SOIL SURVEYS

GEOTECHNICAL INVESTIGATION

PROJECT NO. 1-12516

JANUARY, 2016

825 STANLEY PTY LTD

APARTMENT BUILDINGS

825 STANLEY STREET, WOOLLOONGABBA

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1.0 INTRODUCTION

This report presents the results of the geotechnical investigation carried out by Soil Surveys Engineering Pty Limited for the proposed Apartment Buildings development at 825 Stanley Street, Woolloongabba.

It is understood that the proposed development will comprise:-

- Three, twenty level towers, constructed in three stages.
- Buildings 2 and 3 will incorporate three levels of basement carparking. Earthworks will comprise excavations of up to 9.5m to form the lower basement level of RL -4.5m.
- No basement is proposed for Building 1. However, excavation to RL 3.0m is proposed at Building 1 location to create a lined detention basin (concrete base and walls) beneath ground floor; the detention basin will be located to the east of the brick drain.

Refer Figures 1, 2 and 3.

FIGURE 1 – STANLEY STREET PERSPECTIVE

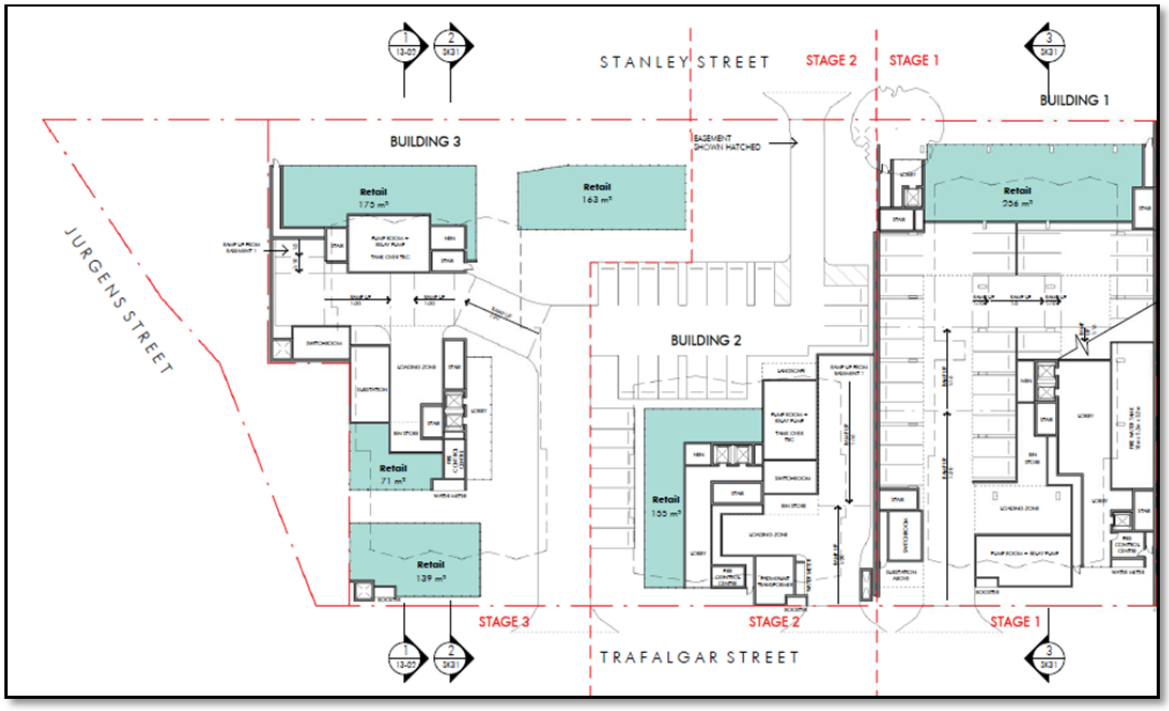


FIGURE 2 – GROUND FLOOR

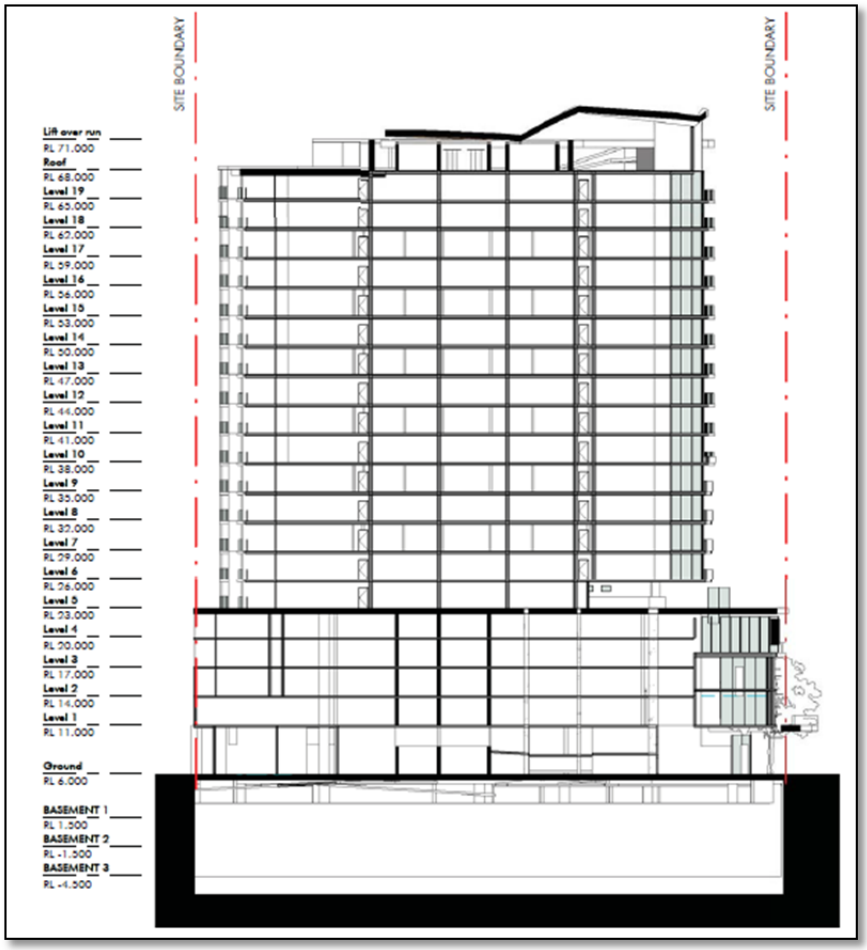


FIGURE 3 – SECTION

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 1-12516 dated 20th November, 2015:-

- Investigation of the subsurface profile by drilling, sampling and insitu testing with ten boreholes.
- Laboratory testing on selected samples to assess engineering properties of the subsurface material.
- Engineering analysis of site investigation and laboratory test results to evaluate:-
    - Trafficability
    - Excavatability
    - Construction Dewatering
    - Excavation Retention System Options
    - Retaining Wall Design Parameters
    - Building Foundations
    - Basement Slab Construction

3.0 SITE DESCRIPTION

The site of the proposed development is located at 825 Stanley Street, Woolloongabba – refer Figure 4.

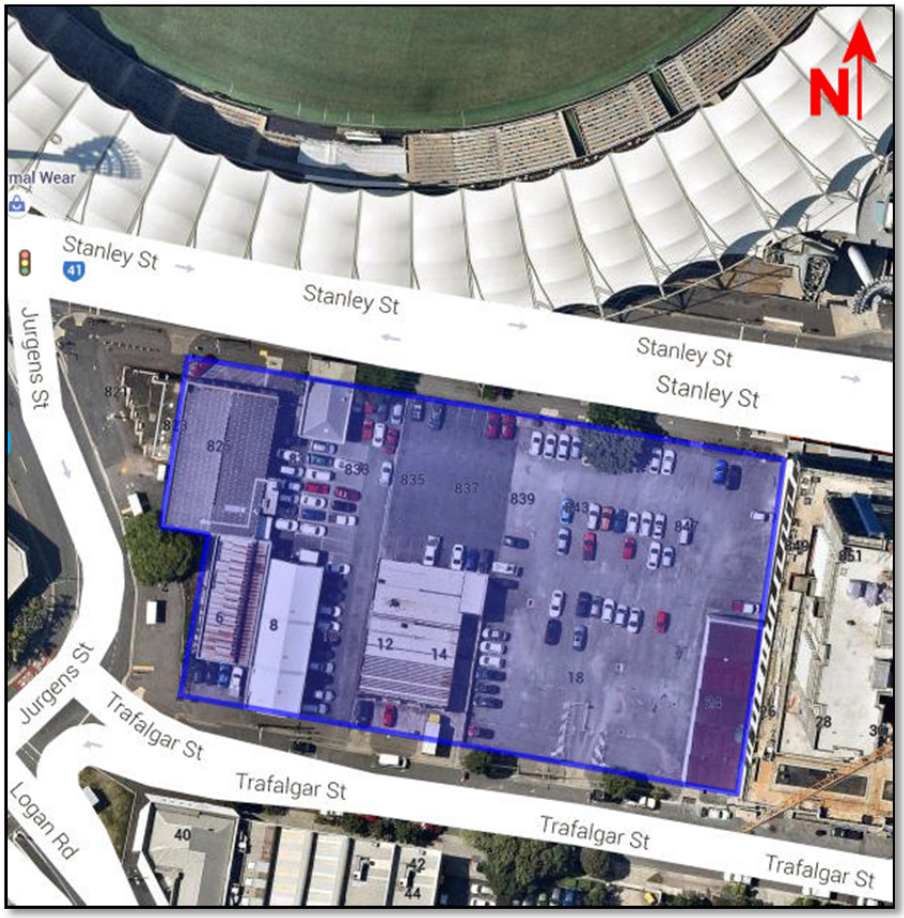


FIGURE 4 – SITE LOCATION

The site is occupied by a series of single and two level structures, along with a large open carpark area.

Ground surface levels fall north to south and west to east, with ground surface levels typically between RL 5.0m and RL 4.5m.

Drainage conditions are considered to be poor.

Numerous underground services exist on site.

Of particular note is the presence of the “brick drain” located to the east of the site within Stage 1 – refer detailed survey, Appendix D. Provided survey indicates that this brick drain runs north south, is approximately 2.8m wide, has an invert level of RL 1.07m, with top of drain recorded at levels between RL 3.83m and RL 3.38m. The brick drain will be retained as part of the proposed development.

Boundary conditions comprise:-

- Northern Boundary – Stanley Street
- Eastern Boundary – residential tower, currently under construction (refer Photographs 1 and 4).

- Southern Boundary – Trafalgar Street.
- Western Boundary – Jurgen Street, with a single storey brick veneer "BCC Building" (refer Photograph 3) located adjacent the north western corner of the development site.

Photographs 1 to 4 indicate typical site conditions. Please also refer Detailed Survey prepared by Jensen Bowers (Appendix D).

PHOTOGRAPH 1

PHOTOGRAPH 2

PHOTOGRAPH 3

PHOTOGRAPH 4

4.0 GEOTECHNICAL INVESTIGATION

4.1 Field Investigation

Subsurface conditions at the site were investigated by drilling and sampling ten boreholes to depths up to 26.77m; all boreholes extended to rock. Boreholes were drilled using both a 4WD mounted small drilling rig (EVH1750) along with a truck mounted large drilling rigs (Scout rigs), i.e.:-

- Boreholes 1 to 4 and 8 to 10 – Scout drilling rigs
- Boreholes 5 to 7 – EVH1750 drilling rig.

The soil classification descriptions, field and laboratory testing were carried out in general accordance with the following Australian Standards:-

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

A description of the investigation method, borehole records and a site plan showing investigation locations are included in the Appendices. Borehole coordinates were recorded using a hand held GPS device, with accuracy consistent with such devices.

4.2 Laboratory Testing

Laboratory testing was carried out on selected samples retrieved from the site investigation program and was directed towards assessing the strength of the rock.

The laboratory testing certificate is contained in Appendix C.

5.0 INVESTIGATION FINDINGS

5.1 Regional Geology

Reference to the Department of Mines 1:100,000 Brisbane Geological Map (Sheet 9543), 1986 (Refer Figure 5), indicates that the site is underlain by undifferentiated alluvial soils (Qa), above a basement geology comprising rocks of the Middle Triassic Period (~240 Mya), which in this area are made up of the Brisbane Tuff (Rii). This unit is understood to outcrop in a broad band from Annerley in the south through Woolloongabba and Kangaroo point to Bowen Hills in the north.

It is expected that the majority of the soil directly underlying the site is most likely to be from the older of the alluvial deposits (sand, silt, clay and gravel) and/or residual soils derived from the weathering of the underlying rock.

The typical lithologies of the Brisbane Tuff can include ignimbrite, stratified and massive rhyolitic tuff, conglomerate, sandstone and scree breccia. Structurally, the rocks commonly show clearly defined orthogonal joint sets (linear rock defects), creating a blocky rock mass.

It is understood that these volcanic rocks were formed as the product of explosive eruptions of rhyolitic magma, onto an erosional surface. The older bedrock consisted of Bunya Phyllite (DCb) which also outcrops nearby. Associated with the Tuff are sedimentary rocks (sandstones, conglomerate, shale, coal, etc.) of the Aspley Formation (Rip) which were laid down in and adjacent to rivers and lakes also during this period.

Because the volcanic and sedimentary rocks were laid down at a similar time, there is generally not a clear boundary between the units; rather they tend to be inter-bedded, particularly towards the outer edges of the Tuff flows.

