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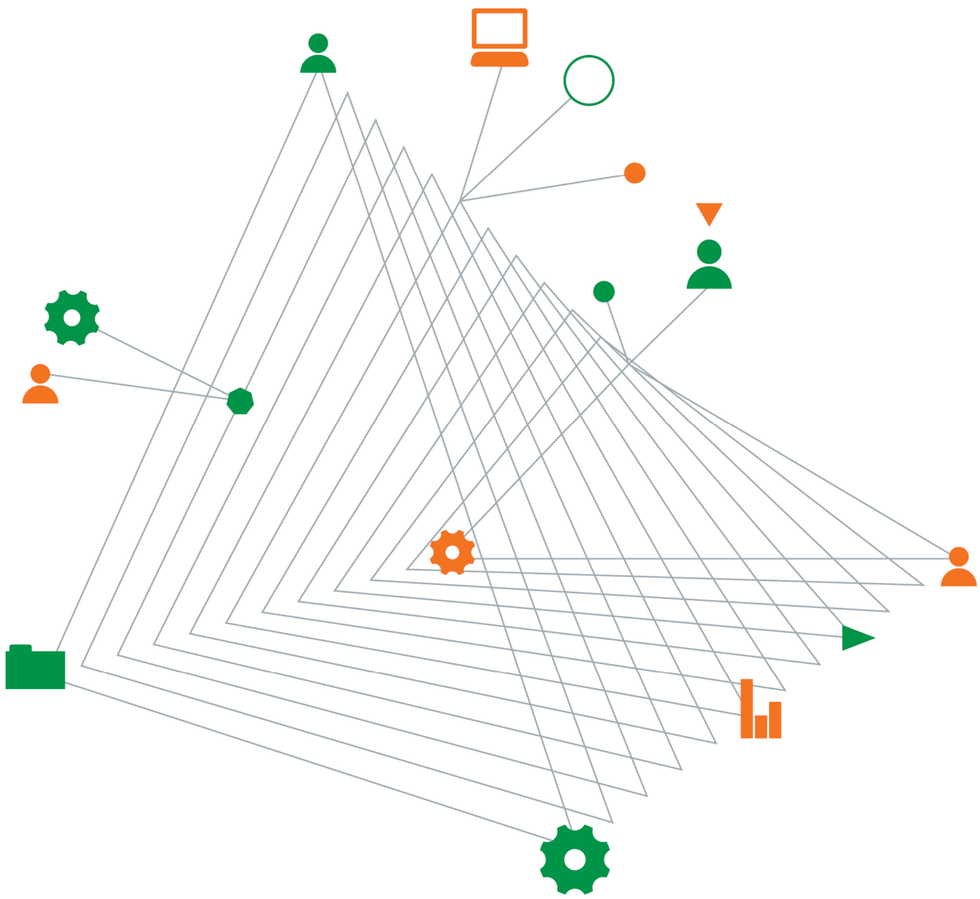
Dexus Project Pty Ltd

North Shore Private Hospital, Stage 1 - East Tower

Geotechnical Investigation Report

4 April 2016



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North Shore Private Hospital, Stage 1 - East Tower

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4 April 2016

Document authorisation

Our ref: GEOTLCOV25513AB-AB

For and on behalf of Coffey

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Geotechnical Engineer

Quality information

Revision history

Revision	Description	Date	Author	Reviewer	Signatory
V1	First issue	4/4/2016	RH	RT	RH

Distribution

Report Status	No. of copies	Format	Distributed to	Date
V1	1	PDF	Patrick Caruso, Dexus Projects	4/4/2016

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1. Introduction

This report presents the results of a geotechnical investigation for the proposed Stage 1 development of a property known as 12 Frederick Street, St Leonards (the property). Stage 1 development comprises a multi-level medical facility known as East Tower, which will be part of North Shore Private Hospital. East Tower will be located at the southern end of the subject property, occupying an area of land at the north east corner of Reserve Road and Westbourne Street (the Stage 1 site).

The geotechnical investigation was commissioned by Dexus Project Pty Ltd following our fee proposal reference GEOTLCOV25513AA-AD dated 7 March 2016, submitted to Donald Cant Watts Cork. Coffey has previously submitted a desktop study for this site (reference GEOTLCOV25513AA-AC).

