summary
480ha (net of parks)
Residential Densities
Type
Percent
Density
District Centre
Neighbourhood Centres
Neighbourhoods
Urban
Semi-Urban
Suburban
Urban Fringe
Site Information
Site Boundary
Gradient
16% - 20%
Over 20%
Flood Line (Q100)
Endangered Vegetation
Sandy Creek 100m Core
Sandy Creek 50m Buffer
Connected Watercourses
Powerful Owl Site
Timber Camp

FIGURE 1

4.0 GEOTECHNICAL INVESTIGATION

4.1 Field Investigation

To achieve the above objectives, the following geotechnical investigation was undertaken:

- Drill 7 boreholes to depths of between 0.3m and 1.95m (drilling rig refusal) using our 4WD mounted Jacro 105 drilling rig, augmented with Dynamic Cone Penetrometer (DCP) tests, Undisturbed 50mm tube sampling (U50's) and Disturbed (D) sampling.
- Excavate 10 test pits to depths of between 0.25m and 1.9m using a 3.5 tonne tracked excavator. Each pit was augmented with a Dynamic Cone Penetrometer (DCP) test and Disturbed (D) sampling undertaken.

The soil classification descriptions, field and laboratory testing were carried out in general accordance with Australian Standards.

AS.1726 - 1993	Geotechnical Site Investigations
AS.1289	Methods of Testing Soils for Engineering Purposes

Notes relating to this report, borehole records and a site plan showing the location of the boreholes are included in the Appendices.

4.2 Laboratory Testing

Laboratory testing was carried out on selected samples retrieved from the site investigation program and was directed towards assessing the reactivity, strength and subgrade characteristics of the subsurface material.

Laboratory testing included:-

- Shrink/Swell Index - to assess the reactivity of the subsurface material.
- Emerson Class and Conductivity testing - to assess the dispersive nature of the soils.
- Atterberg Limits - to assess the liquid limit, plastic limit, plasticity index and linear shrinkage of the subsurface material.
- Particle Size Distribution - to assess the particle size of the subsurface material.

The results of the laboratory testing are contained in Appendix C.

4.3 Site Description

The site of the proposed residential community development is located at Wyatt Road, Undullah, is described as Lot 3 on RP 45236, Lot 28 on SP S311174 and Lot 3 on RP 49296, and comprises approximately 1024.8 hectares of land. Refer Figure 2 for site location.

FIGURE 2 – AERIAL IMAGE

The site is essentially undeveloped with numerous access tracks cut across the area.

Development on the site is restricted to a number of small houses and sheds with some evidence of previous use of the site for cattle grazing especially in the southern area of the site. The site is also understood to have been used for quarrying and logging in the past.

A creek bisects the site in a generally north-easterly direction in the northern half of the site. with numerous gullys and smaller creek beds across the site.

The site is typically undulating with significant surface level change across the site, with ground surface levels ranging from RL225m in the north western corner of the site, to approximately RL20m in the southern east and north east corners.

Vegetation varied significantly across the site, from heavy vegetation in the higher areas of the site, to a more sparsely native bushland. In the cleared areas of the site, a sparse grass cover was present.

Significant erosion gullys were noted across the site, where clearing of the vegetation had been undertaken. This was especially noted on the downhill slopes of the access tracks.

5.0 GEOTECHNICAL MODEL

5.1 Regional Geology

The regional geology comprises the Marburg formation from the Jurassic period. The geology generally comprises sandstone, siltstone, shale, mudstone and thin coal seams. (Moreton Region 1:250,000).

5.2 Subsurface Profile

The encountered subsurface profile can be broadly delineated as follow:-

- Natural Soils
- Weathered rock

Natural Soils

The natural soil strata encountered in all of the boreholes/test pits generally comprised very loose sand, medium dense silty/clayey sand and hard sandy/silty clay and clay to depths of between 0.05m and 1.7m.

Weathered Rock

The underlying rock, encountered in all of the boreholes/test pits (with the exception of Test Pit 04 and 10), was described sandstone. The depth to rock ranged from 0.05m to 1.7m across the site.

Table 1 presents a summary of the encountered subsurface profile. Detailed borehole record sheets are appended to this report.

TABLE 1 SUBSURFACE PROFILE SUMMARY

BH No.	NATURAL			Termination Depth
	Silty / Clayey Sand and Sand	Sandy/Silty Clay and Clay	Sandstone	
BH01	0.0-0.1	0.1-1.7	1.7-TD	1.95[3)]
BH02	0.0-0.05	0.05-1.3	1.3-TD	1.95[3)]
BH03	0.0-0.25	0.25-0.8	0.8-TD	1.25[3)]
BH04	0.0-0.07	0.07-0.9	0.9-TD	1.3[3)]
BH05	0.0-0.05	NE	0.05-TD	0.3[3)]
BH06	0.0-0.25	0.25-0.9	0.9-TD	1.15[3)]
BH07	NE	0.0-0.8	0.8-TD	1.25[3)]
TP01	0.2-0.7	0.0-0.2	0.7-TD	1.0[3)]
TP02	0.0-0.15	0.15-1.4	1.4-TD	1.9[3)]
TP03	NE	0.0-0.15	0.15-TD	0.25[3)]
TP04	0.0-0.35	0.35-TD	NE	1.0
TP05	0.0-0.1	0.1-0.45	0.45-TD	0.65[3)]
TP06	NE	0.0-0.1	0.1-TD	0.55[3)]
TP07	0.0-0.1	0.1-1.25	0.25-TD	1.5[3)]
TP08	0.0-0.1	0.1-0.9	0.9-TD	1.1[3)]
TP09	0.0-0.15	0.15-0.3	0.3-TD	0.8[3)]
TP10	0.0-TD	NE	NE	1.5

Notes:
1. All depths in metres below ground level at time of investigation.
2. NE - Not Encountered; TD - Termination Depth.
3. Maximum TC bit/drilling rig refusal/excavator refusal.

5.3 Groundwater

No groundwater was encountered in the boreholes and test pits at the time of the investigation, with the exception of TP10 (in a creek bed).

Seepage could be expected within the sands and along the sand/clay and clay/rock interfaces following periods of rainfall. The presence of groundwater is expected to be variable across the site and should be assessed as part of future investigations.

6.0 ENGINEERING ASSESSMENT

This section of the report includes evaluation of the following:-

- Earthworks
- Foundations
- Retaining Walls
- Pavements
- Site Management

6.1 Trafficability and Site Preparation

At the time of the field investigation, trafficability was considered to be fair across the majority of the site, where access was available around the existing vegetation, due to the dry weather conditions encountered. However, trafficability through the lower lying areas of the site was significantly restricted with vehicles becoming bogged in the creek crossing.

Following periods of rainfall, areas stripped of vegetation are expected to provide significant trafficability issues.

Where loose clayey sands overlie clays, as is the situation on some of the site, seepage may occur through the sands and along the sand/clay interface resulting in a subsequent loss of strength. This may limit trafficability and create difficulties for earthworks operations. This situation would be more pronounced if rainfall followed initial clearing, stripping and grubbing.

Problems may also arise from disturbance of the upper level soil fabric with removal of vegetation. Depressions could be formed resulting in water traps and potential softening of adjacent and underlying soils.

It is recommended that after stripping, clearing and grubbing, the exposed surface in the construction area be proof rolled to identify areas of weak surficial soils and to improve trafficability.

An important aspect of maintaining trafficability is drainage control. It should be ensured that runoff is diverted away from the construction area to prevent ponding of water. In addition, the construction area should be "sealed" in the event of rain.

Potential trafficability problems with this site should not be underestimated. The site will very quickly become untrafficable if appropriate seepage and drainage control measures, along with construction practices appropriate for site conditions, are not maintained.

Nevertheless, the contractor should fully inform himself of the ground conditions, on site, prior to commencement of earthworks. This requirement should be explicit in any earthworks specifications or contract.

6.2 Earthworks

It is understood that bulk earthworks across the site are expected to comprise a series of significant cut to fill operations to depths that have not been determined at this stage.

The following general comments are made for any proposed works.

Earthwork procedures should be carried out in a responsible manner in accordance with AS 3798-2007 "Guidelines on Earthworks for Commercial and Residential Developments".

Earthwork procedures should include the following:-

- Clearing, stripping and grubbing should be carried out in areas subject to earthworks. Also all soils containing organic matter should be stripped from the construction area. This material is not considered suitable for use as structural fill.
- Sloping ground, etc. should be benched to "key in" fill material and optimise compaction. The benches should slope back at 1V:10H and be at least 0.5m wide. Wider benches to accommodate the width of the roller may need to be adopted in some situations. Figure 3 refers.

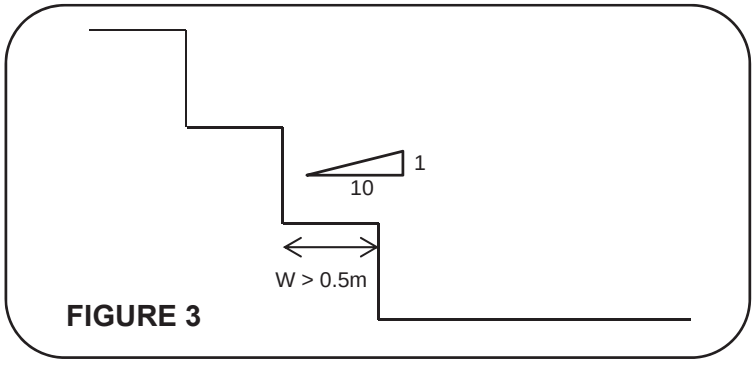

FIGURE 3

- Depressions formed by the removal of vegetation, underground elements etc. should have all disturbed weakened soil cleaned out and be backfilled with compacted select material.
- Following stripping, the exposed ground surface should be proof rolled to detect any soft or loose material. Loose soils, particularly loose surface clayey sands, should be compacted to the appropriate requirements. Soft, wet clays should preferably be removed. In areas of cut, proof rolling may be deferred until after the cut operation.
- Any imported fill, if needed to make up earthwork deficiencies, should be of fair to good quality and conform to the following general specification:-
  - Soaked CBR Minimum of 10%
  - Maximum Aggregate Size 75mm
  - Shrink/Swell Index Maximum of 1.0%
  - Emerson Class Minimum of Class 4
- Guidelines for minimum relative compaction values for insitu soils and imported fill for the building and pavements are presented in Table 2 below.