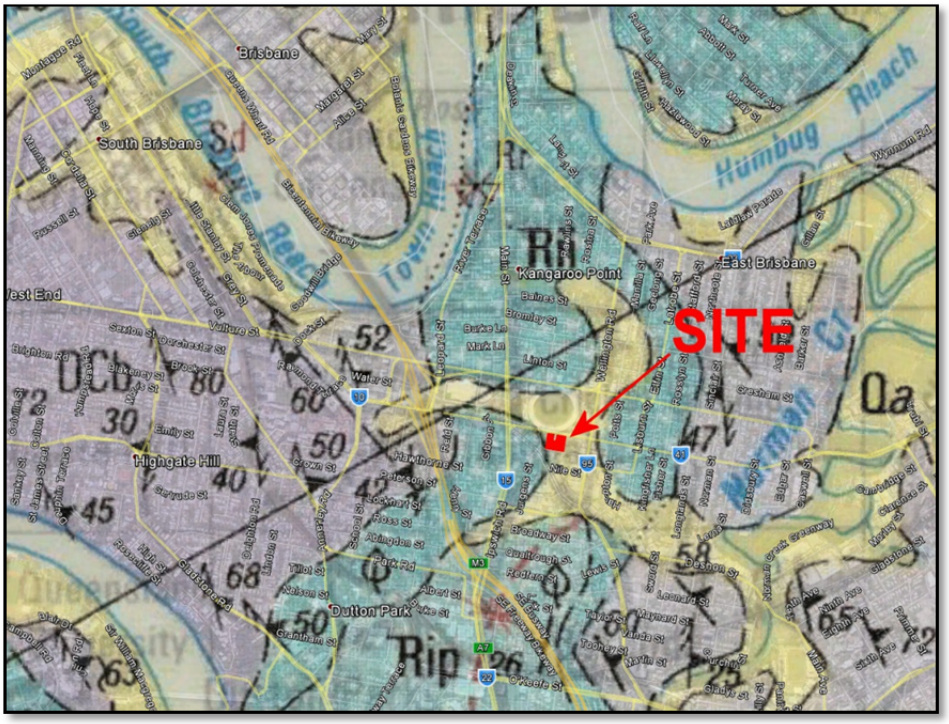


FIGURE 5 – SECTION OF REGIONAL GEOLOGY MAP ON GOOGLE EARTH

5.2 Subsurface Profile

Subsurface conditions encountered are consistent with conditions described on geological maps; subsurface conditions can be broadly grouped into three material types:-

- Fill Material
- Natural Soils
- Tuff Rock

Fill Material

Fill material was encountered at all boreholes to depths between 0.2m (BH5) and 2.6m (BH8); maximum depth of fill is expected to be encountered directly adjacent the brick drain, with fill depth approximating the drain invert level. The fill material is variable in terms of nature and type and comprised:-

- Bitumen and pavement gravels
- Ash
- Clayey Gravel – medium dense
- Clayey/Gravelly Sand – loose/very loose
- Clayey Sand – loose
- Gravelly Sand – medium dense
- Gravelly/Sandy Clay – stiff
- Clay – stiff

The fill stratum is considered to be generally poor quality, weak and uncontrolled.

Natural Soils

Natural soils were encountered at levels between RL 4.86m (BH1) and RL 2.4m (BH8). Please note that depth to natural soils is expected to be greater along the brick drain alignment, with level to top of natural approximately the same as the brick drain invert level (approximately RL 1.0m).

Natural soils encountered were variable in nature and type, and comprised:-

- Gravelly Clayey Sand – very loose/loose/medium dense
- Silty Clayey Sand/Clayey Sand – very loose/loose/medium dense
- Silty Clay/Clay – firm/stiff/very stiff
- Sandy Clay – firm/stiff/very stiff/hard
- Gravelly Sandy Clay – stiff/very stiff/hard

Tuff Rock

Tuff rock was encountered at levels between RL 4.4m (BH5) and RL -1.8m (BH7). As borehole records indicate, the level to tuff rock is variable, with significant differences in levels to rock observed at adjacent boreholes.

The tuff rock was described as initially being very weak/weak, however, rock strength increased with depth, with medium strong/strong/very strong tuff encountered (refer Boreholes 8, 9 and 10).

* * *

A summary of the subsurface profile is presented in Table 1.

TABLE 1 SUBSURFACE PROFILE

Location	Surface Level RL (m)	Fill Material (m)	Natural Soils (m)	Tuff Rock (m)	Termination Depth (m)
BH 1	5.5	0.00-0.80	0.80-5.30	5.30-6.00	6.00
BH 2	5.0	0.00-0.25	0.25-4.00	4.00-4.50	4.50
BH 3	5.0	0.00-1.60	1.60-5.20	5.20-6.00	6.00
BH 4	4.0	0.00-1.20	1.20-2.60	2.60-3.00	3.00
BH 5	5.0	0.00-0.20	0.20-0.60	0.60-1.20	1.20(4)
BH 6	4.5	0.00-0.80	0.80-2.70	2.70-3.20	3.20(4)
BH 7	5.0	0.00-0.14	0.14-6.80	6.80-7.00	7.00(4)
BH 8	5.0	0.00-2.60	2.60-4.80	4.80-26.77	26.77
BH 9	4.2	0.00-1.60	1.60-5.50	5.50-20.20	20.20
BH10	5.0	0.70-4.30	0.70-4.30	4.30-20.66	20.66

Notes:-
1. NE – Not Encountered.
2. All depths below existing ground surface level as of date of investigation.
3. Surface levels inferred from Client supplied survey.
4. Borehole terminated at drill rig refusal ('TC' bit refusal).

5.3 Groundwater

Groundwater was encountered at most borehole locations as seepage at the time of the investigation during augering; Table 2 refers.

TABLE 2 GROUNDWATER

Location	Surface Level RL (m)	Groundwater Noted RL (m)
BH1	5.5	4.9
BH2	5.0	4.1
BH3	5.0	2.7
BH4	4.0	NE
BH5	5.0	NE
BH6	4.5	3.7
BH7	5.0	0.5
BH8	5.0	2.4
BH9	4.2	2.2
BH10	5.0	NE

Note:- Groundwater noted indicates depth at which groundwater was observed during open hole augering.

As Table 2 indicates, seepage (where encountered) was encountered at or near (within 0.4m) of the fill/natural interface at Boreholes 1, 2, 6, 8 and 9, with seepage encountered within natural soils at Boreholes 3 and 7.

Groundwater monitoring wells were installed at Boreholes 3, 9 and 10, with steady groundwater levels recorded at RL 0.7m, RL 0.3m and RL -0.8m respectively (refer borehole records).

Groundwater wells at Boreholes 9 and 10 were also checked on 3rd February, 2016, with groundwater levels recorded at RL 0.4m and RL -1.3m respectively.

Seepage is expected to be encountered, particularly within the fill material/natural soils, and at the fill/natural and soil/rock interfaces at all boreholes locations. It should also be noted that groundwater conditions can vary both seasonally and with prevailing weather conditions. If construction is to be undertaken at a "significant" time following this investigation, or following 'wet' weather, then it would be prudent to confirm groundwater levels prior to construction.

6.0 ENGINEERING ASSESSMENT

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

- Trafficability
- Excavatability
- Construction Dewatering
- Excavation Retention System Options
- Retaining Wall Design Parameters
- Building Foundations
- Basement Slab Construction

* * *

An Acid Sulfate Soil (ASS) Study was carried out by Soil Surveys Engineering for this site. It should be ensured that all works are carried out in accordance with recommendations contained within the ASS management plan.

6.1 Trafficability

Trafficability conditions at the time of the geotechnical study were considered to be fair due to the paved surface. However, some problems may be anticipated following removal of pavement/building slabs.

The soils underlying the pavements (fill and natural) are sensitive to repetitive vehicle loading and water (ie. they will lose strength through repetitive vehicle loading or if they become overly moist or wet). Further, seepage may also result in a subsequent loss of strength. This may limit trafficability for light weight construction vehicles and create difficulties during construction. This situation would be more pronounced if rainfall followed demolition, clearing, excavation, etc.

Problems may also arise from disturbance of the soil fabric with removal of existing structures, services, etc. Depressions could be formed resulting in water traps and potential softening of adjacent and underlying soils. Extreme care should be exercised during the demolition/clearing phase to ensure that excessive subgrade disturbance is not caused during removal of existing structures, services, etc.

6.1.1 Stage 1

Stage 1 works will include foundation construction using large truck mounted foundation rigs and cranes, and excavation to RL 3.0m, to the east of the brick drain, to create a lined detention basin (concrete base and walls).

Borehole records indicate that subgrade conditions at RL 3.0m may comprise:-

- Uncontrolled fill material, eg. Boreholes 4A, 8 and 9.
- Natural stiff sandy clay and loose gravelly clayey sand, eg. Borehole 3A.
- Tuff rock, eg. Borehole 5.

Trafficability conditions are expected to be poor in areas where uncontrolled fill material and natural soils form the subgrade.

Considering the above, it is recommended that foundation works for Stage 1 be carried out prior to removal of the existing pavement or concrete floor slab (associated with the building to the south east of the site), i.e. **place the working platform (to support construction plant) on top of the existing pavement**. Please note that the scope of Soil Surveys Engineering's study **DOES NOT** include the design of a working platform for heavy construction vehicles or heavy tracked plant. Detailed design of a working platform should be carried out considering the operation of actual machinery proposed to be used. This is particularly important when considering the use of **heavy** foundation rigs and **heavy** cranes - the piling/crane contractor should be consulted regarding their requirements.

Following foundation works, working platform material, along with select "good quality" existing fill material, should be excavated and stockpiled for later reuse (refer next paragraph and Section 6.2).

Following excavation to RL 3.0m for the detention basin, in areas where soils form the subgrade, it is recommended that a working layer (bridging layer), possibly in conjunction with a geotextile, be placed to support personnel and light weight construction equipment (as required). Working platform material and select "good quality" existing fill material is envisaged to be suitable (and reused) for this working layer. Some over excavation (below RL 3.0m) will be required. The working layer thickness is subject to subgrade conditions at time of construction, proposed works, machinery type/weight proposed to be operated at the base of the detention basin, etc. However, planning should consider the advantages associated with limiting the use of any machinery operating at the base of the detention basin.

Brick Drain

Whilst Soil Surveys Engineering do not have any knowledge as to the condition of the brick drain, and the ability of the brick drain to accommodate construction plant/vehicle loads, a cautious approach is recommended. It is recommended that plant/vehicles do not travel over the brick drain, i.e. construct a temporary bridge, and that construction works be carried out in a manner where the brick drain is not adversely affected.

It is recommended that dilapidation survey of this brick drain be carried out prior to construction.

6.1.2 Stages 2 and 3

Stages 2 and 3 works will comprise excavation to RL -4.5m to form basement levels. Subgrade conditions at RL -4.5m will comprise tuff rock.

Trafficability conditions are expected to be good in areas where tuff rock forms the subgrade. However, during excavation works, trafficability will be poor where soils (uncontrolled fill material and natural soils) form the subgrade.

The Building Contractor should acknowledge the nature of the uncontrolled fill material and natural soils, and groundwater/seepage conditions, when planning excavation works for Stages 2 and 3.

6.2 Earthworks

Earthworks will comprise:-

- Stage 1 – excavation to RL 3.0m to create a detention basin. Further, subgrade treatment is expected to be required in areas where existing uncontrolled fill material/natural soils form the subgrade.
- Stages 2 and 3 – excavation to RL -4.5m for basement construction. Refer Section 6.3.

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

The following earthwork procedures are recommended for Stage 1.

Stage 1

Uncontrolled fill material was encountered across Stage 1, with natural soils recorded at levels between RL 2.4m and RL 4.8m. The fill material is of poor quality, weak, is considered to be uncontrolled and is very sensitive to water (ie. will lose strength if it becomes wet) and vehicle movement.

Further natural soils encountered beneath the uncontrolled fill were weak on occasions, eg. loose gravelly clayey sand as encountered at Borehole 3A and Borehole 4 at RL 2.9m and RL 3.5m respectively.

It is envisaged that the detention basin will be lined with a concrete base and walls – subgrade treatment will therefore be required.

The following subgrade treatment is recommended:-

- **Fill material encountered should be considered uncontrolled and requiring treatment ie. excavate to expose natural soils (subject to ongoing site inspections by Soil Surveys Engineering during excavation works).**

- In areas where soils form the subgrade, it is envisaged that a working layer (to support construction personnel and light weight construction equipment) will be required. The following is offered for consideration:-
    - Place a geotextile (say 'G' rating of 2400); the geotextile will act as a separator as well as providing some strength.
    - Place bridging layer (say rocky material, ie. crushed rock/concrete/brick and/or working platform material), lightly compact.

  It is envisaged that the bridging layer may need to be at least 0.3m in thickness. However, the bridging layer thickness is subject to inspection by Soil Surveys Engineering during excavations, proposed works, machinery type/weight, movement, etc.

Engineering supervision of the earthworks operations by Soil Surveys Engineering Pty Limited is recommended.

6.3 Excavatability

Subsurface conditions are variable and comprise fill material, natural soils and weathered rock.

Considering the findings of the geotechnical investigation, the following comments can be made on excavation characteristics:-

- Soils – soils will be within the excavation limits of a medium sized backhoe.
- Rock - rock excavation will require the use of large excavators (say 30 tonne) with use of rock breakers, rock saws, etc.
- Bored Piers - the ability to drill piers in the rock is not only dependent on material characteristics but also the type (power and size) of the bored pier drilling rig, drilling teeth, size of pier, etc. **It is recommended that the drilling contractors be consulted on this matter.** However, we recommend that planning considers that the use of large tracked mounted bored pier machines (say 30 tonne machines) with rock coring capabilities will be required for piers extending into the tuff rock stratum.

Vibrations

The effect of vibrations on adjacent structures, services, brick drain, roads, etc. from excavation works, particularly use of rock breakers, must be carefully considered. Regardless, adequate vibration monitoring and control is recommended.

Inspection of Core

Soil Surveys Engineering hold rock core recovered from the site.

It is recommended that tender documents include a requirement to inspect retrieved core so that intending contractors can make their own assessment and judgement on the excavatability of the rock stratum.

6.4 Dewatering - Construction

The potential to encounter groundwater exists (refer Section 5.2).

For construction works a drainage system, comprising a gravel blanket, side drains etc., grading to a sump pump, could be considered.

6.5 Excavation/Boundary Retention

6.5.1 General

Considering the proposed development, excavation support will be required, i.e.:-

Stage 1

To retain soils associated with the detention basin excavation (approximately 2.0m in height), a cantilever sheet pile system (possibly with internal propping) is recommended. In areas where high level rock is encountered, eg. Borehole 5, alternative retention methods would need to be considered, eg. mesh/shotcrete wall with anchor/dowel.

Groundwater was recorded as seepage within fill material and natural soils. Steady groundwater levels were recorded at levels between RL 0.7m and RL -1.3m. Refer Section 5.3. The Designer of the retention system will need to consider groundwater conditions.

Stages 2 and 3

Excavation from approximately RL 5.0m to approximately RL -4.5m (i.e. 9.5m excavation) will be required for basement construction. The retention system will retain soils, both fill and natural soils, and tuff rock.

Groundwater was recorded as seepage within fill material and natural soils. Steady groundwater levels were recorded at levels between RL 0.7m and RL -0.8m. Refer Section 5.3. The Designer of the retention system will need to consider groundwater conditions.

Considering subsurface conditions encountered the following retention system is recommended:-

- In that zone from ground level to tuff rock, an anchored secant pile wall (interlocking piers) is recommended. Piers are to found into the tuff rock.
- In that zone retaining tuff, i.e. that zone below secant pile wall piers, an anchored mesh/shotcrete wall, is recommended.

* * *

Retention systems must be installed prior to excavation works.

6.5.2 Detailed Design

DETAILED RETENTION SYSTEM DESIGN (which is outside the scope of Soil Surveys Engineering's commission and study) IS REQUIRED; a detailed soil-structure analysis must be carried out to determine an effective retention support system.

The requirement to limit deflections to acceptable levels should be explicit in the brief to retention system designers.

The effect of potential vertical and horizontal movements (resulting from deflection of the retention system) on existing adjacent structures, services, brick drain, road etc. must be carefully considered. Services locations and adjacent building foundation systems must be established/considered by the retention system designer – this matter is the responsibility of the retention system designer.

The design of a support system should take into account overexcavation possibly associated with foundation construction, earthworks, services installation, etc.

UNSUPPORTED EXCAVATIONS ARE NOT RECOMMENDED.

Further, it is recommended that several monitoring stations be set up to check for movement during excavation. A regular monitoring program of these stations should be implemented e.g. twice daily during excavation and daily at any other time.

6.5.3 Cantilever Sheet Pile

Stage 1 excavations will extend to approximately RL 3.0m. The retention system will largely retain fill and natural soils – groundwater is expected to be encountered (refer Section 5.3).

A cantilever sheet pile system (possibly with internal propping), with sheets founding at a suitable level below proposed excavation level, is recommended.

In areas where high level rock is encountered, eg. Borehole 5, alternative retention methods would need to be considered, eg. mesh/shotcrete wall with anchor/dowel.

6.5.4 Secant Pile Wall

With this option, **interlocking piers** are drilled and then joined at the surface using a capping beam.

The following general construction procedure would be applicable:-

- Install secant piers with a suitable embedment into the tuff stratum.
- Excavate to allow installation of the first row of temporary ground anchors.

- Continue excavation/installation of temporary ground anchors in accordance with design requirements.

Please note that permission to install anchors into adjacent properties would be required.

It is recommended that a capping beam be incorporated into the design. Figure 6 refers.

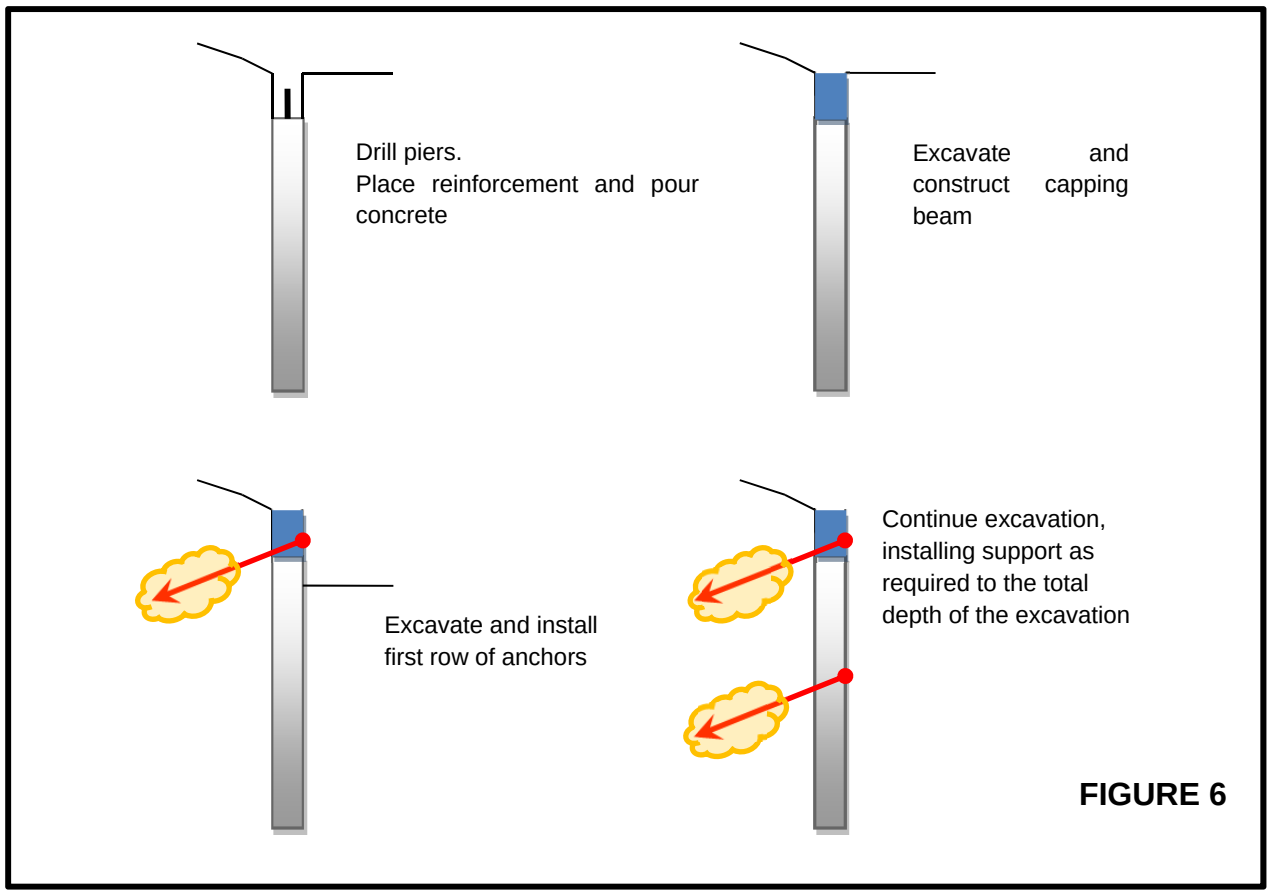


FIGURE 6

A minimum pier diameter of 0.60m is recommended for anchored piers, however, pier diameter is dependent on the moment capacity of the pier section, lateral deflection requirement, boundary conditions, etc.

6.5.5 Anchor Design

Anchor design should consider the following:-

- Anchor free length should extend from the anchor head to 0.15H (H is total excavation height) behind the design failure plane drawn up at 60^{o} from the base of the cut with a minimum length of 3m (temporary only).
- Anchor bond length will depend upon desired anchor capacity, drill hole size and material parameters of intersected material. An allowable bond stress of 250kPa for SW tuff rock or better could be adopted. It is recommended that pull out tests be carried out during excavation to assess allowable bond stress design values. It is possible that greater values could be used, subject to test results.

- Anchors are designed as temporary.

6.5.6 Anchored Mesh/Shotcrete Wall

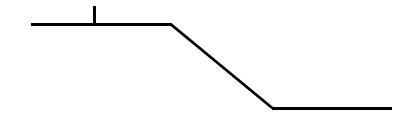
An anchored mesh/shotcrete wall is considered appropriate for temporary support of the tuff rock stratum and below the secant pile system.

A maximum panel size of 2.0m wide by 2.0m high is recommended, subject to inspection during excavation works.

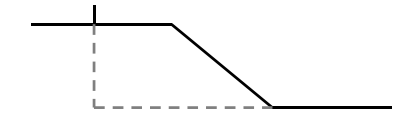
The method of construction for this wall type comprises excavation in stages/levels; at each level, excavate on a hit one/miss two basis leaving the buttress supporting the area to be retained, (Figures 7 and 8); please note that this requirement may be relaxed subject to inspection by Soil Surveys Engineering during bulk earthworks. The anchor hole is drilled, anchor placed and grouted, panel steel placed and sprayed.

Drainholes (in conjunction with strip drains) should be drilled during the process and a short piece of PVC placed in the neck of the hole during spraying to allow the hole to continue through the wall.

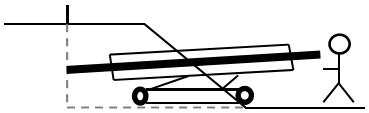
Once a panel has been completed the adjoining panels should then be excavated and the process repeated until all panels have been constructed.



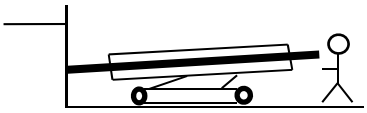
1. Install secant pile system and carry out bulk earthworks to nominated level.



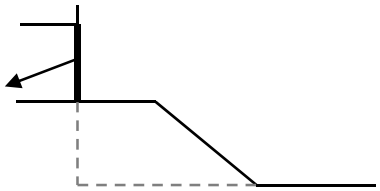
2. Excavate panels leaving required buttresses in place. (hit one miss two)



3. Drill anchor holes, place reo and spray with shotcrete.



4. Excavate each panel in turn.



5. Excavate to next panel level leaving buttresses as required.

CONSTRUCTION SEQUENCE FOR AN ANCHORED MESH/SHOTCRETE WALL

FIGURE 7

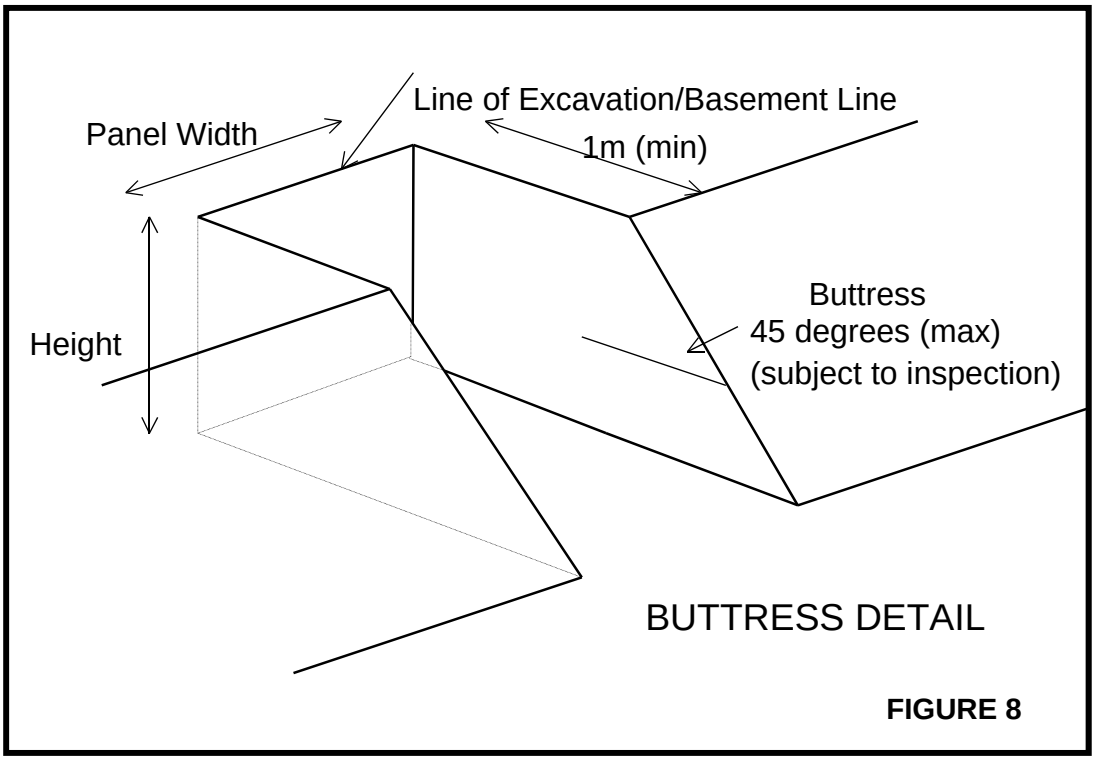


FIGURE 8

6.5.7 Retaining Walls

Retaining walls should be designed in accordance with AS4678-2002 "Earth Retaining Structures".

The following parameters (unfactored) may be adopted for basement wall design (Table 3).

TABLE 3 PARAMETERS FOR USE IN RETAINING WALL DESIGN

Material	Density (kN/m^3)	Earth Pressure Coefficient Vertical Wall Ko	Long Term Drained Ø (degrees)
Rock	23	0.43	35
Natural Soils	19	0.53	28

6.5.8 Design Comments

As noted previously, **detailed retention system design is required (and is outside the scope of Soil Surveys Engineering's commission and study)**; Soil Surveys Engineering would however be pleased to assist with the geotechnical engineering aspects of the design process, if requested.

However, please note that Soil Surveys Engineering do not produce engineering drawings; our geotechnical engineering retention design will be provided in a report which sets out sufficient detail to allow the drafting (by others) of engineering drawings for construction. These drawings should (at least) consist of an elevation showing anchor installation locations (if required) as well as typical sections and other design/construction parameters. Soil Surveys Engineering should provide geotechnical design review of the drawings.

It should be noted that as well as geotechnical design review of drawings, construction inspections (i.e. inspection of piers associated with retention system, inspections during earthworks, etc. - please contact Soil Surveys Engineering for advice) will also be required. **Soil Surveys Engineering is however not able to provide construction inspection services unless we have reviewed and approved any drawings prepared from our report PRIOR TO CONSTRUCTION COMMENCING**.

Further, vertical and lateral movement of soils will occur for any non-anchored system; movements occur as a result of stress release caused by the excavation.

The effect of potential vertical and horizontal movement on adjacent structures, brick drain, roads, services etc. must be carefully considered. The construction methods described may need to be modified following detailed design.

6.6 Dilapidation Survey

Adjacent buildings, brick drain, roads and underground services are located within and adjacent to proposed works.

It is recommended that a dilapidation survey of adjoining structures, brick drain, roads, etc. be carried out in order to establish their present condition prior to commencement of construction.

This survey should include the following:-

- The general condition of the property, ie. condition of all exposed walls, pavement condition, etc.
- The extent of existing damage (if any)
- Photographs/video

Actual locations of underground services and adjacent building foundation systems should be established prior to construction and during the design phase.

6.7 Building Foundations

6.7.1 General

Stage 1

The foundation system for Stage 1 should consider the following:-

- Detention basin beneath Stage 1 building.
- Structure loads – up to 15,000kN (working) loads have been advised.
- Presence of brick drain.
- Proposed Stage 2 works, i.e. basement to RL -4.5m.
- Subsurface conditions.

All considered, a deep foundation system, i.e. bored piers (in conjunction with liners), with piers founding in tuff rock, creating a fully suspended structure, is recommended. Piers will need to not only extend to levels below Stage 2 basement works, but extend to a sufficient level to accommodate structural loads.

Stages 2 and 3

For Stages 2 and 3, a high level pad footing system could be adopted with pads founding in fresh tuff rock at basement level.

6.7.2 Bored Piers – Stage 1

The pier foundation system should be designed in accordance with AS 2159-2009 'Piling - Design and Installation'. This code uses the limit state design method.

A bored pier foundation system (in conjunction with liners – liners to found into rock) is recommended.