TABLE 2 MINIMUM RELATIVE COMPACTION

Location	Minimum Dry Density Ratio (%)
Building Area	98
Pavement Area a) > 0.3m below pavement subgrade b) ≤ 0.3m below pavement subgrade	 95 98
Note: The recommended compactions are percentages of the maximum dry density determined by Australian Standard 1289 5.1.1 (Standard Compaction).	

- Field density testing should be carried out to check the standard of compaction achieved and the placement moisture content. The frequency and extent of testing should be as per guidelines in AS.3798-2007, Section 8.0.
- Backfilling for service trenches, etc. should use good quality material. The backfill should be placed in uniform layers over the full width of the excavations with the layers not exceeding 200mm thickness, loosely placed. The backfill material should be compacted to the specifications outlined above for insitu or imported cohesive material.

Suitability of the Excavated Materials for Reuse as Engineered Fill

Based on the encountered subsurface conditions, the materials excavated from the site will comprise clay based soils of moderate to high reactivity, clayey sands, and extremely to distinctly weathered sandstone rock. Less weathered rock will be encountered in areas of deep excavation.

The silty/clayey sands and the weathered rock will be suitable for reuse in compacted fills without significant treatment (i.e. only moisture conditioning required), with the extremely weathered sandstone rock breaking down to clayey sands, and clayey gravelly sands and a high plasticity clay soil. It is recommended that the more silty/clayey material is used in the lower levels of fill platforms.

Less weathered siltstone and sandstone rock should also break down under compaction to form clayey sandy gravel or clayey gravelly sands, but some additional compactive effort may be required to break down the larger rock pieces. Less weathered stronger rock which may be encountered below the test pit and borehole termination depths may require excavation using hammering or blasting techniques and will probably not break down readily. On this basis the less weathered rock may not be suitable for use in structural fills without treatment such as crushing. These rock-fill materials could be used at the base of deep fills which are not required to be penetrated by building footings or service trenches.

The following recommendations are provided for the reuse of excavated material as engineered fill:

- The excavated silty sands, clayey sands, sandstone rock are suitable for use as engineered fill, when broken down to suitable size to aid compaction. Moisture content within the range of OMC (Standard Optimum Moisture Content) to OMC +2% is recommended.
- The clay soils should be used in the deeper sections of fills, so as not to impact on the footing performance in terms of shrink/swell movements;
- The less weathered sandstone and siltstone rock at depth should also be used in the deeper sections of fills, so as to not impact on the footing performance in terms of differential or total settlements;
- Filling for the proposed buildings should be carried out in accordance with AS3798-2007;
- The fill should be assessed and further testing may be required after it has been exposed by excavation and prior to it being used.

Earthworks Supervision

Given the building type and the nature of the earthworks operation, "engineering supervision" of the earthworks operations is recommended.

It is recommended that the following objectives (as a minimum) be incorporated into the earthworks specification:-

- Certification that all general earthworks operations (ie. stripping proof rolling of subgrade, etc.) have been carried out in accordance with the earthworks specification.
- Certification that fill has been placed and compacted to the required minimum density in accordance with the earthworks specification.
- Certification that the controlled fill is suitable for support of conventional high level footings and has a minimum bearing capacity of 150kPa.
- Certification that the quality of any imported fill complies with the earthworks specification requirements.

It is recommended that all certification be signed by an RPEQ.

Excavation Characteristics

It is anticipated that excavations will consist of cuts possibly to significant depths.

The assessment of excavation characteristics of soil and weathered rock is normally based on the depth of penetration of the drilling rig using various bit attachments. These depths are recorded on the Borehole Record Sheets and summarised in Table 3.

TABLE 3 SUMMARY OF DRILL BIT/EXCAVATOR LIMITS

Test Location	Limit of 'TC' Bit (Boreholes) (m)	Excavator Refusal Depth (Test Pits) (m)
BH 1	1.95	N/A
BH 2	1.95	N/A
BH 3	1.25	N/A
BH 4	1.3	N/A
BH 5	0.3	N/A
BH 6	1.15	N/A
BH 7	1.25	N/A
TP 1	N/A	1.0
TP 2	N/A	1.9
TP 3	N/A	0.25
TP 4	N/A	1.0
TP 5	N/A	0.65
TP 6	N/A	0.55
TP 7	N/A	1.5
TP 8	N/A	1.1
TP 9	N/A	0.8
TP 10	N/A	Not Encountered
Notes: N/A = Not Applicable		

When augering, the bits are attached to the flight auger.

The limit of the 'TC' bit is indicative of the limit of excavations of a medium sized dozer in bulk excavation (Cat D6 or D7) or a large excavator in trench excavation (20 to 25 tonne machine).

Generally, below the 'TC' bit limit, either larger equipment, compressor driven pneumatic tools or hydraulic rock breakers would be required for excavation. No assessment of this has been undertaken as part of this investigation.

Ripping depths can be significantly increased when the rock is bedded, laminated and highly jointed. The nature of the rock and inherent planes of weakness therefore play an important part in rock excavation assessment.

It is considered that excavations could be carried out to the depths of the 'TC' bit limit using the appropriate plant as indicated above. Below the depth of the 'TC' bit limit, larger plant or specialised attachments, eg. rock breakers may be required for the proposed construction. Some budgeting should be allocated for the possibility of encountering zones of stronger rock.

Batters

The following maximum batter angles are typically recommended for batters up to 4m. Steeper batters are possible by use of retaining structures. Fill batter slopes are dependent on suitable compaction being achieved.

TABLE 4 BATTER ANGLES (4M MAXIMUM HEIGHT)

Material	Short Term	Long Term
Controlled Fill	45 degrees	26 degrees
Clay Soils	45 degrees	26 degrees
Clayey Sands	45 degrees	20 degrees
Weathered Rock	60 degrees [1)]	45 degrees [1)]
Note [1)] Subject to investigation and degree of weathering, etc.		

Temporary and permanent fill batters should be over-compacted and trimmed back to ensure proper compaction in the outer zones. The outermost layer of fill batters should be constructed of non-dispersive materials to limit erosion potential. Based on the test results non-dispersive soils may be required to be sourced to provide erosion protection.

The batter angles given in this Section are based on unsurcharged slopes, whereby a buffer distance behind the crest of the batter equal to its height is free of any surcharges. Surcharged or batters with seepages will require some reduction in batter angle.

It is very important that all cut and fill batters, once constructed are immediately protected from scouring and erosion by suitable protection measures, such as establishing a non dispersive soil and plant cover as well as adequate drainage to limit the potential for erosion.

It is essential that batters be suitably protected from erosion and scour by the installation of surface drains, etc. Runoff should not be allowed to discharge directly across the batters.

6.2.1 Erosion Hazard Assessment

General

This section discusses the Soil Classification, Emerson Class Number, Dispersion Index, Particle Size Distribution, Electrical Conductivity, pH and D_{30} particle size of the soil samples tested.

Soil Classification and Assessment Level

A review of the soil types in the area (Field Guide – Soils of Ipswich) would suggest that the site is underlain by the following soil types – Dermosols and Chromosols.

Both of these are deemed to be highly erodible and as such an assessment level 1 (as set out in Table 3.2 of BPESC) will be required.

Emerson Class Number

Selected samples retrieved from the field investigation program were tested for dispersiveness using the Emerson Class Number test method, i.e. AS1289.3.8.1.

The test method AS1289.3.8.1 divides soils into seven classes (refer Table 5) on the basis of their coherence in water, with one further class being distinguished by the presence of calcium-rich minerals.

TABLE 5 EMERSON CLASS

Class	Description	Erosion Potential
1	Slaking and complete dispersion of natural soil crumbs in still water	Very High
2	Slaking and some dispersion of natural soil crumbs in still water	Very High
3	Slaking but no dispersion of natural soil crumbs in still water, dispersion of moistened, remoulded soil crumbs in still water	High
4	Slaking but no dispersion of natural soil crumbs in still water, no dispersion of moistened, remoulded soil crumbs in still water, calcite or gypsum present	Medium
5	Slaking but no dispersion of natural soil crumbs in still water, no dispersion of moistened, remoulded soil crumbs in still water, no calcite or gypsum present, dispersion of soil/water suspension after shaking	Medium
6	Slaking but no dispersion of natural soil crumbs in still water, no dispersion of moistened, remoulded soil crumbs in still water, no calcite or gypsum present, flocculation of soil/water suspension after shaking	Medium
7	No slaking and swelling of natural soil crumbs in still water	Low
8	No slaking and no swelling of natural soil crumbs in still water	Low

Emerson Class Numbers (ECN) of between 1 and 3 were recorded for the samples tested and therefore are deemed to have a **very high** erosion potential. This correlates with onsite observations.

To allow assessment of erosion potential, the following laboratory testing was undertaken:-

- Emerson Class
- pH
- Conductivity
- Salinity

The results of laboratory testing are included in Appendix C.

Construction activities and erosion/sediment control measures should be implemented in a manner consistent with good building practices and Authority requirements.

Erosion Potential

Soils with relatively high silt and fine sand fractions are most susceptible to erosion, while very fine grained, high plasticity clay soils are least susceptible. The majority of the surficial materials were silts and sands and are therefore considered susceptible to erosion.

Soil Electro-Chemistry

Dispersive clay soils often contain significant levels of chemically exchangeable Sodium, however if they are also saline, (i.e. according to BPESC an EC of about 0.5 mS/cm or greater is deemed to be saline), or contain natural flocculants such as calcite or gypsum, then they will usually resist dispersion.