The design of a single pier or a pier group must be such that both the design geotechnical strength $R_{d,g}$ and the structural strength $R_{d,s}$, are greater than or equal to the design action effect E_d, i.e.

$$R_{d,g} \geq E_d \; and \; R_{d,s} \geq E_d$$

The design geotechnical strength ($R_{d,g}$) can be calculated as the ultimate design geotechnical strength ($R_{d,ug}$) multiplied by the geotechnical strength reduction factor $Ø_g$. Ultimate design geotechnical strength ($R_{d,ug}$) parameters for the materials encountered on the site are outlined in Table 4.

TABLE 4 ULTIMATE GEOTECHNICAL STRENGTH ($R_{d,ug}$) PARAMETERS

Material	fb - Base Bearing (kPa)	fm,s - Skin Friction (kPa)
Fill Material	NR	NC
Natural Soils	NR	NC
Tuff Rock - Weak/Medium Strong - Strong to Very Strong	 7500 15000	 150 500

Notes:
1. NR - Not Recommended; NC - Not Considered in skin friction calculations.
2. Ultimate geotechnical strength for compression can be determined from Rd,ug= fm,s As + fbAb.
3. For determination of geotechnical strength reduction factor (Øg) refer Section 4.3.2 AS2159-2009.
4. Considering limit state analysis (AS 2159-2009), the design geotechnical strength Rd,g is calculated by multiplying the ultimate geotechnical strength Rd,ug by the geotechnical strength reduction factor Øg, ie. Rdg = Rd,ug x Øg.
5. Should a "working stress" approach be adopted, a minimum factor of safety of 3.0 on base and 2.0 on skin friction is recommended.
6. The above parameters are for single piers. If piers are spaced at closer than three diameters, a reduction factor (Group Efficiency Ratio) may apply.
7. Base bearing and skin friction parameters to be confirmed by inspection.

It should be ensured that all loose material is removed from the base of piers prior to pouring of concrete. The use of a 'clean-out' bucket or vacuum truck should be explicit in instructions to the drilling contractor. The practice of 'using water and spinning the augers' to remove loose material from the pier base is generally unacceptable.

Groundwater was encountered in boreholes (refer Section 5.3) at the time of the investigation.

An allowance for dewatering and the use of liners should be made.

Screw Piers

Screw piers (as an alternative to piers) could be considered for support of the detention basin perimeter wall. Screw piers should extend to found in tuff rock.

6.7.3 Pad Footings – Stages 2 and 3

It is envisaged that fresh tuff rock will be exposed at basement level (RL -4.5m) over Stages 2 and 3. In this case, a high level foundation system could be considered.

High level footings should found into the fresh tuff stratum. Footings founding in the fresh tuff stratum may be dimensioned for an allowable bearing capacity (subject to inspection by Soil Surveys Engineering) of 5,000kPa.

It should be ensured that the bases of all footings are cleaned of loose material.

6.7.4 Detention Basin Slab

The detention basin slab will need to be designed for groundwater/seepage. An under slab drainage system, in conjunction with hydrostatic valves, could be considered.

6.7.5 Basement Slab – Stages 2 and 3

For design purposes, it is recommended that the basement slab be designed adopting principles as contained in the Cement & Concrete Association of Australia, Industrial Floors & Pavements, Guidelines for Design, Construction & Specification.

It is envisaged that tuff rock will be exposed at basement level over the site. For design, a design CBR value of > 15% may be adopted where tuff rock forms the subgrade.

The basement slab will need to be designed for groundwater/seepage. A drained basement comprising an under slab drainage system with permanent pumps could be considered subject to water quality issues, long term maintenance of pumps, etc. A fully tanked basement, designed for hydrostatic uplift, could also be considered. Please note that significant uplift pressures may develop; permanent anchors/dowels may be required to resist uplift loads.

7.0 LIMITATIONS

We have prepared this report for the use of **825 Stanley 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 **825 Stanley Pty Ltd**; it may not contain sufficient information for purposes of other parties or for other uses. Please note that any third party relying on the information contained in this report for any purpose whatsoever does so entirely at its own risk, and any duty of care to that third party is excluded.

Any interpretation or recommendation given by Soil Surveys Engineering shall be understood to be based on judgement and experience and not on greater knowledge of the facts than the reported investigations would imply. The interpretation and recommendations are therefore opinions provided for our Client's sole use in accordance with the specific brief. As such they do not necessarily address all aspects of ground behaviour on the subject site. Information provided by others has been taken in good faith, but no liability can be accepted for information provided by others.

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.

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 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 becomes available.

The above statements are 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.

It is highly recommended that the Client avail themselves of these review and inspection services; our standard rates will apply.

M.Geale

M. V. GEALE (RPEQ 3839)
PRINCIPAL ENGINEER

for and on behalf of
SOIL SURVEYS ENGINEERING PTY LIMITED

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 SHEET

Soil Surveys Engineering Pty. Limited
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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 1A

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 24/07/2010 Page: 1 OF 1

Easting: 503740 Northing: 6959618 RL: 5.5 m
Logger: DA Operator: DA Machine: Scout 2

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	Samples and Remarks
	0.20		FILL Sandy GRAVEL (GP) Medium dense, fine to medium size, grey and yellow brown, fine to coarse grained sand, dry.	ASS
	0.60		FILL Clayey Gravelly SAND (SC) Loose, fine to coarse grained, dark grey and brown, fine to medium size gravel, high plasticity fines, dry.	ASS
	0.80		FILL Clayey Gravelly SAND (SC) Very loose, fine to coarse grained, dark grey, fine size gravel, high plasticity fines, wet.	ASS
	1.0		NATURAL Clayey SAND (SC) Very loose, fine to medium grained, grey brown, high plasticity fines, wet.	ASS
	1.60		CLAY (CH) Very stiff, high plasticity, red brown and grey mottled, moist.	ASS
	2.0			ASS
				ASS
				ASS
				ASS
	2.80			ASS
	3.0		Sandy CLAY (CH) Very stiff to hard, high plasticity, grey and red brown mottled, fine grained sand, moist.	ASS
	3.40		CLAY (CH) Very stiff, high plasticity, grey red and yellow brown mottled, moist.	ASS
	4.0			ASS
				ASS
	4.20			ASS
	4.50		CLAY (CH) Very stiff, high plasticity, grey, trace of fine grained sand, moist.	ASS
	4.80		CLAY (CH) Very stiff, high plasticity, yellow brown mottled, trace of fine grained sand, moist.	ASS
	5.0		Gravelly Sandy CLAY (CH) Hard, high plasticity, grey mottled, fine to coarse grained sand, fine size gravel, moist.	ASS
	5.30			ASS
	5.60		TUFF (DW) Very weak, light grey and light yellow brown.	ASS
	6.0		TUFF (DW) Weak, light yellow brown.	ASS
	6.00		BOREHOLE BH 1A TERMINATED AT 6.00 m	
	7.0			
	8.0			
	9.0			
	10.0			

Comments:
1) Groundwater noted at 0.6m.

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: JD
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 2A

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 24/07/2010

Easting: 503748 Northing: 6959568 RL: 5.0 m
Logger: DA Operator: DA Machine: Scout 2

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	Samples and Remarks
	0.25		FILL Sandy GRAVEL (GP) Medium dense, fine to medium size, yellow brown, fine to coarse grained sand, dry.	ASS
	0.50		NATURAL Clayey SAND (SC) Loose, fine to medium grained, dark grey and brown, high plasticity fines, moist.	ASS
	0.90		Clayey SAND (SC) Very loose, fine to coarse grained, brown, high plasticity fines, moist.	ASS
	1.0 ▽ 1.10		Clayey SAND (SC) Very loose, fine to coarse grained, brown, high plasticity fines, wet.	ASS
	1.60		Gravelly Sandy CLAY (CH) Very stiff, high plasticity, grey and red brown, fine to coarse grained sand, fine to medium size gravel, moist.	ASS
	2.0 2.20		Sandy CLAY (CH) Very stiff, high plasticity, grey and red brown, fine to medium grained sand, moist.	ASS
	3.0 3.70		Sandy CLAY (CH) Very stiff, high plasticity, grey and red brown, with fine grained sand, moist.	ASS
	4.0 4.00		Gravelly Sandy CLAY (CH) Hard, high plasticity, grey red and yellow brown, fine to coarse grained sand, fine to medium size gravel, moist.	ASS
	4.50		TUFF (DW) Weak, yellow brown, dry.	ASS
	5.0		BOREHOLE BH 2A TERMINATED AT 4.50 m	
	6.0			
	7.0			
	8.0			
	9.0			
	10.0			

Comments:
1) Groundwater noted at 0.9m.

▽ 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: JD
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 3A

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 24/07/2010 Page: 1 OF 1

Easting: 503797 Northing: 6959609 RL: 5.0 m
Logger: DA Operator: DA Machine: Scout 2

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	Samples and Remarks
	0.00		Bitumen	ASS
			FILL Gravelly Clayey SAND (SC) Loose, fine to coarse grained, dark grey and brown, high plasticity fines, fine size gravel, dry.	ASS
	0.90			ASS
	1.0			ASS
	1.20		FILL Clayey SAND (SC) Loose, fine to coarse grained, dark grey, high plasticity fines, with charcoal, dry.	ASS
			FILL Gravelly Sandy CLAY (CH) Stiff, high plasticity, yellow red brown and dark grey, fine to coarse grained sand, fine to medium size gravel, moist.	ASS
	1.60		NATURAL Sandy CLAY (CH) Stiff, high plasticity, grey brown, fine to medium grained sand, moist.	ASS
	2.0			ASS
	2.10		Gravelly Clayey SAND (SC) Loose, fine to coarse grained, orange and yellow brown, high plasticity fines, some fine size gravel.	ASS
				ASS
	2.60		Clayey SAND (SC) Loose, fine to medium grained, grey and light yellow brown mottled, high plasticity fines, wet.	ASS
	3.0			ASS
	3.20		Sandy CLAY (CH) Hard, high plasticity, yellow brown and light grey, fine to medium grained sand, moist.	ASS
				ASS
	3.80		Clayey SAND (SC) Medium dense, fine to coarse grained, yellow brown and light grey, high plasticity fines, moist.	ASS
	4.0			ASS
24/07/10				ASS
				ASS
	4.70		Sandy CLAY (CH) Hard, high plasticity, yellow brown and light grey, fine to medium grained sand, moist.	ASS
	5.0			ASS
	5.20		TUFF (DW) Weak, yellow brown and light grey.	ASS
				ASS
	6.0			ASS
	6.00		BOREHOLE BH 3A TERMINATED AT 6.00 m	
	7.0			
	8.0			
	9.0			
	10.0			

Comments:
1) Groundwater noted at 2.3m.
2) Groundwater level noted at 4.3m.
3) Groundwater monitoring well installed to 6.0m.

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: JD
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 4A

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 24/07/2010

Easting: 503807 Northing: 6959567 RL: 4.0 m
Logger: DA Operator: DA Machine: Scout 2

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	Samples and Remarks
	0.25		Bitumen	ASS
	0.40		FILL Sandy GRAVEL (GP) Medium dense, fine to medium size, yellow brown, fine to coarse grained sand, dry.	ASS
	0.60		FILL Gravelly Clayey SAND (SC) Very loose, fine to coarse grained, dark grey, high plasticity fines, fine size gravel, moist.	ASS
	1.0			ASS
	1.20		FILL Gravelly Sandy CLAY (CH) Stiff, high plasticity, grey brown, fine to coarse grained sand, fine size gravel, moist.	ASS
	1.50		FILL Gravelly Clayey SAND (SC) Loose, fine to coarse grained, brown, high plasticity fines, fine size gravel, moist.	ASS
			NATURAL Gravelly Sandy CLAY (CH) Stiff, high plasticity, yellow red brown, fine to coarse grained sand, fine size gravel, moist.	ASS
	2.0			ASS
	2.00		Gravelly Clayey SAND (SC) Loose, fine to coarse grained, red yellow brown and grey mottled, high plasticity fines, some fine size gravel.	ASS
	2.60		Gravelly Clayey SAND (SC) Medium dense, fine to coarse grained, red yellow brown and grey mottled, high plasticity fines, some fine size gravel.	ASS
			TUFF (DW) Weak, yellow brown and light grey.	ASS
	3.0			
	3.00		BOREHOLE BH 4A TERMINATED AT 3.00 m	SPT 30/120mm N=R
	4.0			
	5.0			
	6.0			
	7.0			
	8.0			
	9.0			
	10.0			

Comments:
1) Groundwater not observed.

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

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 05

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 14/01/2016

Easting: 503824 Northing: 6959588 RL: 5.0 m
Logger: RH Operator: RH Machine: EVH1750

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		BITUMEN		
	0.20		FILL Gravelly CLAY (CH) Stiff, high plasticity, dark grey, fine to medium sized gravel, moist,		
	0.50		NATURAL Silty CLAY (CH) Stiff, high plasticity, dark brown, trace of fine sized gravel, moist.		
	0.60		Silty CLAY (CH) Stiff, high plasticity, dark brown mottled orange-brown, trace of fine to medium sized gravel, moist.		
	1.0		TUFF (DW) Very weak, light brown, moist.		
	1.10		TUFF (DW) Weak, light brown, moist.		
	1.20		BOREHOLE BH 05 TERMINATED AT 1.20 m		
	2.0				
	3.0				
	4.0				
	5.0				
	6.0				
	7.0				
	8.0				
	9.0				
	10.0				

Comments:
1. Groundwater not encountered.
2. DCP refusal at 0.62m.
3. 'TC' bit refusal at 1.20m.

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: JD
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 06

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 14/01/2016

Easting: 503781 Northing: 6959587 RL: 4.5 m
Logger: RH Operator: RH Machine: EVH1750

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.09		BITUMEN		
	0.20		FILL Sandy GRAVEL (GP) Very dense, fine to medium sized, dark brown, fine to coarse grained sand, moist.		
	0.50		FILL Gravelly CLAY (CI-CH) Stiff, medium to high platicity, dark brown, fine to medium sized gravel, with fine to coarse grained sand, smell of hydrocarbons, moist.		D
	0.80				
	1.0				
	1.10		FILL Clayey GRAVEL (GC) Medium dense, fine to medium sized, dark brown mottled dark grey, medium to high plasticity fines, with fine to coarse grained sand, smell of hydrocarbons, moist.		U50 PP = 110
	2.0		NATURAL Clayey SAND (SC) Loose, fine to coarse grained, dark grey, medium to high plasticity fines, trace of fine sized gravel, wet.		
	2.40		Silty CLAY (CH) Stiff, high plasticity, dark grey mottled red-brown, trace of fine sized gravel, moist.		
	2.70		Silty CLAY (CH) Very stiff, high plasticity, orange-brown mottled light brown, trace of fine sized gravel, moist.		
	3.0		TUFF (DW) Very weak, light brown mottled light grey, moist.		
	3.20		BOREHOLE BH 06 TERMINATED AT 3.20 m		
	4.0				
	5.0				
	6.0				
	7.0				
	8.0				
	9.0				
	10.0				

Comments:
1. Groundwater encountered at 0.80m.
2. DCP refusal at 2.73m.
3. 'TC' bit refusal at 3.20m.

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: JD
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 07

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 14/01/2016

Easting: 503754 Northing: 6959591 RL: 5.0 m
Logger: RH Operator: RH Machine: EVH1750

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.02		BITUMEN		
	0.14		FILL Sandy GRAVEL (GP) Dense, fine to medium sized, light brown, fine to coarse grained sand, trace of low plasticity fines, moist.		
	0.60		NATURAL Silty CLAY (CH) Firm, high plasticity, dark grey, with fine to coarse grained sand, trace of fine sized gravel, moist.		U50 PP = 140
	1.0		Silty CLAY (CH) Stiff, high plasticity, dark grey mottled red-brown, trace of fine sized gravel, moist.		U50 PP = 100
	2.0				
	2.30		Silty CLAY (CH) Very stiff, high plasticity, dark grey mottled red-brown, trace of fine sized gravel, moist.		
	3.0				U50 PP = 230
	3.40		Silty CLAY (CH) Very stiff, high plasticity, light grey mottled red-brown, trace of fine sized gravel, moist.		
	4.0				
	4.20		Silty CLAY (CH) Very stiff, high plasticity, dark grey mottled light brown, trace of fine sized gravel, moist.		
	5.0				
	6.0				U50 PP = 230
	6.20		Silty CLAY (CH) Very stiff, high plasticity, dark grey mottled light brown, trace of fine sized gravel, with some GRAVEL bands, moist.		
	6.80				
	7.0		TUFF (DW) Weak, light brown, moist.		
	7.00		BOREHOLE BH 07 TERMINATED AT 7.00 m		
	8.0				
	9.0				
	10.0				

Comments:
1. Groundwater encountered at 5.50m.
2. DCP refusal at 4.09m.
3. 'TC' bit refusal at 7.00m.

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: JD
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 08

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 15/01/2016

Easting: 503817 Northing: 6959609 RL: 5.0 m
Logger: DA/CB Operator: DA Machine: Scout

Depth	Description	Weathering	Rec (%)	RQD	Samples and Remarks
0.02	BITUMEN				
0.60	FILL Sandy GRAVEL (GP) Medium dense, fine to medium sized, grey, fine to coarse grained sand, dry.				
0.80	FILL ASH Very loose, dark grey/black.				
1.10	FILL Gravelly Clayey SAND (SC) Loose, fine to coarse grained, brown mottled, high plasticity fines, fine sized gravel, moist.				SPT 2, 2, 4 N=6
1.70	FILL Gravelly Sandy CLAY (CH) Stiff, high plasticity, brown, fine to coarse grained sand, fine sized gravel, moist.				U50
2.60	FILL Gravelly Clayey SAND (SC) Loose, fine to coarse grained, yellow-brown, high plasticity fines, fine sized gravel, moist.				
3.25	NATURAL Clayey SAND (SC) Very loose, fine to coarse grained, grey and brown, high plasticity fines, wet.				SPT 1, 2, 2 N=4
3.90	Sandy CLAY (CH) Firm, high plasticity, dark grey, fine to medium grained sand, moist.				
4.30	Clayey SAND (SC) Loose, fine to medium grained, brown, high plasticity fines, wet.				
4.80	Sandy CLAY (CH) Very stiff, high plasticity, light grey and yellow brown, fine to medium grained sand, moist.				U50 PP > 600
5.60	TUFF (DW) Weak, yellow brown and light grey.				
6.05	TUFF (DW) Weak, orange/yellow-brown.				
6.10	TUFF (DW) Weak, yellow-brown.	DW			SPT 30/80mm N=R
	TUFF fine to medium grained, light grey/light red, mottled orange, massive, with very closely spaced fractures, with some limonite staining and viens.				6.14 m; J, **15°**, P, R, O, L 6.26 m; J, **20°**, S, R, O, W 6.32 m; J, **15°**, P, R, O, L 6.45 m; J, **10°**, S, R, O, W 6.52 m; J, **15°**, S, R, O, L 6.76 m; J, **20°**, S, R, O, W 7.16m, Is50 = 0.16 MPa 7.08 m; J, **10°**, S, R, O, L 7.10 m; J, **5°**, P, R, O, L 7.25 m; J, **10°**, P, R, O, L 7.34 m; J, **10°**, P, R, O, L 7.41 m; J, **15°**, P, R, O, L 7.84 m; J, **10°**, P, R, O, L 8.20 m; J, **10°**, S, V, O, L 8.33 m; J, **10°**, S, R, O, L 8.40 m; J, **10°**, S, R, O, L
9.67		DW - SW	100	18	
					8.70 m; J, **20°**, P, R, O, L 8.9m, Is50 = 0.68 MPa 8.83 m; J, **15°**, P, R, O, L 9.04 m; J, **10°**, S, R, O, W 9.19 m; J, **10°**, P, R, O, Z 9.24 m; J, **20°**, P, R, O, L 9.35 m; V, **80°**, R, C, L
10.00	TUFF fine to coarse grained, light grey/light brown with closely spaced fractures.	DW	100	76	

15/01/16

Comments:
1. Groundwater encountered at 2.60m.
2. Borehole bailed on completion of drilling.
3. Steady water level measured post bailing at 4.75m on 15/1/16.

Chainage :m Offset : m
Water First Noted Water Steady Level

Defects - 1.54m : F,60°,P,R,O,C

Depth (m) Type Dip (deg) Planarity Roughness Aperature Infill
B - Bedding C - Curvilinear L - Slickensides C - Closed C - Clay
C - Clay seam D - Discontinuous P - Polished F - Filled F - Iron Oxide
F - Foliation P - Planar R - Rough N - Clean K - Calcite
H - Schistosity S - Subplanar S - Smooth O - Open L - Limonite
J - Joint T - Stepped V - Very rough S - Stain Q - Quartz
L - Cleavage U - Undulating S- Secondary mineral
R - Fracture U - Unidentified mineral
S - Shear zone W - Weathered rock
T - Contact X - Carbonaceous
V - Vein Z - Clean
Z - Decomposed Zone
DI - Drilling Induced break

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: JD
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 08

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 15/01/2016

Easting: 503817 Northing: 6959609 RL: 5.0 m
Logger: DA/CB Operator: DA Machine: Scout

Depth	Graphic	Description	Weathering	Strength (Estimated: RS VW W MS S VS)	Defect Spacing (20 60 200 600)	Rec (%)	RQD	Samples and Remarks
0.0		TUFF, fine to coarse grained, light grey/light green, mottled orange, massive with moderatly widely spaced fractures and trace limonite staining.	DW - SW					10.07 m; J, **15°,** P, R, O, L
			SW					10.48 m; J, **10°,** S, R, O, L
11.0						100	76	10.92m, Is50 = 0.22 MPa 10.88 m; J, **10°,** P, V, O, L
11.00		TUFF, fine to coarse grained, speckled light grey, massive with widely spaced fractures with a limonite stained clay infilled joint at 12.65m, near vertical joint between 14.9m and 15.5m.	FR					11.54m, Is50 = 1.43 MPa 11.47 m; J, **12°,** P, V, O, Z
12.0								
			SW - FR					12.65 m; J, **60°,** P, R, O, L/C
13.0						100	84	13.20 m; J, **30°,** P, R, O, Z
								13.45 m; J, **20°,** U, R, O, W
14.0								14.08 m; J, **50°,** P, R, O, Z 14.18 m; J, **15°,** S, V, O, Z
								14.64 m; J, **10°,** S, R, O, W
15.0								14.88m, Is50 = 0.75 MPa 15.05 m; J, **70°,** U, R, O, W 15.20 m; J, **20°,** S, R, O, Z
			FR					
16.0								15.9m, Is50 = 1.45 MPa
16.00		TUFF, fine to coarse grained, speckled grey to dark grey, massive, with widely to very widely spaced fractures, with some calcite lenses.				100	79	
17.0								16.64 m; J, **10°,** P, R, O, Z
								17.28 m; J, **10°,** S, V, O, Z 17.38 m; J, **10°,** S, V, O, Z
18.0								17.89m, Is50 = 1.15 MPa
19.0						100	100	
								19.46 m; J, **40°,** P, R, O, Z
20.0								

Drilling Method: TC, WB, RR, NMLC, Casing

Comments:
1. Groundwater encountered at 2.60m.
2. Borehole bailed on completion of drilling.
3. Steady water level measured post bailing at 4.75m on 15/1/16.

Chainage :m Offset : m
Water First Noted Water Steady Level

Defects - 1.54m : F,60°,P,R,O,C

Depth (m) | Type: B - Bedding, C - Clay seam, F - Foliation, H - Schistosity, J - Joint, L - Cleavage, R - Fracture, S - Shear zone, T - Contact, V - Vein, Z - Decomposed Zone, DI - Drilling Induced break | Dip (deg) | Planarity: C - Curvilinear, D - Discontinuous, P - Planar, S - Subplanar, T - Stepped, U - Undulating | Roughness: L - Slickensides, P - Polished, R - Rough, S - Smooth, V - Very rough | Aperature: C - Closed, F - Filled, N - Clean, O - Open, S - Stain | Infill: C - Clay, F - Iron Oxide, K - Calcite, L - Limonite, Q - Quartz, S- Secondary mineral, U - Unidentified mineral, W - Weathered rock, X - Carbonaceous, Z - Clean

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: JD
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 08

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 15/01/2016

Easting: 503817 Northing: 6959609 RL: 5.0 m
Logger: DA/CB Operator: DA Machine: Scout

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	Weathering	Strength (Estimated: RS VW W MS S VS)	Defect Spacing (20 60 200 600)	Rec (%)	RQD	Samples and Remarks
NMLC	21.0		TUFF, fine to coarse grained, speckled grey to dark grey, massive, with widely to very widely spaced fractures, with some calcite lenses. *(continued)*	FR			100	100	20.85m, Is50 = 1.36 MPa 21.12m, Is50 = 1.28 MPa 21.19 m; J, **10°,** S, R, O, Z
	22.0								
	23.0						100	100	
	24.0								24.20 m; J, **15°,** P, R, O, Z
	25.0								24.9m, Is50 = 1.06 MPa 24.80 m; J, **10°,** S, R, O, Z
	26.0						100	100	
	26.77								26.55m, Is50 = 0.99 MPa
	27.0		BOREHOLE BH 08 TERMINATED AT 26.77 m						
	28.0								
	29.0								
	30.0								

Comments:
1. Groundwater encountered at 2.60m.
2. Borehole bailed on completion of drilling.
3. Steady water level measured post bailing at 4.75m on 15/1/16.

Chainage :m Offset : m
Water First Noted Water Steady Level

Defects - 1.54m : F,60°,P,R,O,C

Depth (m) | Type | Dip (deg) | Planarity | Roughness | Aperature | Infill
B - Bedding | C - Curvilinear | L - Slickensides | C - Closed | C - Clay
C - Clay seam | D - Discontinuous | P - Polished | F - Filled | F - Iron Oxide
F - Foliation | P - Planar | R - Rough | N - Clean | K - Calcite
H - Schistosity | S - Subplanar | S - Smooth | O - Open | L - Limonite
J - Joint | T - Stepped | V - Very rough | S - Stain | Q - Quartz
L - Cleavage | U - Undulating | | | S- Secondary mineral
R - Fracture | | | | U - Unidentified mineral
S - Shear zone | | | | W - Weathered rock
T - Contact | | | | X - Carbonaceous
V - Vein | | | | Z - Clean
Z - Decomposed Zone
DI - Drilling Induced break

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: JD
Date: 4/02/2016

Client: 825 Stanley Street Pty Ltd
Project: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba

Project no: 110-12516

SSE Borehole: 8
Depth: 6.10m - 12.00m
Box: 1 of 4

Client: 825 Stanley Street Pty Ltd
Project: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba

Project no: 110-12516

SSE Borehole: 8
Depth: 12.00m - 18.00m
Box: 2 of 4

PointID : BH 08 Depth Range: 12.00 - 18.00 m

SOIL SURVEYS

TITLE

825 Stanley Pty Ltd
825 Stanley Street, Woolloongabba
Apartment Buildings
Core Photo - BH 08

DRAWN	CB	DATE	18/01/2016
CHECKED	GB	DATE	18/01/2016
SCALE	Not To Scale		A4
PROJECT No	110-12516	FIGURE No	1/2

Client: 825 Stanley Street Pty Ltd
Project: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba

Project no: 110-12516

SSE Borehole: 8
Depth: 18.00m - 24.00m
Box: 3 of 4

Client: 825 Stanley Street Pty Ltd
Project: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba

Project no: 110-12516

SSE Borehole: 8
Depth: 24.00m - 26.77m
Box: 4 of 4

PointID : BH 08 Depth Range: 24.00 - 26.77 m

SOIL SURVEYS

TITLE: 825 Stanley Pty Ltd 825 Stanley Street, Woolloongabba Apartment Buildings Core Photo - BH 08	DRAWN: CB	DATE: 18/01/2016	
	CHECKED: GB	DATE: 18/01/2016	
	SCALE: Not To Scale		A4
	PROJECT No: 110-12516	FIGURE No: 2/2	

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 09

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 13/01/2016

Easting: 503780 Northing: 6959568 RL: 4.2 m
Logger: DA/CB Operator: DA Machine: Scout

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	Weathering	Strength (Estimated: RS VW W MS S VS)	Defect Spacing (20 60 200 600)	Rec (%)	RQD	Samples and Remarks
	0.00		BITUMEN						
	0.20		FILL Clayey SAND (SC) Loose, fine to coarse grained, dark grey, high plasticity fines, dry.						
	0.70		FILL Clayey SAND (SC) Loose, fine to coarse grained, dark grey, high plasticity fines, with ASH, dry.						SPT 3, 3, 1 N=4
	0.90		FILL CLAY (CH) Stiff, high plasticity, brown mottled, moist.						U50
	1.60		NATURAL Silty Clayey SAND (SC) Very loose, fine to medium grained, dark brown, high plasticity fines.						SPT 2, 1, 2 N=3
	2.00		Clayey SAND (SC) Very loose, fine to coarse grained, grey, high plasticity fines, wet.						U50 PP = 100
	2.60		Sandy CLAY (CH) Firm to stiff, high plasticity, grey, fine to medium grained sand, moist.						
	4.30		Gravelly Clayey SAND (SC) Very loose, fine to coarse grained, dark grey, high plasticity fines, fine sized gravel.						SPT 1, 0, 0 N=0
	5.50		TUFF (DW) Weak, yellow-brown and grey.						SPT 30/20mm N=R
	5.70		TUFF (SW) Medium strong, yellow-brown and grey.	SW					5.82 m; J, **35°**, P, V, O, L 5.95m, Is50 = 1.51 MPa
	5.80		TUFF fine to medium grained, light grey mottled light brown, massive, with closely spaced fractures. Some orange stained weathered bands from 6.27m to 6.49m and 6.69m to 6.93m.	DW SW DW					6.08 m; J, **10°**, P, V, O, W 6.21 m; J, **15°**, P, V, O, W 6.27 m; J, **10°**, P, R, O, W 6.33 m; J, **10°**, S, R, O, W 6.36 m; J, **10°**, P, R, O, W 6.41 m; J, **15°**, P, R, O, L 6.48 m; J, **10°**, P, R, O, L 6.71 m; J, **10°**, P, R, O, L 6.79 m; J, **10°**, P, R, O, L 6.86 m; J, **10°**, S, R, O, L
	6.93		TUFF fine to medium grained, light grey, massive, with widely spaced fractures, possible shear zone at 9.60m.	FR			100	70	7.37 m; J, **10°**, P, V, O, Z 7.85m, Is50 = 2.71 MPa
	10.00						100	100	8.94 m; J, **70°**, P, R, O, C 9.05m, Is50 = 2.77 MPa 9.22 m; J, **10°**, P, V, O, Z 9.42 m; J, **15°**, P, R, O, Z 9.61 m; J, **60°**, P, R, O, W

Comments:
1. Groundwater encountered at 2.00m.
2. Borehole bailed on completion of drilling and groundwater monitoring well installed to 9.20m (RL -5.0m). 3. Steady water level measured at 3.90m on 15/1/16 and 3.8m 03/02/16.