The EC test results indicate values of between 0.05 and 0.31 mS/cm and therefore could be considered as “non-saline” to low level saline and therefore potentially moderately dispersive. However, based on the Emerson Class tests, soils returned results of Class 1 to 3, indicating that calcite and gypsum are present which usually reduces the probability of being dispersive.

In addition to the EC results above, the soils recorded around neutral pH values (of 6.1 to 7.5).

Summary

A review of the test results with respect to the above comments suggests the following:-

- The soils would be generally considered fine grained.
- The soils would be defined as “non-saline” saline based on the EC testing. Suggesting moderately dispersive. The presence of gypsum and calcite may however reduce this.
- pH of all samples were typically neutral (6.1 to 7.1).
- The soil would be considered dispersive according to the dispersive index result.
- All the test results suggest a very high erosion potential for soils on the site.

6.2.2 Types of Active Erosion

The processes of active erosion are evident throughout the site as:-

- Sheet erosion which is removing the shallow surface soils initiated by rainfall splash and then runoff and is seen as the accumulation of sediment and soil debris at the base of the slope features.
- Rill erosion evident as small channels typically less than 300mm deep in the access track, and adjacent to the main drainage features and the tributary gullies, caused by concentrations of rainfall runoff.
- Gully erosion where continued concentrated surface runoff has caused deepening of the erosion rills, to form large gullies up to 2m deep, across the site.

6.2.3 Construction Activities which Increase Erosion Risk

Construction activities which will increase the risk of erosion on this site include:-

- Removal of topsoil can initiate sheet and rill erosion, as well as tunnel erosion in dispersive soil.
- Cutting and filling may expose dispersive soils and sands, silts and clays to rainfall and runoff, initiating erosion.

- Installation of in-ground services increases the risk of tunnel erosion in dispersive soils.
- Concentrations of rainfall runoff and stormwater, possibly exacerbated by changes in hydrology and site drainage, will initiate and promote sheet, rill and tunnel erosion processes.
- Poor compaction of fill materials containing dispersive soil will result in the initiation of erosion.
- Haul roads, access tracks and bare work areas will initiate erosion.

6.2.4 Erosion and Sediment Control Techniques

Erosion and sediment control on this site during construction is required to:-

- Minimise the further occurrence of erosion;
- Intercept, divert and dispose of run-on water from upslope areas above disturbed work areas or allow clean water to pass through the site without mixing with sediment laden water;
- Allow progressive stabilising and revegetating of disturbed worked areas;
- Minimise sediment laden water leaving active construction areas and entering the main site drainage systems.

Measures to control erosion and sediment transport during construction include the following:-

Integration of Project Design and Site Constraints

The project design should be compatible with the site constraints, such as topography and drainage lines and hydrological constraints. Cut and fills should be limited where practical to reduce the areas of disturbance and hence the potential for erosion.

Erosion and Sediment Control Planning

An Erosion and Sediment Control (ESC) Plan is considered to be essential for this site so that control measures can be integrated into the construction sequence. The main components of an Erosion and Sediment Control Plan are:-

1) Planning
2) Site Assessment
3) Site Investigation
4) Evaluation of Work Sites
5) Identification and Documentation of Erosion and Sediment Control Practices
6) Implementation, Monitoring, Validation and Corrective Actions

Minimising Disturbance

Topsoil stripping and construction work areas should be sequenced and minimised within practical limits to reduce the potential for erosion. Small parcel construction with manageable sized areas is recommended, and finished site areas must be stabilised as soon as practical.

Near the drainage lines and gullies, vegetation must be retained as far as practical.

Stormwater Control Onto and Through Site and Works Areas

Run-on water must be intercepted above works areas and diverted to avoid contamination. Construction should include temporary drains and stormwater collection systems, including sediment ponds.

Use of Erosion Controls

Erosion controls must be incorporated into all construction phases. These include:-

- Maintain vegetation where practical
- Compost blankets
- Erosion control blankets
- Gravel platforms over exposed soils
- Mulching
- Revegetation
- Soil binders and surface stabilisers
- Surface roughening

Specific control measures will have to be selected, depending on site conditions.

Focal points for erosion control are entry and exit points to all areas of work where heavy vehicles transit frequently. These need to be covered with silty sandy gravel or clayey sandy gravel. These sites are characterised by soil fines due to constant vehicle movements.

Effective erosion control also means effective drainage control measures. Considerations should include:-

- Diversion of upslope stormwater runoff around soil disturbances.
- Division of work site into manageable drainage areas, with stabilised flow paths. Dirty water should be kept on site and disposed of appropriately, without entering the main drainage lines.
- Reduce flow velocity and therefore soil erosion within drainage channels and chutes, by incorporating mounds or check dams.

Stabilisation of Disturbed Areas

Disturbed areas must be promptly stabilised and revegetated as soon as earthworks are completed.

Sediment Control

Sediment control measures are secondary in preventing on-site and off-site erosion effects. These trap and retain sediment eroded from the works areas and prevent movement of sediment into the drainage lines.

Typical sediment control measures include:-

- Buffer zones, especially between the creek gully and development areas
- Construction exits
- Sediment fences
- Sediment basins/weirs
- Check dams
- Grass filter traps
- Rock filter traps
- Compost/mulch berms
- Drop inlet protection
- Flocculants

Specific control measures should need to be selected, depending on work area conditions.

Drainage control measures applicable to sediment control include:-

- Diverting upslope stormwater runoff away from excavations;
- Diversion of “clean” water around sediment traps, reducing total volume of water to be trapped and treated, and in turn reducing the size of the sediment control measure.

Sediment Basin

Sediment basins are used to settle soil particles as well as to retain runoff. Should it be assessed that a sediment basis is required, the selection of the basin type is influenced by the particle size distribution and the dispersion index of the materials and suitable protection may be required.

6.3 Pavements

Considering the nature of the subgrade soils, typical CBR values in the order of 2 to 5% could be expected for the clays and 5 to 8% for the clayey sands, across the site. As planning develops, sampling and testing should be undertaken to determine the actual CBR values of the soils.

Along with recommendations contained in Sections 6.1 and 6.2, the following general earthworks recommendations are made:-

i) Incorporate a perimeter drain at the pavement edges to prevent possible deterioration under wet weather.

ii) Pavements should be well drained both during and upon completion of construction. Water should not be allowed to pond on or near pavement surfaces.

iii) Pavement gravel should comply with the DOT quality specifications for sub base and base course material.

iv) Subgrades should be compacted to achieve the minimum density ratios as outlined in Section 6.2 'Earthworks'.

v) Pavement materials should be compacted to the following minimum density ratios:

Sub base	95% - AS 1289 5.2.1 (Modified)
Base	98% - AS 1289 5.2.1 (Modified)

vi) It is recommended that inspection and testing be carried out following general earthworks to confirm subgrade conditions.

vii) Concrete pavements should preferably be keyed and dowelled at transverse joints and keyed and tied at longitudinal joints.

6.4 Geotechnical Constraints

The development of the site is significant. Geotechnical constraints require addressing during both the planning stages and the construction of the estate. Issues that will require considerations will include (but not limited to):-

- Low pavement subgrade CBR values
- Excavatability of the rock in areas of even relatively shallow cuts.
- Presence of dispersive soils which will require suitable treatment (i.e. addition of gypsum and/or suitable protection during construction)
- Optimisation of reuse of cut material addressing issues such as reactivity, material particle size from the less weathered rock, etc.
- Trafficability issues during construction as a result of the vegetation stripping, etc.

These geotechnical constraints should be investigated as part of a more detailed assessment of the site.

7.0 LIMITATIONS

We have prepared this report for the use of **PIONEER FORTUNE PTY LTD**, for design purposes in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has not been prepared for use by parties other than **PIONEER FORTUNE PTY LTD**. It may not contain sufficient information for purposes of other parties or for other uses.

Your attention is drawn to 'Appendix A', 'Notes Relating to this Report'. Interpretation of factual data given in this report is based on judgement, not a greater knowledge of facts other than those reported.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes, the method of drilling, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes. Subsurface conditions between boreholes may vary significantly from conditions encountered at the borehole locations.

In the event that conditions encountered on site during construction appear to vary from those expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are more readily resolved when conditions are exposed than at some later stage, after the event.

Soil Surveys Engineering consider that a documentation review service (during the design phase and prior to construction) to verify that the intent of geotechnical recommendations is properly reflected in the design, along with construction inspections, forms a very important component of the geotechnical engineering design service/process.

This statement is not intended to reduce the level of responsibility accepted by Soil Surveys Engineering in accordance with our commission, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in doing so and the risks they accept should they decline to have Soil Surveys Engineering carry out a geotechnical documentation review and geotechnical construction inspections.

The geotechnical review ensures geotechnical risks to our Client and their project are minimised at the design and tender stage of the project. Further, with Soil Surveys Engineering being commissioned to carry out geotechnical construction inspections, an opportunity becomes available at the time of construction to confirm any assumptions made in the preparation of the report and allow the effect of any normally occurring variation in ground conditions to be assessed with respect to construction.

P. ELKINGTON (RPEQ 7226)

For and on behalf of
SOIL SURVEYS ENGINEERING PTY LIMITED

APPENDICES

APPENDIX A

NOTES RELATING TO THIS REPORT

INTRODUCTION

These notes are provided by Soil Surveys Engineering Pty Limited (the Company) to complement the geotechnical report in regard to classification methods and field procedures. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited information about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such information obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and at the time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

Soils - The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726-1993 (Geotechnical Site Investigations), where appropriate. In general, descriptions cover the following properties - soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the dominant particle size and behaviour as set out in AS 1726-1993.

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, shear vane, laboratory testing or engineering examination. The strength terms are defined in AS1726-1993 Table A4.

Non-cohesive soils are classified on the basis of relative density usually based on insitu testing or engineering examination (see AS1726-1993 Table A5).