Chainage :m Offset : m
Water First Noted Water Steady Level

Defects - 1.54m : F,60°,P,R,O,C

Depth (m) | Type | Dip (deg) | Planarity | Roughness | Aperature | Infill
Type: B - Bedding; C - Clay seam; F - Foliation; H - Schistosity; J - Joint; L - Cleavage; R - Fracture; S - Shear zone; T - Contact; V - Vein; Z - Decomposed Zone; DI - Drilling Induced break
Planarity: C - Curvilinear; D - Discontinuous; P - Planar; S - Subplanar; T - Stepped; U - Undulating
Roughness: L - Slickensides; P - Polished; R - Rough; S - Smooth; V - Very rough
Aperature: C - Closed; F - Filled; N - Clean; O - Open; S - Stain
Infill: C - Clay; F - Iron Oxide; K - Calcite; L - Limonite; Q - Quartz; S- Secondary mineral; U - Unidentified mineral; W - Weathered rock; X - Carbonaceous; Z - Clean

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: MG
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 09

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 13/01/2016

Easting: 503780 Northing: 6959568 RL: 4.2 m
Logger: DA/CB Operator: DA Machine: Scout

Depth	Graphic	Description	Weathering	Strength (Estimated) RS VW W MS S VS	Defect Spacing 20 60 200 600	Rec (%)	RQD	Samples and Remarks
		TUFF fine to medium grained, light grey mottled light red, massive, with widely spaced fractures, with a near vertical joint between 13.70m and 13.95m.	FR			100	100	10.61 m; J, **10°**, P, R, O, Z 10.73 m; J, **10°**, P, R, O, Z
11.0								11.32 m; J, **15°**, S, R, O, Z
12.0						100	94	12.75m, Is50 = 2.51 MPa 12.66 m; J, **15°**, P, V, O, Z 12.91 m; J, **20°**, P, V, O, Z
13.0								
14.0								13.80 m; J, **70°**, U, R, O, U
14.10		TUFF fine to medium grained, light grey mottled light green, massive, with moderately widely spaced fractures.	SW - FR					14.33 m; J, **10°**, P, R, O, Z 14.50 m; J, **10°**, P, R, O, Z 14.57 m; J, **15°**, P, V, O, Z 14.73 m; J, **10°**, T, R, O, Z
15.0						98	89	
16.0								15.86 m; J, **10°**, P, V, O, Z 16.15 m; J, **70°**, P, R, O, U
17.0								16.63 m; J, **70°**, T, R, O, U 16.95m, Is50 = 3.38 MPa
17.00		TUFF fine to medium grained, light grey mottled light red, massive, with very widely spaced fractures.	FR					
18.0						100	100	
19.0								19.8m, Is50 = 5.59 MPa
20.0								

Drilling Method: TC, WB, RR, NMLC, Casing

Comments:
1. Groundwater encountered at 2.00m.
2. Borehole bailed on completion of drilling and groundwater monitoring well installed to 9.20m (RL -5.0m). 3. Steady water level measured at 3.90m on 15/1/16 and 3.8m 03/02/16.

Chainage :m Offset : m
Water First Noted Water Steady Level

Defects - 1.54m : F,60°,P,R,O,C

Depth (m) | Type | Dip (deg) | Planarity | Roughness | Aperature | Infill
B - Bedding | C - Curvilinear | L - Slickensides | C - Closed | C - Clay
C - Clay seam | D - Discontinuous | P - Polished | F - Filled | F - Iron Oxide
F - Foliation | P - Planar | R - Rough | N - Clean | K - Calcite
H - Schistosity | S - Subplanar | S - Smooth | O - Open | L - Limonite
J - Joint | T - Stepped | V - Very rough | S - Stain | Q - Quartz
L - Cleavage | U - Undulating | | | S- Secondary mineral
R - Fracture | | | | U - Unidentified mineral
S - Shear zone | | | | W - Weathered rock
T - Contact | | | | X - Carbonaceous
V - Vein | | | | Z - Clean
Z - Decomposed Zone
DI - Drilling Induced break

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

Rock Strength
VW - Very weak
W - Weak
MS - Medium strong
S - Strong
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Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved: MG
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 09

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 13/01/2016

Easting: 503780 Northing: 6959568 RL: 4.2 m
Logger: DA/CB Operator: DA Machine: Scout

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	Weathering	Strength (Estimated: RS VW W MS S VS)	Defect Spacing (20 60 200 600)	Rec (%)	RQD	Samples and Remarks
	20.20			FR			100	100	20.15m, Is50 = 6.77 MPa
			BOREHOLE BH 09 TERMINATED AT 20.20 m						

21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0

Comments:
1. Groundwater encountered at 2.00m.
2. Borehole bailed on completion of drilling and groundwater monitoring well installed to 9.20m (RL -5.0m). 3. Steady water level measured at 3.90m on 15/1/16 and 3.8m 03/02/16.

Chainage :m Offset : m
Water First Noted Water Steady Level

Defects - 1.54m : F,60°,P,R,O,C

Depth (m) | Type: B - Bedding, C - Clay seam, F - Foliation, H - Schistosity, J - Joint, L - Cleavage, R - Fracture, S - Shear zone, T - Contact, V - Vein, Z - Decomposed Zone, DI - Drilling Induced break | Dip (deg) | Planarity: C - Curvilinear, D - Discontinuous, P - Planar, S - Subplanar, T - Stepped, U - Undulating | Roughness: L - Slickensides, P - Polished, R - Rough, S - Smooth, V - Very rough | Aperature: C - Closed, F - Filled, N - Clean, O - Open, S - Stain | Infill: C - Clay, F - Iron Oxide, K - Calcite, L - Limonite, Q - Quartz, S- Secondary mineral, U - Unidentified mineral, W - Weathered rock, X - Carbonaceous, Z - Clean

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: MG
Date: 4/02/2016

Client: 825 Stanley Street Pty Ltd
Project: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba

Project no: 110-12516

SSE Borehole: 9
Depth: 5.80m - 11.00m
Box: 1 of 3

Client: 825 Stanley Street Pty Ltd
Project: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba

Project no: 110-12516

SSE Borehole: 9
Depth: 11.00m - 17.00m
Box: 2 of 3

PointID : BH 09 Depth Range: 11.00 - 17.00 m

SOIL SURVEYS

TITLE

825 Stanley Pty Ltd
825 Stanley Street, Woolloongabba
Apartment Buildings
Core Photo - BH 09

DRAWN	CB	DATE	18/01/2016
CHECKED	GB	DATE	18/01/2016
SCALE	Not To Scale		A4
PROJECT No	110-12516	FIGURE No	1/2

Client: 825 Stanley Street Pty Ltd
Project: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba

SSE Borehole: 9
Depth: 17.00m - 20.20m
Box: 3 of 3

Project no: 110-12516

SOIL SURVEYS

TITLE

825 Stanley Pty Ltd
825 Stanley Street, Woolloongabba
Apartment Buildings
Core Photo - BH 09

DRAWN	CB	DATE	18/01/2016
CHECKED	GB	DATE	18/01/2016
SCALE	Not To Scale		A4
PROJECT No	110-12516	FIGURE No	2/2

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 10

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 14/01/2016

Easting: 503768 Northing: 6959624 RL: 5.0 m
Logger: DA/CB Operator: DA Machine: Scout

Depth	Graphic	Description	Weathering	Strength (Estimated: RS VW W MS S VS)	Defect Spacing (20 60 200 600)	Rec (%)	RQD	Samples and Remarks
0.02		BITUMEN						
0.08		FILL Gravelly SAND (SP) Medium dense, fine to coarse grained, brown, fine to medium sized gravel, dry.						
0.70		FILL ASH Loose, fine to coarse grained, black, dry.						SPT 3, 1, 2 N=3
1.10		FILL Clayey Gravelly SAND and ASH (SC) Very loose, fine to coarse grained, brown and dark grey/black, fine to medium sized gravel, moist.						
1.60		NATURAL Sandy CLAY (CH) Firm, high plasticity, grey brown, fine grained sand, wet.						U50 PP = 200
		Sandy CLAY (CH) Stiff to very stiff, high plasticity, red-brown and grey mottled, fine to medium grained sand, moist.						
2.40		Sandy CLAY (CH) Very stiff, high plasticity, grey and brown mottled, fine grained sand, moist.						
3.40		Sandy CLAY (CH) Very stiff, high plasticity, light grey mottled, fine to coarse grained sand.						U50 PP = 200-450
4.30								
4.50		TUFF(DW) Very weak, light grey.						SPT 50/60mm N=R
4.60		TUFF (SW) Strong, light yellow-brown and light grey.	DW - SW					
		TUFF fine to medium grained, light grey mottled orange with some limonite staining, massive, with widely spaced fractures with a dark brown mineral infill in some defects, some evidence of near vertical jointing.				100	83	4.92m, Is50 = 4.44 MPa 5.34 m; J, **70°**, U, V, O, X
			SW					
			DW					6.36 m; J, **15°**, S, R, O, W 6.46 m; J, **20°**, S, V, O, Z 6.50 m; J, **15°**, P, R, O, W 6.54 m; J, **15°**, P, R, O, W 6.58 m; J, **15°**, S, V, O, W 6.9m, Is50 = 3.5 MPa 7.05m, Is50 = 1.93 MPa
			SW			100	55	
			DW - SW					7.43 m; J, **70°**, P, R, O, L 7.70 m; J, **80°**, U, V, O, X 8.10 m; J, **80°**, U, C, X 8.23 m; J, **10°**, T, V, O, X 8.39 m; J, **15°**, S, R, O, W 8.51 m; J, **10°**, S, R, O, W
9.00		TUFF fine to medium grained, light grey, massive with very widely spaced fractures.	FR			100	89	8.80 m; J, **75°**, S, V, O, X 9.95m, Is50 = MPa
10.0								

15/01/16
03/02/16

Comments:
1. Groundwater not encountered during augering.
2. Borehole bailed on completion of drilling and groundwater monitoring well installed to 10.0m (RL-5.0m).
3. Steady water level measured at 5.80m on 15/1/16 and 6.3m 03/02/16.

Chainage :m Offset : m
Water First Noted Water Steady Level

Defects - 1.54m : F,60°,P,R,O,C

Depth (m) Type Dip (deg) Planarity Roughness Aperature Infill
B - Bedding C - Curvilinear L - Slickensides C - Closed C - Clay
C - Clay seam D - Discontinuous P - Polished F - Filled F - Iron Oxide
F - Foliation P - Planar R - Rough N - Clean K - Calcite
H - Schistosity S - Subplanar S - Smooth O - Open L - Limonite
J - Joint T - Stepped V - Very rough S - Stain Q - Quartz
L - Cleavage U - Undulating S- Secondary mineral
R - Fracture U - Unidentified mineral
S - Shear zone W - Weathered rock
T - Contact X - Carbonaceous
V - Vein Z - Clean
Z - Decomposed Zone
DI - Drilling Induced break

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: MG
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 10

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 14/01/2016

Easting: 503768 Northing: 6959624 RL: 5.0 m
Logger: DA/CB Operator: DA Machine: Scout

Depth	Graphic	Description	Weathering	Strength (Estimated)	Defect Spacing	Rec (%)	RQD	Samples and Remarks
		TUFF fine to medium grained, light grey, massive with very widely spaced fractures. *(continued)*	FR					
11.0						100	89	11.53m, Is50 = 3.6 MPa
11.72								
12.0		TUFF fine to medium grained, light grey, massive with moderlatly widely spaced fractures. With several Calcite infilled near vertical, irregular joints.	SW - FR					12.48 m; V, **70°,** C, K 12.70 m; J, **80°,** P, R, O, K
13.0						100	83	13.1m, Is50 = 4.07 MPa
								13.70 m; V, **80°,** C, K
14.0								
								14.7m, Is50 = 2.12 MPa
15.0								15.20 m; V, **80°,** C, K
16.0						100	48	15.80 m; J, **85°,** S, R, O, K
								16.51 m; V, **5°,** C, K
17.0								16.80 m; V, **85°,** C, K
17.68								
18.0		TUFF fine to medium grained, light grey, massive with widely spaced fractures and trace calcite lenses/bands.	FR					17.9m, Is50 = 3.32 MPa
19.0						100	100	19.11 m; J, **45°,** P, R, O, K
20.0								

Drilling Method: TC, WB, RR, NMLC, Casing

Comments:
1. Groundwater not encountered during augering.
2. Borehole bailed on completion of drilling and groundwater monitoring well installed to 10.0m (RL-5.0m).
3. Steady water level measured at 5.80m on 15/1/16 and 6.3m 03/02/16.

Chainage :m Offset : m
Water First Noted Water Steady Level

Defects - 1.54m : F,60°,P,R,O,C

Depth (m) Type Dip (deg) Planarity Roughness Aperature Infill
B - Bedding C - Curvilinear L - Slickensides C - Closed C - Clay
C - Clay seam D - Discontinuous P - Polished F - Filled F - Iron Oxide
F - Foliation P - Planar R - Rough N - Clean K - Calcite
H - Schistosity S - Subplanar S - Smooth O - Open L - Limonite
J - Joint T - Stepped V - Very rough S - Stain Q - Quartz
L - Cleavage U - Undulating S- Secondary mineral
R - Fracture U - Unidentified mineral
S - Shear zone W - Weathered rock
T - Contact X - Carbonaceous
V - Vein Z - Clean
Z - Decomposed Zone
DI - Drilling Induced break

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: MG
Date: 4/02/2016

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 10

Project Number: 110-12516
Project Name: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba
Client: 825 Stanley Pty Ltd
Date: 14/01/2016

Easting: 503768 Northing: 6959624 RL: 5.0 m
Logger: DA/CB Operator: DA Machine: Scout

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	Weathering	Strength Estimated (RS VW W MS S VS)	Defect Spacing (20 60 200 600)	Rec (%)	RQD	Samples and Remarks
NMLC	20.66		TUFF fine to medium grained, light grey, massive with widely spaced fractures and trace calcite lenses/bands. *(continued)*	FR			100	100	20.38 m; V, **15°**, C, K 20.6m, Is50 = 3.35 MPa
	21.0		BOREHOLE BH 10 TERMINATED AT 20.66 m						
	22.0								
	23.0								
	24.0								
	25.0								
	26.0								
	27.0								
	28.0								
	29.0								
	30.0								

Comments:
1. Groundwater not encountered during augering.
2. Borehole bailed on completion of drilling and groundwater monitoring well installed to 10.0m (RL-5.0m).
3. Steady water level measured at 5.80m on 15/1/16 and 6.3m 03/02/16.

Chainage :m Offset : m
Water First Noted Water Steady Level

Defects - 1.54m : F,60°,P,R,O,C

Depth (m) | Type | Dip (deg) | Planarity | Roughness | Aperature | Infill
B - Bedding | C - Curvilinear | L - Slickensides | C - Closed | C - Clay
C - Clay seam | D - Discontinuous | P - Polished | F - Filled | F - Iron Oxide
F - Foliation | P - Planar | R - Rough | N - Clean | K - Calcite
H - Schistosity | S - Subplanar | S - Smooth | O - Open | L - Limonite
J - Joint | T - Stepped | V - Very rough | S - Stain | Q - Quartz
L - Cleavage | U - Undulating | | | S- Secondary mineral
R - Fracture | | | | U - Unidentified mineral
S - Shear zone | | | | W - Weathered rock
T - Contact | | | | X - Carbonaceous
V - Vein | | | | Z - Clean
Z - Decomposed Zone
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Weathering Grades
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Rock Strength
VW - Very weak
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MS - Medium strong
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Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved: MG
Date: 4/02/2016

Client: 825 Stanley Street Pty Ltd
Project: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba

Project no: 110-12516

SSE Borehole: 10
Depth: 4.60m - 10.00m
Box: 1 of 3

Client: 825 Stanley Street Pty Ltd
Project: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba

Project no: 110-12516

SSE Borehole: 10
Depth: 10.00m - 16.00m
Box: 2 of 3

PointID : BH 10 Depth Range: 10.00 - 16.00 m

SOIL SURVEYS

TITLE

825 Stanley Pty Ltd
825 Stanley Street, Woolloongabba
Apartment Buildings
Core Photo - BH 10

DRAWN	CB	DATE	18/01/2016
CHECKED	GB	DATE	18/01/2016
SCALE	Not To Scale		A4
PROJECT No	110-12516	FIGURE No	1/2

Client: 825 Stanley Street Pty Ltd
Project: Apartment Buildings
Location: 825 Stanley Street, Woolloongabba

Project no: 110-12516

SSE Borehole: 10
Depth: 16.00m - 20.66m
Box: 3 of 3

SOIL SURVEYS

TITLE

825 Stanley Pty Ltd
825 Stanley Street, Woolloongabba
Apartment Buildings
Core Photo - BH 10

DRAWN	CB	DATE	18/01/2016
CHECKED	GB	DATE	18/01/2016
SCALE	Not To Scale		A4
PROJECT No	110-12516	FIGURE No	2/2

APPENDIX C

LABORATORY TEST CERTIFICATES

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SOIL SURVEYS

POINT LOAD INDEX TEST REPORT

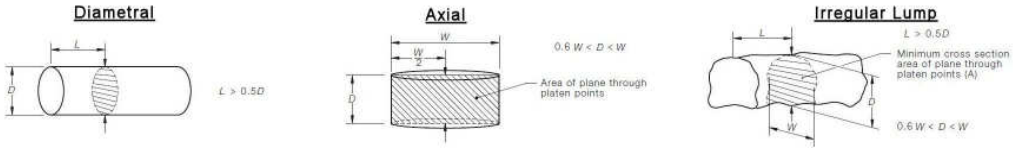
as per AS4133.4.1-2007

Project Number : 110-12516 **Project Name : Apartment Buildings**

Project Location : 825 Stanley Street, Woolloongabba

Project Client : 825 Stanley Pty Ltd

Borehole	Depth	Rock Type	Weathering Grade	Moisture Condition	Test Method	Core Size (mm)	Date Drilled	Date Tested	Failure Type	Failure Load (kN)	Is (MPa)	Is50 (MPa)	AS1726 Classification	Operator
BH 08	7.16	TUFF	DW	Field	Diametral	52	15/01/2016	18/01/2016	Along joint	0.4	0.16	0.16	LOW	CB
BH 08	8.90	TUFF	DW-SW	Field	Axial	52	15/01/2016	18/01/2016	Through rock mass	2.2	0.63	0.68	MEDIUM	CB
BH 08	10.92	TUFF	SW	Field	Axial	52	15/01/2016	18/01/2016	Through rock mass	0.7	0.2	0.22	LOW	CB
BH 08	11.54	TUFF	FR	Field	Diametral	52	15/01/2016	18/01/2016	Through rock mass	3.8	1.41	1.43	HIGH	CB
BH 08	14.88	TUFF	SW-FR	Field	Axial	52	15/01/2016	18/01/2016	Through rock mass	2.4	0.7	0.75	MEDIUM	CB
BH 08	15.90	TUFF	FR	Field	Diametral	52	15/01/2016	18/01/2016	Through rock mass	3.9	1.42	1.45	HIGH	CB
BH 08	17.89	TUFF	FR	Field	Diametral	52	15/01/2016	18/01/2016	Through rock mass	3.1	1.13	1.15	HIGH	CB
BH 08	20.85	TUFF	FR	Field	Diametral	52	15/01/2016	18/01/2016	Through rock mass	3.6	1.33	1.36	HIGH	CB
BH 08	21.12	TUFF	FR	Field	Axial	52	15/01/2016	18/01/2016	Through rock mass	4.1	1.19	1.28	HIGH	CB
BH 08	24.90	TUFF	FR	Field	Axial	52	15/01/2016	18/01/2016	Through rock mass	3.4	0.98	1.06	HIGH	CB
BH 08	26.55	TUFF	FR	Field	Diametral	52	15/01/2016	18/01/2016	Through rock mass	2.6	0.97	0.99	MEDIUM	CB
BH 09	5.95	TUFF	SW	Field	Diametral	52	13/01/2016	18/01/2016	Through rock mass	4.0	1.48	1.51	HIGH	CB
BH 09	7.85	TUFF	FR	Field	Diametral	52	13/01/2016	18/01/2016	Through rock mass	7.2	2.67	2.71	HIGH	CB
BH 09	9.05	TUFF	FR	Field	Axial	52	13/01/2016	18/01/2016	Through rock mass	8.9	2.58	2.77	HIGH	CB
BH 09	12.75	TUFF	FR	Field	Diametral	52	13/01/2016	18/01/2016	Through rock mass	6.7	2.47	2.51	HIGH	CB
BH 09	16.95	TUFF	SW-FR	Field	Axial	52	13/01/2016	18/01/2016	Through rock mass	10.8	3.14	3.38	VERY HIGH	CB
BH 09	19.80	TUFF	FR	Field	Axial	52	13/01/2016	18/01/2016	Through rock mass	17.9	5.2	5.59	VERY HIGH	CB
BH 09	20.15	TUFF	FR	Field	Diametral	52	13/01/2016	18/01/2016	Through rock mass	18.0	6.65	6.77	VERY HIGH	CB
BH 10	4.92	TUFF	DW-SW	Field	Diametral	52	14/01/2016	18/01/2016	Through rock mass	11.8	4.36	4.44	VERY HIGH	CB
BH 10	6.90	TUFF	SW	Field	Axial	52	14/01/2016	18/01/2016	Through rock mass	11.2	3.26	3.5	VERY HIGH	CB
BH 10	7.05	TUFF	SW	Field	Diametral	52	14/01/2016	18/01/2016	Through rock mass	5.1	1.9	1.93	HIGH	CB
BH 10	9.95	TUFF	FR	Field	Axial	52	14/01/2016	18/01/2016	Exceeded Machine limit	>20.0	>7.4	>7.53		CB
BH 10	11.53	TUFF	FR	Field	Diametral	52	14/01/2016	18/01/2016	Through rock mass	9.6	3.54	3.6	VERY HIGH	CB
BH 10	13.10	TUFF	SW-FR	Field	Axial	52	14/01/2016	18/01/2016	Through rock mass	13.1	3.79	4.07	VERY HIGH	CB
BH 10	14.70	TUFF	SW-FR	Field	Diametral	52	14/01/2016	18/01/2016	Along joint	5.6	2.08	2.12	HIGH	CB



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SOIL SURVEYS

POINT LOAD INDEX TEST REPORT

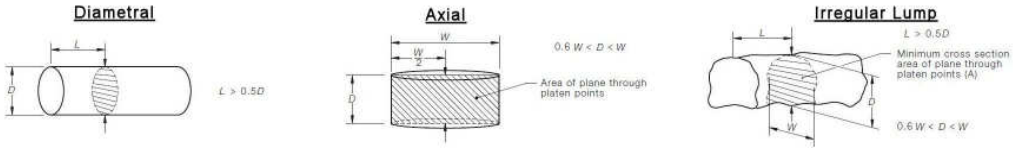
as per AS4133.4.1-2007

Project Number : 110-12516 **Project Name : Apartment Buildings**

Project Location : 825 Stanley Street, Woolloongabba

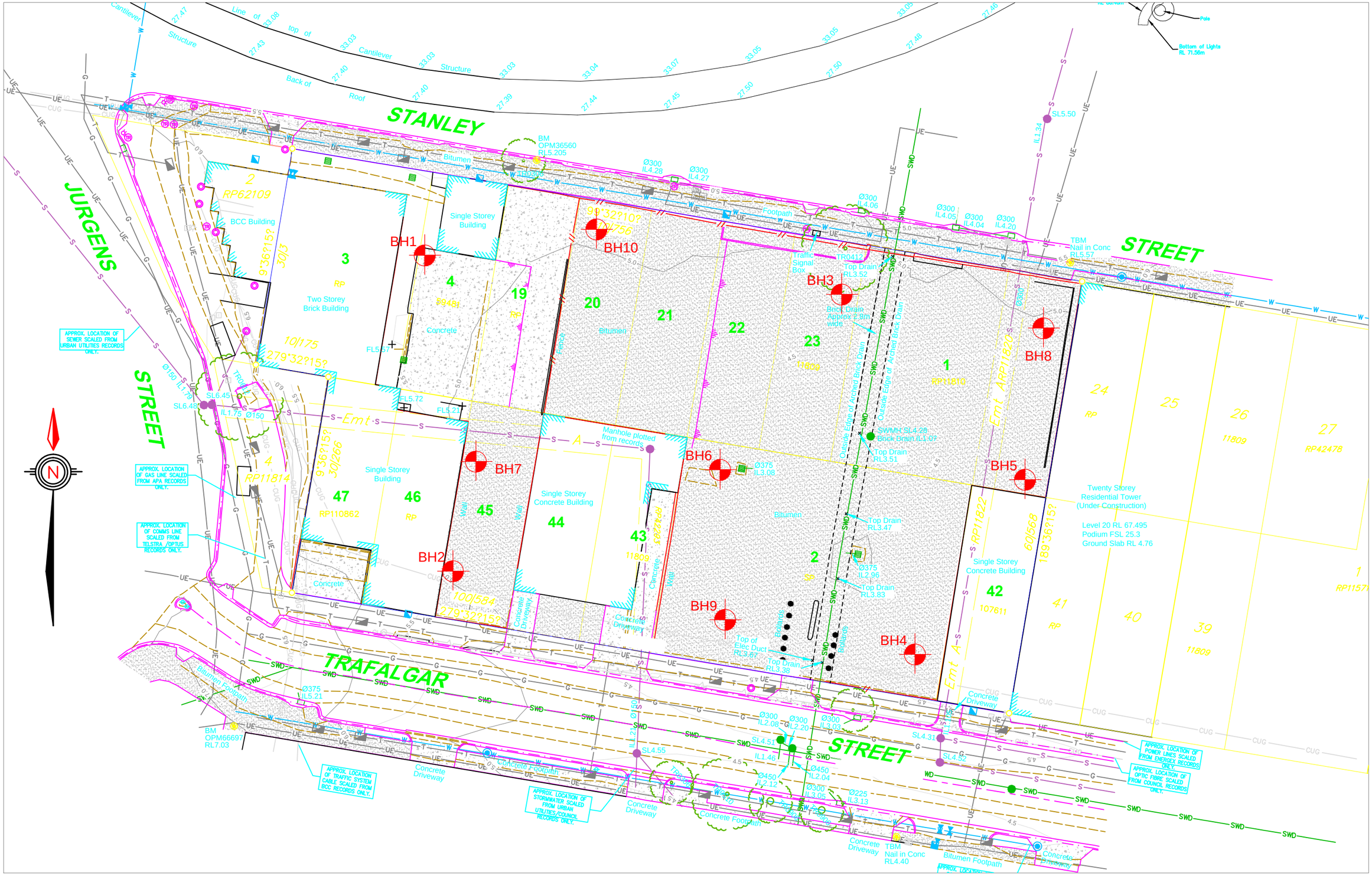
Project Client : 825 Stanley Pty Ltd

Borehole	Depth	Rock Type	Weathering Grade	Moisture Condition	Test Method	Core Size (mm)	Date Drilled	Date Tested	Failure Type	Failure Load (kN)	Is (MPa)	Is50 (MPa)	AS1726 Classification	Operator
BH 10	17.90	TUFF	FR	Field	Axial	52	14/01/2016	18/01/2016	Through rock mass	10.7	3.09	3.32	VERY HIGH	CB
BH 10	20.60	TUFF	FR	Field	Diametral	52	14/01/2016	18/01/2016	Through rock mass	8.9	3.29	3.35	VERY HIGH	CB