Rocks - Rock types are classified by their geological names (AS1726-1993 Table A6), together with descriptive terms regarding weathering (AS1726-1993 Table A9), strength (refer Table 1 below), defects (AS1726-1993 Table A10), etc. Where strength testing (ie Point Loads) is carried out, AS1726-1993 Table A8 is used. Where relevant, further information regarding rock classification is attached.

Table 1 Estimated strength descriptions given to rock based on engineering examination

Strength Term	Approximate Qu (MPa)
Extremely Weak	< 1.0
Very Weak	1.0 - 5.0
Weak	5.0 - 25
Medium Strong	25 - 50
Strong	50 - 100
Very Strong	100 - 250
Extremely Strong	> 250

Ref ISRM "Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses"

SAMPLING

Sampling is carried out during drilling or from other excavations to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon sample disturbance, (information on strength and structure).

Undisturbed samples are taken by pushing a thin walled sample tube, usually 50mm diameter (U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength, volume change potential and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

TEST LOCATIONS

Test locations (e.g. boreholes, CPT's, test pits etc.) were based on available access at the time of testing (access may need to be provided "by others"). Test locations may have been shifted if access was not suitable.

Unless noted otherwise, accuracy of test locations are to the accuracy of hand held GPS equipment.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application.

Test Pits - These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling - A borehole of 50 to 100mm diameter is advanced by manually operated equipment. Refusal of the augers can occur on a variety of materials such as hard clay, gravel or rock fragments and does not necessarily indicate rock level.

Continuous Spiral Flight Augers - The borehole is advanced using 75 to 300 mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the augers. Information from the drilling (as distinct from specific sampling) is of relatively lower reliability due to remoulding, inclusion of cuttings from above or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table has a lower reliability than augering above the water table. Various drill bits are attached to the base of the augers during the drilling. The depth of refusal of the different bit types can provide information as to the strength of the material encountered. Generally two different bit types are used. The 'V' bit is a V shaped steel bit and the 'TC' bit is a tungsten carbide tipped screw type bit.

Wash Boring - The borehole is usually advanced by a rotary bit with water or fluid pumped down the hollow drill rods and returned up in the space between the rods and the soil or casing, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration. More accurate information on soil strata is gained by regular testing and sampling using the Standard Penetration Test (SPT) and undisturbed thin walled tube samples (U50).

Mud Stabilized Drilling - Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilize the borehole. The term "mud" encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from regular intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling - A continuous core sample is obtained using a diamond or tungsten carbide tipped core barrel. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable method of investigation. In rocks, NMLC coring (nominal 52 mm diameter) is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses is determined on site by the supervisor. If the location of the loss is uncertain, it is placed at the top end of the run, when the core is placed in a storage tray and recorded on the log.

Standard Penetration Tests - Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" - Test 6.3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm, the upper 150 mm being neglected due to possible disturbance from the drilling method. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued at a reduced penetration.

In the case where full penetration is obtained with successive blow counts for each 150 mm of, say 4, 6 and 7 blows, the record shows,

4, 6, 7 N = 13

In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm, the record shows:

15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, it is noted on the borehole logs.

A modification to the SPT test is where the same driving system is used with a solid 60^0 tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid SPT are shown as "N_c" on the borehole logs, together with the number of blows per 150 mm penetration.

Cone Penetration Tests - Test Method - Cone Penetration Tests (CPT) are carried out in accordance with AS 1289 Test 6.5.1-1977, using an electrical friction-cone penetrometer.

The test essentially comprises the measurement of resistance to penetration of a cone of 35.7 mm diameter pushed into the soil at a rate of 10-20 mm per second by hydraulic force. The resistance to penetration is recorded in terms of pressure on the end area of the cone (cone resistance, q_c, in MPa) and friction on the side of the 135 mm long sleeve immediately above the top of the cone (friction resistance, f_s, in kPa). These forces are measured by electrical transducers (strain gauges) within the cone device. The ratio between friction resistance and cone resistance is also calculated as a percentage, ie.-

$$Friction\ Ratio\ (FR) = \frac{Friction\ Resistance, f_s\ (kPa) \times 100}{cone\ resistance,\ q_c\ (kPa)}$$

The friction ratio, FR, is generally low in sands (less than 1% or 2%) and generally higher in clays (say 3% or more). The interpretation of sandy clays, clayey sands and material with a high silt content is more difficult, but intermediate values (between 1% and 3%) would be expected. Highly organic clays and peats generally have a friction ratio in excess of 5%.

Static cone data is recorded in the field on disc for later presentation using computer aided drafting.

The equipment can be operated from any conventional drill rig. A total applied load in the range of 4 to 10 tonnes is required for practical purposes, although lighter loads may be used. The cone penetrometers are available with various capacities of cone resistance ranging up to 100 MPa for general purpose investigations, while a range of 0 to 10 MPa can be used where more sensitive investigations of soft clay are required.

The cone resistance value provides a continuous measure of soil strength or density, and together with the friction ratio, provide very useful indications of the presence of narrow bands of geotechnically significant layers such as thin, soft clay layers or lenses of sand which might otherwise be missed using conventional drilling methods.

The lithology of the encountered soils is interpreted from static cone data and is generally presented on the static cone log sheets.

It is important to note that the lithology is interpreted information and is based on research by Schmertmann (1970), Sanglerat (1972), Robinson and Campinalli (1986), modified to suit local conditions as indicated by borehole information and laboratory testing.

As soils generally change gradually it is sometimes difficult to accurately describe depths of strata changes, although greater accuracy is obtained with the static cone compared with conventional drilling. In addition, friction ratios decrease in accuracy with low cone resistance values, and in desiccated soils. As a result, some overlap and minor discrepancies may

exist between static cone and nearby borehole information.

Portable Dynamic Cone Penetrometers - Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 100mm increments of penetration.

The DCP comprises a Cone of 20 mm diameter with 30 degree taper attached to steel rods of smaller section.

The cone end is driven with a 9 kg hammer falling 510 mm (AS. 1289 Test 6.3.2). The test was developed initially for pavement subgrade investigations, and empirical correlations of the test results with California Bearing Ratio have been published by various Road Authorities. The Company has developed their own correlations with Standard Penetration tests and Density Index tests in sands.

LOGS

The borehole or test pit logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems.

- Although groundwater may be present in lower permeability soils, it may enter the hole slowly or perhaps not at all during the time the hole is open.
- A localized perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be bailed out of the bore and mud must be washed out of the hole or "reverted" if water observations are to be made.

More reliable measurements can be made by use of standpipes which are read after stabilizing at periods ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc.) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is important to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms and the attached explanatory notes summarize important aspects of the Laboratory Test Procedures adopted.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. The information provided in Soil Surveys Engineering reports is opinion and interpretation and not factual. The client/contractor increases their risk by not retaining the person who authored the geotechnical report, to carry out site inspection and review (overseeing role) during construction, to confirm opinion and interpretation expressed in the report is accurate. Where the report has been prepared for a specific design proposal the information and interpretation may not be relevant if the design proposal is changed. If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects and recommendations or suggestions for design and construction. Since the test sites in any exploration represent a very small proportion of the total site and since the exploration only identifies actual ground conditions at the test sites, even under the best circumstances actual conditions may vary from those inferred to exist. No responsibility is taken for:-

- Unexpected variations in ground and/or groundwater conditions.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of other persons.
- Any work where the company is not given the opportunity to supervise the construction using the Companies designs/recommendations.

If differences occur, the Company will be pleased to assist with investigation or advice to resolve any problems occurring.

SITE ANOMALIES

In the event that conditions encountered on site during construction appear to vary from those expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are more readily resolved when conditions are exposed than at some later stage, well after the event.

Extreme events including but not limited to the results of climate change, eg. flood levels above previously identified levels, beach scour or erosion beyond normal expectations (as identified by local authorities) extreme rainfall events, war, espionage, sabotage may result in different conditions between time of investigation and time of construction.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document “Guidelines for the Provision of Geotechnical Information in Construction Contracts (1987)”, published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances, where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer. We would be happy to assist in this regard as an extension of our investigation commission. Construction drawings should be reviewed by Soil Surveys Engineering, with sufficient time to allow changes if required, prior to inspections.

Otherwise Soil Surveys Engineering reserves the right to refuse to carry out inspections.

SITE INSPECTION

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

i) Site visits during construction to confirm reported ground conditions

ii) Site visits to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, the stability of a filled or excavated slope; or

iii) Full-time engineering presence on site.

In the vast majority of cases it is advantageous to the principal for the geotechnical engineer who wrote the investigation report to be involved in the construction stage of the project.

The geotechnical engineer cannot take responsibility for variations in encountered conditions, where he is not given the opportunity to review plans for the proposed development with sufficient time to allow review and make changes to the proposed development if required, and where he is not given the opportunity to inspect the site and oversee construction methods with regard to site conditions with sufficient time to observe all relevant site conditions and operations.

RESPONSIBLE USE OF GEOTECHNICAL INFORMATION

Recommendations in our report are for design purposes only and provided on the basis that inspections are carried out to allow finalisation of opinions and recommendations contained in our report.

The geotechnical investigation consisting of field and laboratory testing has been carried out to indicate typical conditions by indicating conditions and parameters at the specific locations of boreholes/test pits. Subsurface conditions are indicated at these locations only and the inference of conditions between or away from these locations (interpolation and extrapolation) involves a certain degree of risk. Persons inferring such conditions or carrying out such inferences should do so with a degree of caution and conservatism which is commensurate with the consequences of the risk of error.

Estimates of volumes based on our findings require interpolation and extrapolation between test locations and as such may be significantly different from actual volumes.