APPENDIX D

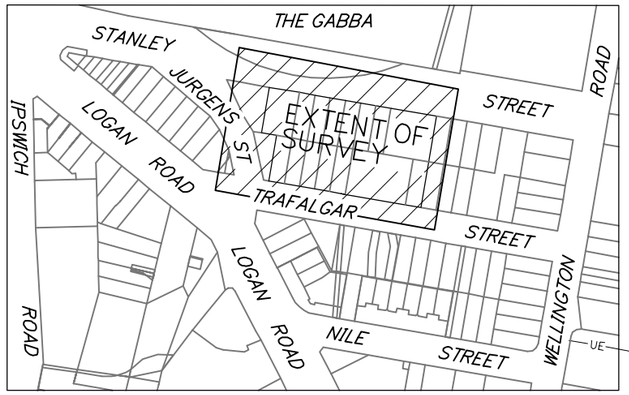
DRAWINGS

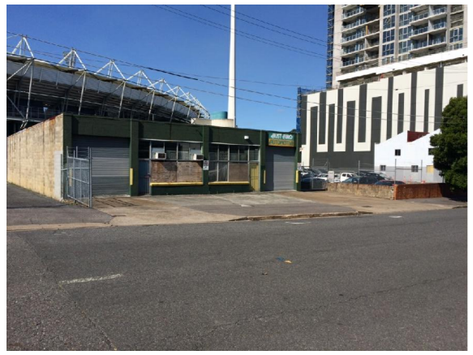


Borehole Location Plan reproduced from plan ref. S-8483-001-A

SCALE 5 0 15 25m	DRAWING TITLE	CLIENT	
REFERENCE V:\Milton\Milton 12001-13000\Milton 12401-12600\1-9819 Woolloongabba\Graphics\	APARTMENT BUILDINGS	825 STANLEY PTY LTD	Soil Surveys
A3 / DRW. NO 110-12516-02 / DATE 13/01/2016 / CHECKED MG	BOREHOLE LOCATION PLAN	LOCATION 825 STANLEY ST, WOOLLOONGABBA	SOIL SURVEYS ENGINEERING PTY.LIMITED Specialists in Applied Geotechnics

KEY MAP

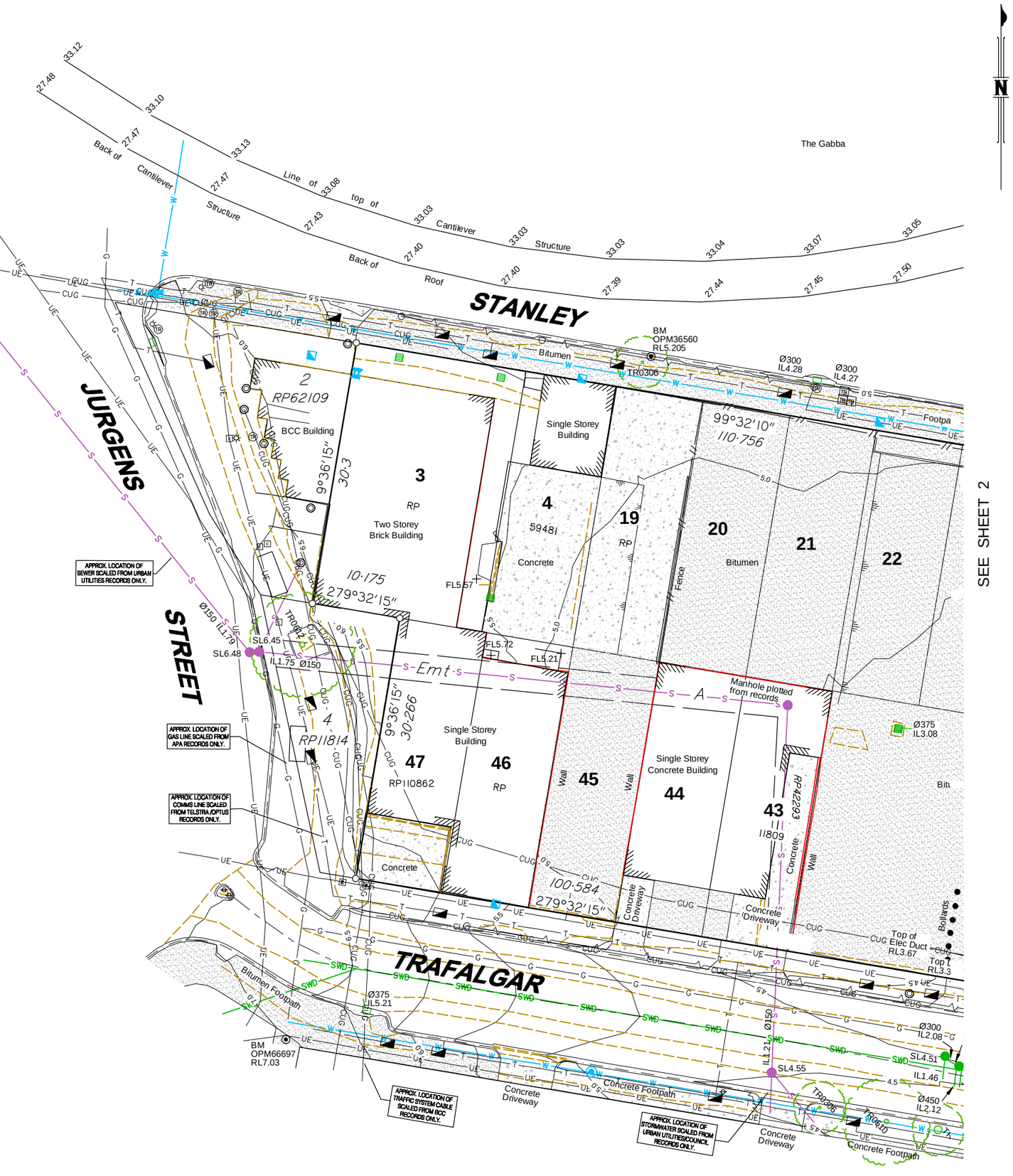




Stanley Street
Looking North toward The Gabba

Legend

CAG	Comms Above Ground	BH	Bore Hole
COMK	Comms Marker	BOL	Bollard
COMP	Comms Pit		Edge Garden
CUG	Comms Under Ground		Fence
SWD	Drainage Swug	IO	Inspection Opening
	Drainage Centre Line	MH	Unidentified Manhole
SWMH	Stormwater MH	PO	Post
SWGT	Stormwater Gully Trap	SI	Sign
SWFI	Field Inlet Pit	TBM	Temporary Bench Mark
SWKA	Stormwater Kerb Adaptor	T	Telecom Line
UE	Power Line Under Ground	TEL	Telecom Pit
	Power Line Above Ground	TELBOX	Telecom Telbox
ELMK	Electrical Marker	TEM	Telecom Marker
ELP	Electrical Pillar	TP	Telecom Pole
ELPI	Electrical Pit		Bottom of Bank
GW	Guy Wire Anchor		Top of Bank
LAMP	Lamp Post		Change of Grade
LP	Light Pole		Water Line
PP #	Power Pole		Edge of Vegetation
PPL	Power Pole with Light	TR 0306	Tree - 0.3m Dia Trunk & 6m Canopy Spread
PPLT	PP with Light & Transformer	W	Water Main
PPT	Power Pole with Transformer	HR	Fire Hose Reel
G	Gas Main	HY	Water Hydrant
GM	Gas Meter	SPR	Water Sprinkler
GV	Gas Valve	SV	Water Valve
	Road Crown	TAP	Water Tap
	Edge of Bitumen	WBE	Hydrant Booster
	Edge Track	WM	Water Meter
GP	Guide Post	WMK	Water Marker
	Guard Rail		Bitumen
	Road Kerb Invert		Concrete
S	Sewer Main		Dirt
SMH	Sewer Manhole		Garden
SMK	Sewer Marker		Gravel / Rock
SVE	Sewer Vent		Pavers
	Awning / Top of Gutter		Tiles



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T.H. Jensen & Bowers Pty. Ltd. (Consulting Surveyors)
ABN. 52 010 872 607

Associated Consultants

Local Authority:	Brisbane C.C.
Authority Ref. No:	
RP Description:	Lots 19-23 & 43-46 on RP11809, Lot 1 on RP11810, Lots 3 & 4 on RP59481, Lot 47 on RP110862 & Lots 2 & 42 on SP107611
Original Portion:	165
Parish/County:	South Brisbane/Stanley
Date of Survey:	01/12/15
Level Datum:	AHD
Origin:	OPM36559 RL 9.354
Level Bk / Fld Bk:	
Horizontal Datum:	IS249973
Contour Interval:	0.5m

Scale

0 5 10 15m
1 : 500@A3 (Before Reduction)

Notes

The services shown hereon have been located where possible by field survey. Whilst due care and attention have been exercised, T.H. Jensen and Bowers Pty. Ltd. does not warrant that the services have been located in their entirety.

The boundaries shown hereon are for plotting purposes only and are subject to final survey.

The location of underground service lines are approximate only and have been plotted from field survey observations and/or service searches. Should their accurate location be critical to detail design we recommend further investigation.

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Drawn:	ML	Date:	03/12/15
Surveyed:	BR	Date:	01/12/15
Checked:	DH	Date:	08/12/15
Approved:			

Issue	Description	Date	Appd
A	Original Issue	08/12/15	DH
B	Adjoining Substation Added	18/12/15	DNH

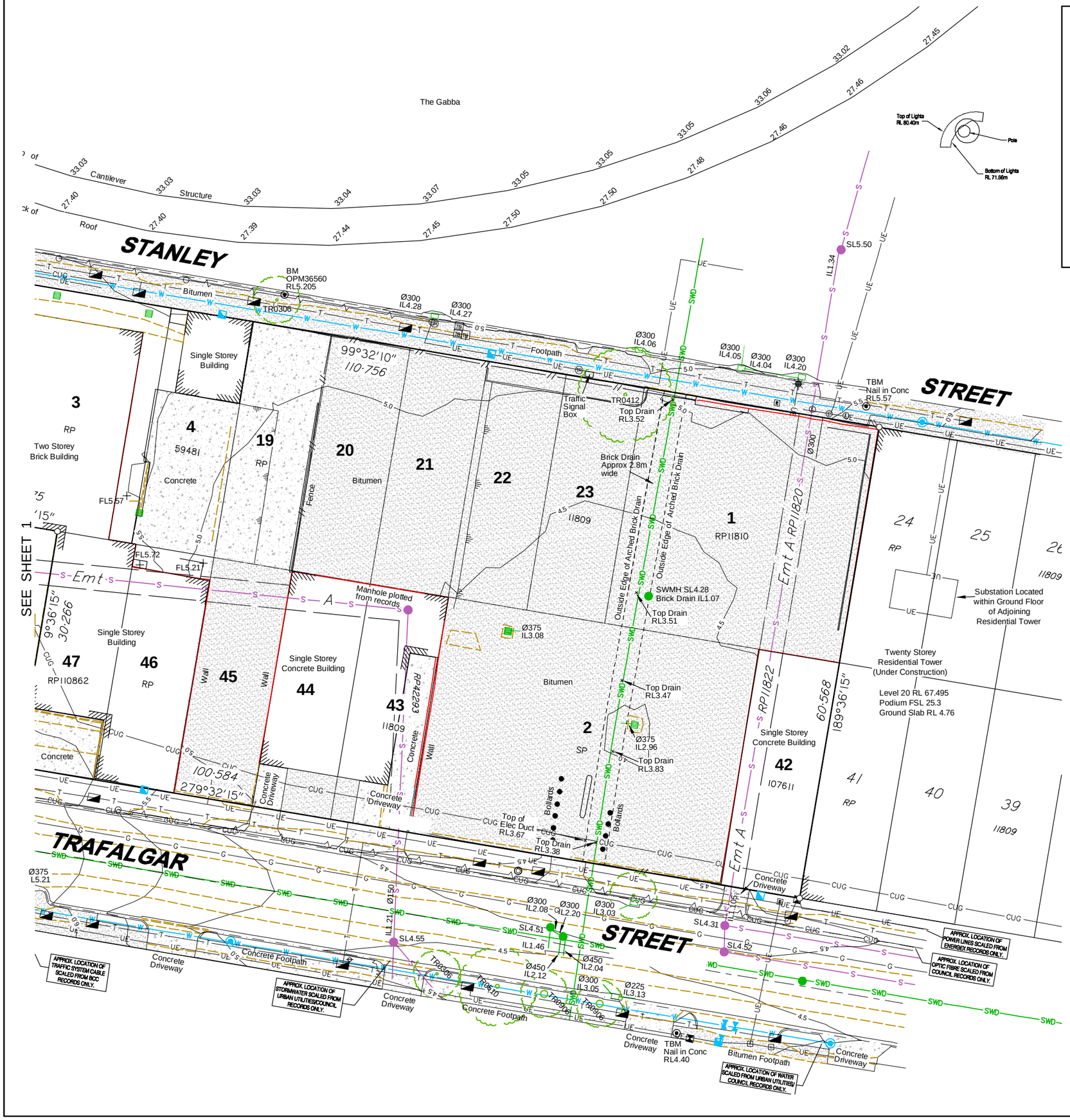
Client

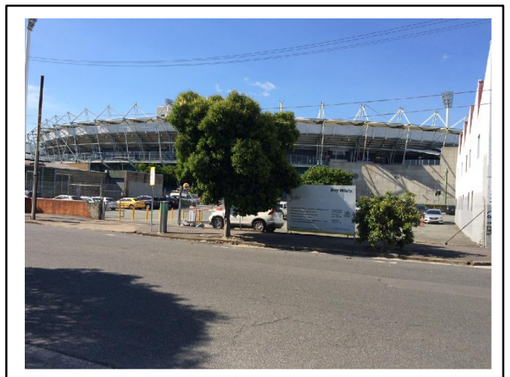
825 Stanley Pty Ltd

825 Stanley Street Woolloongabba

Detail Survey Sheet 1 of 2

Drawing No.	Issue	Original Siz
S-8483-001	B	A3





Stanley Street
Looking North toward The Gabba

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1 : 500@A3 (Before Reduction)

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Approved:			

Issue	Description	Date	Appc
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B	Adjoining Substation Added	18/12/15	DNH

Client

825 Stanley Pty Ltd

825 Stanley Street Woolloongabba

Detail Survey Sheet 2 of 2

Drawing No.	Issue	Original Siz
S-8483-001	B	A3