APPENDIX B

BOREHOLE RECORD SHEETS

Soil Surveys Engineering Pty. Limited
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Gold Coast: ph +61 7 5500 0465 goldcoast@soilsurveys.com.au

BOREHOLE RECORD SHEET

Location Number: BH 01

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 26/05/2016

Easting: 492653 Northing: 6924490 RL:
Logger: TTE Operator: TTE Machine: Jacro 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		NATURAL Silty Clayey SAND (SC) Medium dense, fine to medium grained, grey, low plasticity fines, organics throughout, moist.		
			CLAY (CH) Hard, high plasticity, grey, trace of fine to medium grained sand, moist.		U50 PP=>600
	0.5				
	0.80		Sandy CLAY (CI-CH) Hard, medium to high plasticity, grey, fine to medium grained sand, moist.		
	1.0				
	1.5				
	1.70		SANDSTONE (XW) Extremely weathered, weak, light grey, moist.		
	1.90				
	1.95		SANDSTONE (DW) Distinctly weathered, medium strong, light grey, moist.		
	2.0		BOREHOLE BH 01 TERMINATED AT 1.95 m		
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.7m.
3) Maximum 'TC' bit at 1.95m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 02

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 26/05/2016

Easting: 492294 Northing: 6923447 RL:
Logger: TTE Operator: TTE Machine: Jacro 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.05		NATURAL Silty Clayey SAND (SC) Medium dense, fine to medium grained, grey, low plasticity fines, organics throughout, moist.		
			Silty CLAY (CH) Hard, high plasticity, mottled red brown and grey, trace of fine grained sand, moist.		U50 PP=>600
	0.80		Silty CLAY (CH) Hard, high plasticity, mottled orange brown and grey, trace of fine grained sand, moist.		
	1.30		SANDSTONE (XW) Extremely weathered, weak, mottled light grey and yellow brown, moist.		
	1.90 1.95		SANDSTONE (DW) Distinctly weathered, medium strong, mottled light grey and yellow brown, moist.		
			BOREHOLE BH 02 TERMINATED AT 1.95 m		

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.9m.
3) Maximum 'TC' bit at 1.95m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 03

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 26/05/2016

Easting: 491983 Northing: 6923458 RL:
Logger: TTE Operator: TTE Machine: Jacro 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		NATURAL Silty SAND (SM) Medium dense, fine to medium grained, grey, organics throughout, moist.		
	0.25		Silty SAND (SM) Medium dense, fine to medium grained, grey, moist.		
	0.5		Sandy CLAY (CI-CH) Hard, medium to high plasticity, orange brown, fine to medium grained sand, moist.		
	0.80		SANDSTONE (XW) Extremely weathered, weak, mottled yellow brown and light grey, moist.		
	1.0				
	1.20				
	1.25		SANDSTONE (DW) Distinctly weathered, medium strong, light grey, moist.		
			BOREHOLE BH 03 TERMINATED AT 1.25 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.8m.
3) Maximum 'TC' bit at 1.25m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 04

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 30/05/2016

Easting: 492529 Northing: 6922326 RL:
Logger: TTE Operator: TTE Machine: Jacro 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.07		NATURAL Clayey SAND (SC) Medium dense, fine to medium grained, light brown, low plasticity fines, with fine to medium sized gravel, organics throughout, moist.		
	0.5		CLAY (CH) Hard, high plasticity, orange brown, trace of fine grained sand, moist.		D
	0.90				
	1.0		SANDSTONE (DW) Distinctly weathered, medium strong, mottled light grey and yellow brown, moist.		
	1.30		BOREHOLE BH 04 TERMINATED AT 1.30 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.9m.
3) Maximum 'TC' bit at 1.3m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 05

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 30/05/2016

Easting: 492169 Northing: 6922746 RL:
Logger: TTE Operator: TTE Machine: Jacro 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.05		NATURAL SAND (SC) Very loose, fine to medium grained, light brown, moist.		
	0.30		SANDSTONE (DW) Distinctly weathered, medium strong, light grey, moist.		
			BOREHOLE BH 05 TERMINATED AT 0.30 m		

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.1m.
3) Maximum 'TC' bit at 0.3m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 06

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 30/05/2016

Easting: 491115 Northing: 6924148 RL:
Logger: TTE Operator: TTE Machine: Jacro 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.05		NATURAL SAND (SP) Very loose, fine to medium grained, light brown, organics throughout, moist.		
	0.25		SAND (SP) Very loose, fine to medium grained, light brown, moist.		
	0.5		Sandy CLAY (CI) Hard, medium plasticity, red brown, fine to medium grained sand, moist.		
	0.90				
	1.0		SANDSTONE (DW) Distinctly weathered, medium strong, light grey, moist.		
	1.15		BOREHOLE BH 06 TERMINATED AT 1.15 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.9m.
3) Maximum 'TC' bit at 1.15m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 07

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 30/05/2016

Easting: 490670 Northing: 6922284 RL:
Logger: TTE Operator: TTE Machine: Jacro 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.08		NATURAL Silty Sandy CLAY (CL) Hard, low plasticity, light brown, fine to medium grained sand, organics throughout, moist.		
	0.5		CLAY (CH) Hard, high plasticity, grey, trace of fine grained sand, moist.		
	0.80		SANDSTONE (XW) Extremely weathered, weak, mottled yellow brown and light grey, moist.		
	1.0				
	1.10		SANDSTONE (DW) Distinctly weathered, medium strong, mottled yellow brown and light grey, moist.		
	1.25		BOREHOLE BH 07 TERMINATED AT 1.25 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.8m.
3) Maximum 'TC' bit at 1.25m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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TEST PIT RECORD SHEET

Location Number: TP 01

Project Number: 116-18467

Project Name: Proposed Residential Community

Location: Wyatt Road, Undullah

Client: Pioneer Fortune Pty Ltd

Date: 25/05/2016

Easting: 492937 Northing: 6921302 RL:

Logger: TE Operator: TE Machine: 3t Excavator

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.20		NATURAL Sandy CLAY (CL-CI) Hard, low to medium plasticity. mottled light brown and light grey, fine to medium grained sand, traces of root fibres and organics, moist.		D
	0.5		Clayey SAND (SC) Dense, fine to medium grained, light brown, low plasticity fines, with silt, moist. (Tending to Sandstone)		D
	0.70		SANDSTONE (XW) Extremely weathered, extremely weak, mottled light brown and light grey, moist.		
	0.90				
	1.0	1.00	SANDSTONE (DW) Distinctly weathered, medium strong, mottled light brown and light grey, moist.		
			TEST PIT TP 01 TERMINATED AT 1.00 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.4m.
3) Excavator refusal at 1.0m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

Test Pit 1

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TEST PIT RECORD SHEET

Location Number: TP 02

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 25/05/2016

Easting: 492501 Northing: 6921818 RL:
Logger: TE Operator: TE Machine: 3t Excavator

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.15		NATURAL Silty SAND (SM) Medium dense, fine to medium grained, light brown, trace of root fibres, moist.		
	0.5		Silty CLAY (CH) Hard, high plasticity, mottled orange brown, trace of sand, moist.		D
	0.50		Silty CLAY (CH) Hard, high plasticity, brown, trace of sand, moist.		
	1.0				
	1.00		Silty CLAY (CH) Very stiff to hard, high plasticity, mottled light grey and light brown, trace of sand, moist.		D
	1.40				
	1.5		SANDSTONE (XW) Extremely weathered, extremely weak, light brown, moist.		
	1.70				
	1.90		SANDSTONE (DW) Distinctly weathered, medium strong, light brown, moist.		D
	2.0		TEST PIT TP 02 TERMINATED AT 1.90 m		
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 1.4m.
3) Excavator refusal at 1.9m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

Test Pit 2

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TEST PIT RECORD SHEET

Location Number: TP 03

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 25/05/2016

Easting: 491979 Northing: 6922241 RL:
Logger: TE Operator: TE Machine: 3t Excavator

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.15		NATURAL Sandy CLAY (CI) Hard, medium plasticity, mottled orange brown, fine to medium grained sand, moist.		D
	0.25		SANDSTONE (DW) Distinctly weathered, medium strong, light brown, moist.		
			TEST PIT TP 03 TERMINATED AT 0.25 m		

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.2m.
3) Excavator refusal at 0.25m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

Test Pit 3

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TEST PIT RECORD SHEET

Location Number: TP 04

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 25/05/2016

Easting: 491624 Northing: 6921452 RL:
Logger: TE Operator: TE Machine: 3t Excavator

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		NATURAL Silty SAND (SM) Medium dense, fine to medium grained, light brown, traces of root fibres and organics, moist.		D
	0.35		Clayey Silty SAND (SM) Medium dense to dense, fine to medium grained, light brown, low plasticity fines, moist.		
	0.5		Sandy CLAY (CI) Hard, medium plasticity, mottled orange brown, fine to medium grained sand, moist.		D
	0.80				
	1.0	1.00	Sandy CLAY (CI) Hard, medium plasticity, mottled orange brown, fine to medium grained sand, moist. (Tending to weathered rock)		
			TEST PIT TP 04 TERMINATED AT 1.00 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.8m.
3) Excavator refusal at 1.0m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

Test Pit 4

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TEST PIT RECORD SHEET

Location Number: TP 05

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 26/05/2016

Easting: 493243 Northing: 6924413 RL:
Logger: TE Operator: TE Machine: 3t Excavator

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		NATURAL Silty SAND (SM) Medium dense, fine to medium grained, light brown, traces of root fibres and organics, moist.		
			Sandy CLAY (CI) Hard, medium plasticity, mottled orange brown, fine to medium grained sand, moist.		D
	0.45				
	0.5		SANDSTONE (XW) Extremely weathered, extremely weak, light brown, moist.		D
	0.60				
	0.65		SANDSTONE (DW) Distinctly weathered, medium strong, light brown, moist.		
			TEST PIT TP 05 TERMINATED AT 0.65 m		
	1.0				
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.4m.
3) Excavator refusal met at 0.65m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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TEST PIT RECORD SHEET

Location Number: TP 06

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 26/05/2016

Easting: 493018 Northing: 6924204 RL:
Logger: TE Operator: TE Machine: 3t Excavator

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		NATURAL Sandy CLAY (CI) Hard, medium plasticity, light brown, fine to medium grained sand, moist.		
	0.45		SANDSTONE (XW) Extremely weathered, extremely weak, light brown, moist.		D
	0.5		SANDSTONE (DW) Distinctly weathered, medium strong, light brown, moist.		
	0.55		TEST PIT TP 06 TERMINATED AT 0.55 m		
	1.0				
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.1m.
3) Excavator refusal at 0.55m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

Test Pit 6

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TEST PIT RECORD SHEET

Location Number: TP 07

Project Number: 116-18467

Project Name: Proposed Residential Community

Location: Wyatt Road, Undullah

Client: Pioneer Fortune Pty Ltd

Easting: 492874 Northing: 6924307 RL:

Logger: TE Operator: TE Machine: 3t Excavator

Date: 26/05/2016

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		NATURAL Silty SAND (SM) Loose, fine to medium grained, brown, traces of root fibres and organics, moist.		
	0.30		Sandy CLAY (CI) Hard, medium plasticity, light brown, fine to medium grained sand, with silt, moist.		
	0.5		Silty CLAY (CH) Hard, high plasticity, mottled orange brown, with fine to medium grained sand, moist		D
	1.0				D
	1.25				
	1.5		SANDSTONE (XW) Extremely weathered, extremely weak, light brown, moist.		
	1.50		TEST PIT TP 07 TERMINATED AT 1.50 m		
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 1.2m.
3) Excavator refusal at 1.5m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

Test Pit 7

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TEST PIT RECORD SHEET

Location Number: TP 08

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 26/05/2016

Easting: 492690 Northing: 6924508 RL:
Logger: TE Operator: TE Machine: 3t Excavator

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		NATURAL Silty SAND (SM) Loose, fine to medium grained, brown, traces of root fibres and organics, moist.		
	0.20		Sandy CLAY (CI) Hard, medium plasticity, light brown, fine to medium grained sand, with silt, moist.		D
	0.5		Silty CLAY (CH) Hard, high plasticity, mottled orange brown, with fine to medium grained sand, moist		
	0.60		Sandy CLAY (CI) Hard, medium plasticity, light brown, fine to medium grained sand, moist.		D
	0.90				
	1.0		SANDSTONE (XW) Extremely weathered, extremely weak, light brown, moist.		
	1.10		TEST PIT TP 08 TERMINATED AT 1.10 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.9m.
3) Excavator refusal at 1.1m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

Test Pit 8

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TEST PIT RECORD SHEET

Location Number: TP 09

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 26/05/2016

Easting: 492909 Northing: 6924041 RL:
Logger: TE Operator: TE Machine: 3t Excavator

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.15		NATURAL Clayey SAND (SC) Medium dense, fine to medium grained, brown, low plasticity fines, traces of silt and root fibres and organics, moist.		
	0.30		Sandy CLAY (CI) Hard, medium plasticity, light brown, fine to medium grained sand, moist.		
	0.5		SANDSTONE (XW) Extremely weathered, extremely weak, light brown mottled red brown, moist.		D
	0.70				
	0.80		SANDSTONE (DW) Distinctly weathered, medium strong, light brown mottled red brown, moist.		
	1.0		TEST PIT TP 09 TERMINATED AT 0.80 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater not encountered.
2) DCP refusal met at 0.3m.
3) Excavator refusal at 0.8m.

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

Test Pit 9

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TEST PIT RECORD SHEET

Location Number: TP 10

Project Number: 116-18467
Project Name: Proposed Residential Community
Location: Wyatt Road, Undullah
Client: Pioneer Fortune Pty Ltd
Date: 27/05/2016

Easting: Northing: RL:
Logger: PE Operator: CS Machine: 3t Excavator

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.30		NATURAL Clayey SAND (SC) Loose, fine to medium grained, brown mottled yellow brown, moist.		
	0.5		Clayey SAND (SC) Very loose, fine to medium grained, brown mottled yellow brown, wet.		
	▽ 0.80		Gravelly SAND (SW) Medium dense, fine to coarse grained, grey, fine sized rounded gravel, wet.		
	1.0				
	1.5 1.50		TEST PIT TP 10 TERMINATED AT 1.50 m		
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1) Groundwater encountered at 0.8m.
2) Test Pit collapse at 1.5m.

▽ Water First Noted ▼ Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
DW - Distinctly weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
VS - Very strong
ES - Extremely strong

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

APPENDIX C

LABORATORY TEST CERTIFICATES

Helensvale Lab
Gold Coast
Unit 8, 140 Millaroo Drive
Helensvale QLD 4212
Australia
Ph:+61 7 5502 6795
Fax:+61 7 5502 6724

SOIL SURVEYS

Material Test Report

Report No: MAT:WHL16-0778-S11
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

Sample Details

Sample ID:	WHL16-0778-S11
Field Sample ID:	
Date Sampled:	26/05/2016
Source:	Test Pit
Material:	Unknown
Specification:	Grading
Sampling Method:	As Supplied
Soil Description:	
Sampled By:	SSE
Location Description:	TP 8 0.2-0.5m

Other Test Results

Description	Method	Result	Limits
Emerson Class Number [AS 1289.3.8.1]			
Emerson Class Number		Class 1	
Soil Description		SILTY SANDY CLAY(CH) GREY	
Type of Water		DISTILLED	
Temperature of Water (°C)		22.0	
Date Tested		31/05/2016	
pH and Conductivity			
Conductivity (mS/cm)		0.30	
pH		7.15	
Date Tested		31/05/2016	

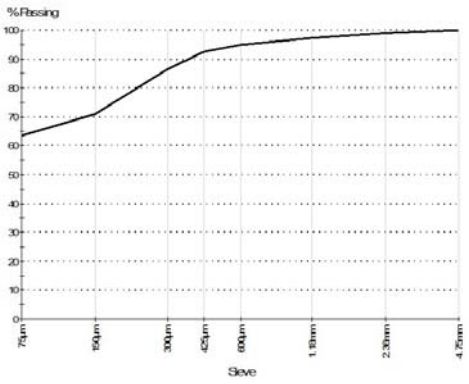
Particle Size Distribution

Method: Grading [AS 1289.3.6.1]

Date Tested: 31/05/2016
Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	
2.36mm	99	
1.18mm	97	
600µm	95	
425µm	93	
300µm	87	
150µm	71	
75µm	63	

Chart



Comments

N/A

Helensvale Lab
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SOIL SURVEYS

Material Test Report

Report No: MAT:WHL16-0778-S10
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

Sample Details

Sample ID:	WHL16-0778-S10
Field Sample ID:	
Date Sampled:	26/05/2016
Source:	Test Pit
Material:	Unknown
Specification:	
Sampling Method:	As Supplied
Soil Description:	
Sampled By:	SSE
Location Description:	TP 7 1.0-1.2m

Test Results

Description	Method	Result	Limits
Atterberg Limits Casagrande [AS 1289.3.1.2, AS 1289.3.2.1, AS 1289.3.3.1, AS 1289.3.4.1]			
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	12.5	
Mould Length (mm)		125.3	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	42	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	14	
Plasticity Index (%)	AS 1289.3.3.1	28	
Date Tested		30/05/2016	

Comments

N/A

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SOIL SURVEYS

Material Test Report

Report No: MAT:WHL16-0778-S9
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

Sample Details

Sample ID:	WHL16-0778-S9
Field Sample ID:	
Date Sampled:	26/05/2016
Source:	Test Pit
Material:	Unknown
Specification:	Grading
Sampling Method:	As Supplied
Soil Description:	
Sampled By:	SSE
Location Description:	TP 7 0.3-0.5m

Other Test Results

Description	Method	Result	Limits
Emerson Class Number [AS 1289.3.8.1]			
Emerson Class Number		Class 1	
Soil Description		SILTY SANDY CLAY(CH) GREY BROWN	
Type of Water		DISTILLED	
Temperature of Water (°C)		22.0	
Date Tested		31/05/2016	
pH and Conductivity			
Conductivity (mS/cm)		0.31	
pH		6.53	
Date Tested		31/05/2016	

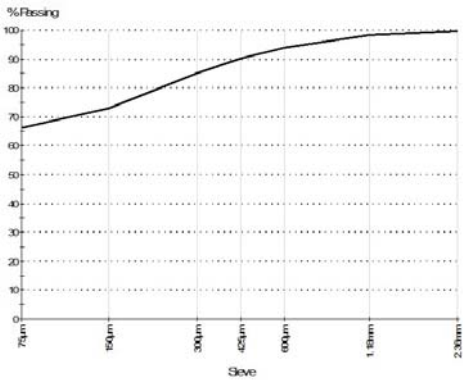
Particle Size Distribution

Method: Grading [AS 1289.3.6.1]

Date Tested: 31/05/2016
Note: Sample Washed

Sieve Size	% Passing	Limits
2.36mm	100	
1.18mm	98	
600µm	94	
425µm	90	
300µm	85	
150µm	73	
75µm	66	

Chart



Comments

N/A

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SOIL SURVEYS

Material Test Report

Report No: MAT:WHL16-0778-S8
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

Sample Details

Sample ID: WHL16-0778-S8
Field Sample ID:
Date Sampled: 26/05/2016
Source: Test Pit
Material: Unknown
Specification:
Sampling Method: As Supplied
Soil Description:
Sampled By: SSE
Location Description: TP 5
0.1-0.45m

Test Results

Description	Method	Result	Limits
Emerson Class Number [AS 1289.3.8.1]			
Emerson Class Number		Class 2	
Soil Description		SILTY SANDY CLAY(CH) GREY BROWN MOTTLE	
Type of Water		DISTILLED	
Temperature of Water (°C)		22.0	
Date Tested		31/05/2016	
pH and Conductivity			
Conductivity (mS/cm)		0.16	
pH		6.13	
Date Tested		31/05/2016	

Comments

N/A

Helensvale Lab
Gold Coast
Unit 8, 140 Millaroo Drive
Helensvale QLD 4212
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SOIL SURVEYS

Material Test Report

Report No: MAT:WHL16-0778-S7
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

Sample Details

Sample ID:	WHL16-0778-S7
Field Sample ID:	
Date Sampled:	25/05/2016
Source:	Test Pit
Material:	Unknown
Specification:	
Sampling Method:	As Supplied
Soil Description:	
Sampled By:	SSE
Location Description:	TP 4 0.5-0.7m

Test Results

Description	Method	Result	Limits
Atterberg Limits Casagrande [AS 1289.3.1.2, AS 1289.3.2.1, AS 1289.3.3.1, AS 1289.3.4.1]			
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.0	
Mould Length (mm)		125.4	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	43	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	14	
Plasticity Index (%)	AS 1289.3.3.1	29	
Date Tested		30/05/2016	

Comments

N/A

Helensvale Lab
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SOIL SURVEYS

Material Test Report

Report No: MAT:WHL16-0778-S6
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

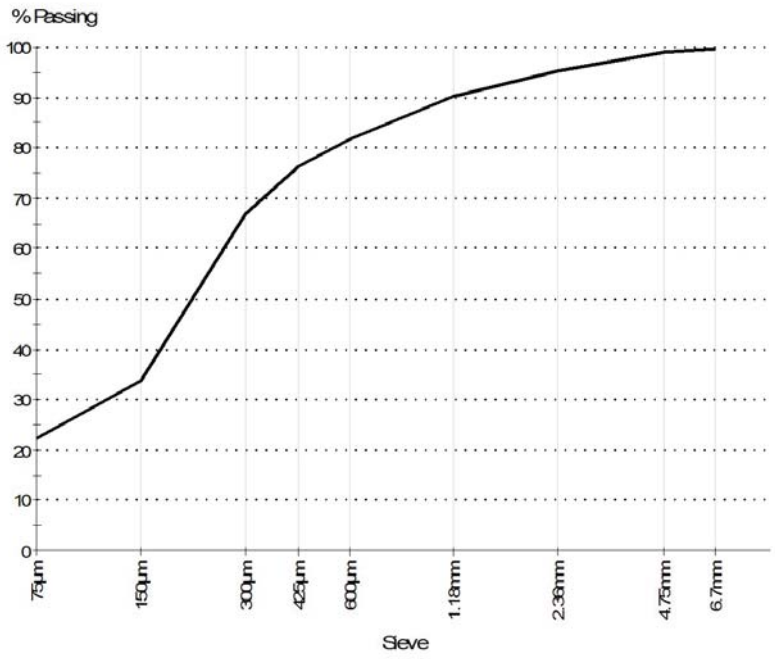
Sample Details

Sample ID:	WHL16-0778-S6
Field Sample ID:	
Date Sampled:	25/05/2016
Source:	Test Pit
Material:	Unknown
Specification:	Grading
Sampling Method:	As Supplied
Soil Description:	
Sampled By:	SSE
Location Description:	TP 4 0.1-0.35m

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution



Method: Grading [AS 1289.3.6.1]

Date Tested: 31/05/2016
Note: Sample Washed

Sieve Size	% Passing	Limits
6.7mm	100	
4.75mm	99	
2.36mm	95	
1.18mm	90	
600µm	82	
425µm	76	
300µm	67	
150µm	34	
75µm	22	

Comments

N/A

Helensvale Lab
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SOIL SURVEYS

Material Test Report

Report No: MAT:WHL16-0778-S5
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

Sample Details

Sample ID:	WHL16-0778-S5
Field Sample ID:	
Date Sampled:	25/05/2016
Source:	Test Pit
Material:	Unknown
Specification:	
Sampling Method:	As Supplied
Soil Description:	
Sampled By:	SSE
Location Description:	TP 3 0.15-0.25m

Test Results

Description	Method	Result	Limits
Atterberg Limits Casagrande [AS 1289.3.1.2, AS 1289.3.2.1, AS 1289.3.3.1, AS 1289.3.4.1]			
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	12.0	
Mould Length (mm)		125.1	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	40	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	14	
Plasticity Index (%)	AS 1289.3.3.1	26	
Date Tested		30/05/2016	
Emerson Class Number [AS 1289.3.8.1]			
Emerson Class Number		Class 3	
Soil Description		SILTY SANDY CLAY(CI) GREY BROWN	
Type of Water		DISTILLED	
Temperature of Water (°C)		22.0	
Date Tested		31/05/2016	
pH and Conductivity			
Conductivity (mS/cm)		0.12	
pH		5.54	
Date Tested		30/05/2016	

Comments

N/A

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SOIL SURVEYS

Material Test Report

Report No: MAT:WHL16-0778-S4
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

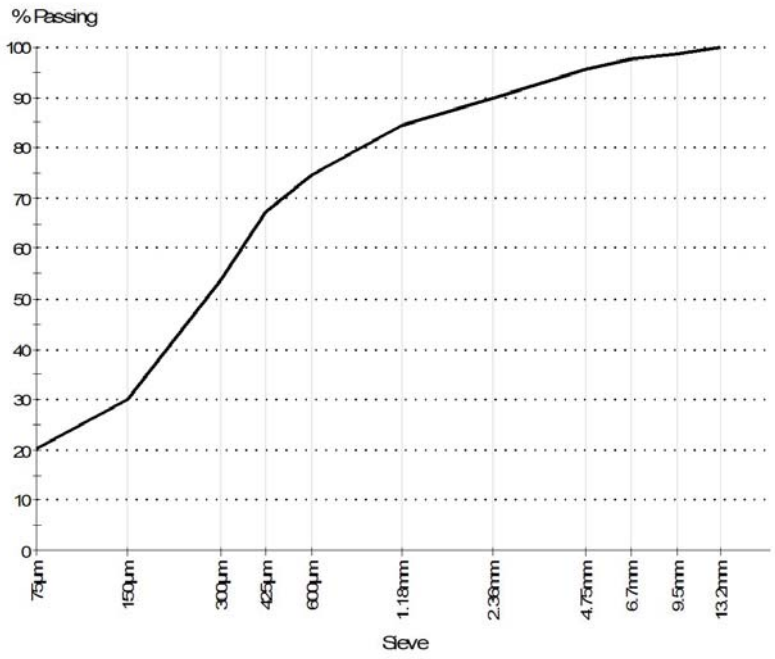
Sample Details

Sample ID:	WHL16-0778-S4
Field Sample ID:	
Date Sampled:	25/05/2016
Source:	Test Pit
Material:	Unknown
Specification:	Grading
Sampling Method:	As Supplied
Soil Description:	
Sampled By:	SSE
Location Description:	TP 1 0.3-0.6m

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution



Method: Grading [AS 1289.3.6.1]

Date Tested: 31/05/2016
Note: Sample Washed

Sieve Size	% Passing	Limits
13.2mm	100	
9.5mm	99	
6.7mm	98	
4.75mm	96	
2.36mm	90	
1.18mm	85	
600µm	75	
425µm	67	
300µm	54	
150µm	30	
75µm	20	

Comments

N/A

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SOIL SURVEYS

Material Test Report

Report No: MAT:WHL16-0778-S3
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

Sample Details

Sample ID:	WHL16-0778-S3
Field Sample ID:	
Date Sampled:	25/05/2016
Source:	Test Pit
Material:	Unknown
Specification:	
Sampling Method:	As Supplied
Soil Description:	
Sampled By:	SSE
Location Description:	TP 1 0.1-0.2m

Test Results

Description	Method	Result	Limits
Emerson Class Number [AS 1289.3.8.1]			
Emerson Class Number		Class 3	
Soil Description		SILTY SANDY CLAY(CH) GREY BROWN, ORANGE MOTTLE	
Type of Water		DISTILLED	
Temperature of Water (°C)		22.0	
Date Tested		31/05/2016	
pH and Conductivity			
Conductivity (mS/cm)		0.05	
pH		5.07	
Date Tested		31/05/2016	

Comments

N/A

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SOIL SURVEYS

Shrink Swell Index Report

Report No: SSI:WHL16-0778-S2
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

Sample Details

Sample ID:	WHL16-0778-S2	Sampling Method:	As Supplied
Field ID:	N/A	Material:	Unknown
Date Sampled:	26/05/2016	Source:	Borehole
Date Submitted:	N/A	Specification:	N/A
Project Location:	Wyatt Road, Undullah		
Sample Location:	BH 2, 0.5m		
Borehole Number:	N/A		
Borehole Depth (m):	N/A		

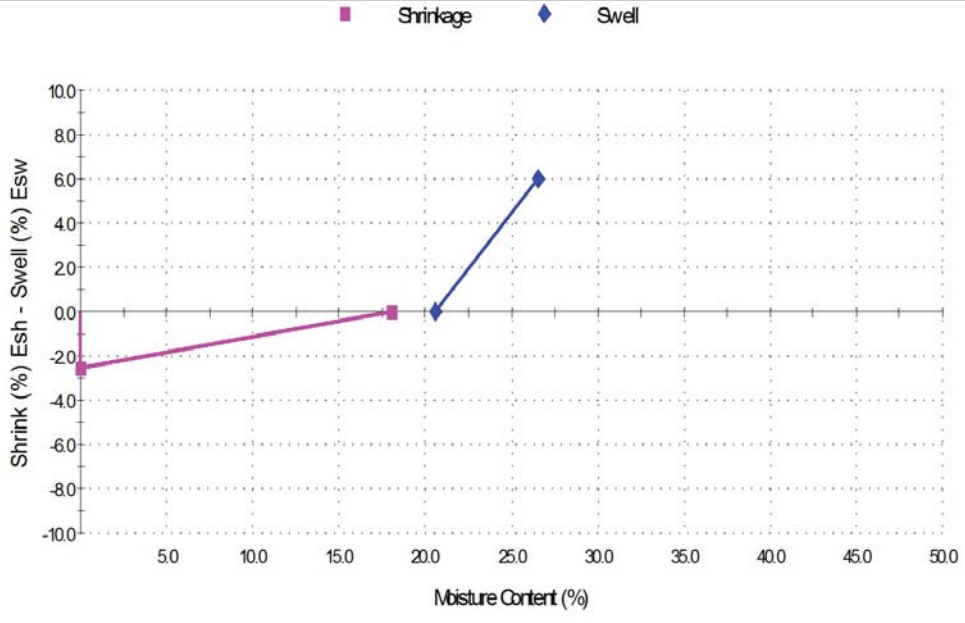
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	6.0
Moisture Content before (%):	20.6
Moisture Content after (%):	26.5
Est. Unc. Comp. Strength before (kPa):	N/A
Est. Unc. Comp. Strength after (kPa):	N/A

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	2.5
Shrinkage Moisture Content (%):	18.0
Est. inert material (%):	N/A
Crumbling during shrinkage:	N/A
Cracking during shrinkage:	N/A

Shrink Swell



Shrink Swell Index - Iss (%): 3.0

Comments

DESCRIPTION: CLAY(CH) BROWN, SOME SAND
UNIT WEIGHT: 1.98 t/m3

Helensvale Lab
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Helensvale QLD 4212
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SOIL SURVEYS

Shrink Swell Index Report

Report No: SSI:WHL16-0778-S1
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

Sample Details

Sample ID:	WHL16-0778-S1	Sampling Method:	As Supplied
Field ID:	N/A	Material:	Unknown
Date Sampled:	26/05/2016	Source:	Borehole
Date Submitted:	N/A	Specification:	N/A
Project Location:	Wyatt Road, Undullah		
Sample Location:	BH 1, 0.5m		
Borehole Number:	N/A		
Borehole Depth (m):	N/A		

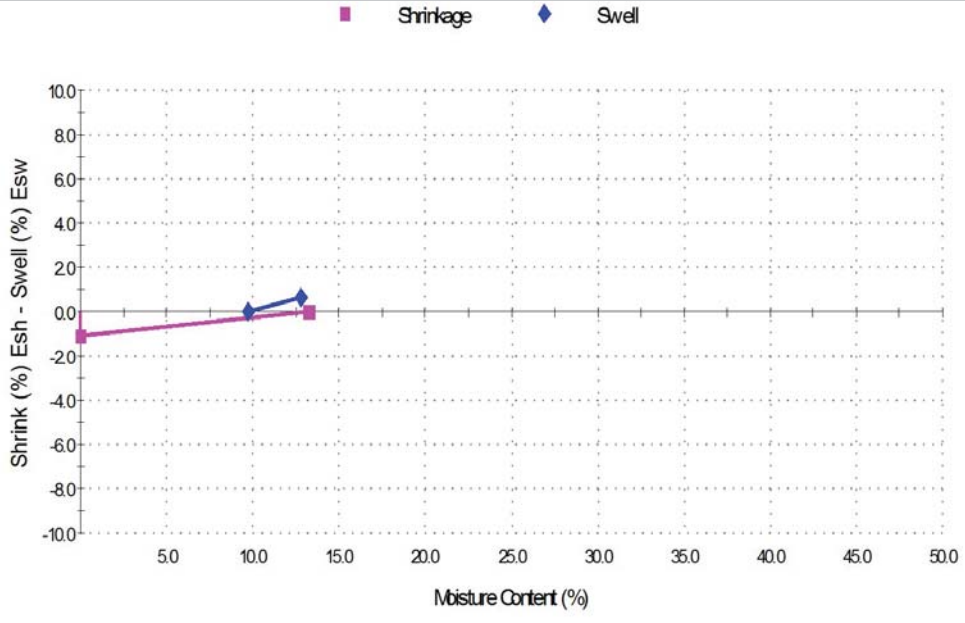
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	0.6
Moisture Content before (%):	9.7
Moisture Content after (%):	12.8
Est. Unc. Comp. Strength before (kPa):	N/A
Est. Unc. Comp. Strength after (kPa):	N/A

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	1.1
Shrinkage Moisture Content (%):	13.3
Est. inert material (%):	N/A
Crumbling during shrinkage:	N/A
Cracking during shrinkage:	N/A

Shrink Swell



Shrink Swell Index - Iss (%): 0.8

Comments

DESCRIPTION: SANDY CLAY(CI) GREY
UNIT WEIGHT: 1.94 t/m3

Helensvale Lab
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SOIL SURVEYS

Material Test Report

Report No: MAT:WHL16-0778-S12
Issue No: 1

Client: Pioneer Fortune Pty Ltd
C/O 2/19 Finchley Street
Milton QLD 4064

Project: Proposed Residential Development

Project Location: Wyatt Road, Undullah

Project Number: 1-18467

This laboratory is accredited for compliance with ISO/IEC 17025.

NATA Accredited Laboratory Number: 15301

Approved Signatory: C.Ferguson-Hannah (Senior Technician)
Date of Issue: 31/05/2016

Sample Details

Sample ID: WHL16-0778-S12
Field Sample ID:
Date Sampled: 26/05/2016
Source: Test Pit
Material: Unknown
Specification:
Sampling Method: As Supplied
Soil Description:
Sampled By: SSE
Location Description: TP 8
0.6-0.9m

Test Results

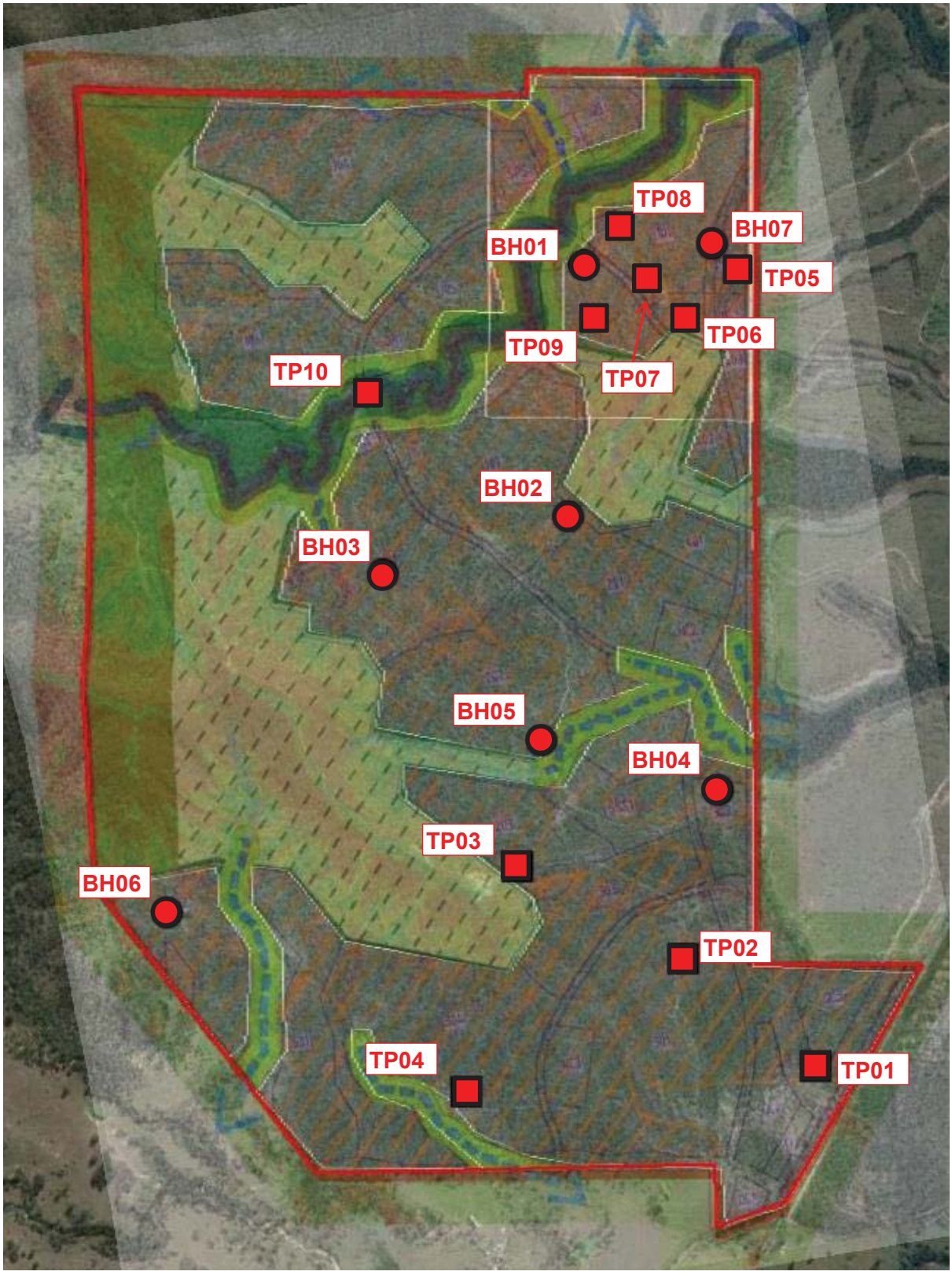
Description	Method	Result	Limits
Atterberg Limits Casagrande [AS 1289.3.1.2, AS 1289.3.2.1, AS 1289.3.3.1, AS 1289.3.4.1]			
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.5	
Mould Length (mm)		125.3	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	43	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	13	
Plasticity Index (%)	AS 1289.3.3.1	30	
Date Tested		30/05/2016	

Comments

N/A

APPENDIX D

SITE PLAN



SOIL SURVEYS ENGINEERING PTY LIMITED
A.C.N. 054 043 631
Consulting Geotechnical Engineers

Drawn AB	Project:	Proposed Residential Community	Drawing No. 116-18467-01	A4
Date May 2016	Location:	Wyatt Road, Undullah		
Checked	Client:	Pioneer Fortune Pty Ltd		