This report presents the findings of the geotechnical investigations and provides comments and recommendations on the following aspects of the proposed Stage 1 development:

- Geotechnical model of subsurface conditions.
- Groundwater conditions.
- Foundation conditions, suitable footing systems and geotechnical design parameters.
- General discussions on quarry face condition, support options and geotechnical parameters.

2. The site and proposed Stage 1 development

2.1. Local geology and quarry history

The site locality is situated over landforms associated with the Ashfield Shale of the Wianamatta Group (typically black to dark grey shale and laminite), close to the geological interface with the underlying Hawkesbury Sandstone (typically medium to coarse grained, quartzose sandstone). At this separation is the variable Mittagong Formation, several metres thick comprising interbedded shale, laminite and medium-grained quartzose sandstone.

The locality was a former low shale ridge that was subject to quarrying for brick-making from about 1880 to the late 1960s (see Plate 1). Quarrying ceased about half a century ago, with the floor of the former quarry likely extending to the underlying Mittagong Formation or Hawkesbury Sandstone.

Plate 1 - North Sydney Brick & Tile Co No 1 pit at Artarmon 1956. (source http://trove.nla.gov.au/version/205756622)

2.2. Current site conditions

The Stage 1 site is located within the south western part of the former quarry footprint and is situated adjacent to the Royal North Shore Hospital Education Building to the south on Westbourne Street and the North Shore Private Hospital to the west on Reserve Road. Figure 1 outlines the site location.

The Stage 1 site is mostly vacant, mostly steeply sloping and heavily vegetated. There is a levelled portion in the southern corner of the site that was formerly the site of a hospital helipad. An existing underground tank is present on the south-eastern edge of site, and has been investigated as part of a separate contamination study.

The northern portion of the Stage 1 site is occupied by an elevated concrete carpark that is part of the existing property development comprising warehouses/commercial structures built at lower elevation to the adjacent road levels. The structures are predominantly concrete floored warehouses approximately 10m high, with rooftops used for parking.

2.3. Quarry wall exposures

Former quarry walls are exposure to a depth of about 18 m below street level to the north of the Stage 1 site. These exposures indicate weathered Ashfield Shale bedrock, grading from residual soil at road level, to slightly weathered to fresh bedrock at the base of the excavation. The weathering due to exposure may disguise the true rock condition behind the faces. Plate 2 shows a typical rock excavation observable to the north of the Stage 1 development.

Plate 2 – Photo of exposed shale to the north of Stage 1 development

Our desktop study (GEOTLCOV25513AA-AC) identified the following possible members within the Ashfield Shale:

- The lower shale face that is cut more steeply represents the Rouse Hill Siltstone member, comprising dark grey to black siltstone/mudstone.
- The upper quarry wall faces are assessed as the Kellyville Laminite member which is a regularly laminated dark grey siltstone and fine-grained sandstone.

- It is possible that the overlying Regentville Siltstone is located at the uppermost quarry face but this was not detected.

2.4. Nearby geotechnical information

Coffey has previously completed an investigation for a hospital building located on the south side of Westbourne Street. This investigation encountered ground conditions relatively consistent with those observed in the quarry faces. The boreholes extended to a maximum depth of 20 m, and a toe elevation of about RL 76 m. In summary these borehole encountered:

- Up to 1.5 m of fill and topsoil or residual soil.
- Up to 13 m thickness of shale of low strength, with variable weathering between extremely weathered and moderately weather, with overall weathering generally decreasing with depth.
- Up to 8 m thickness of moderately weathered shale, typically of low to medium strength.
- Slightly weathered, medium strength shale to the depth of investigation. The top of this unit varied from RL 80 m and RL 76 m.

The depths and condition of these units showed significant variation across the lateral extent of site.

Groundwater was encountered at RL 86.9 m within a standpipe piezometer on the nearby site.

2.5. Proposed Stage 1 development

The new development will consist of a five to six level medical facility, with ground floor level at about RL 98m (near current street level at the intersection of Reserve Road and Westbourne Street at the south corner of the site). Below this will be a three level basement for underground car parking and storage.

The current design documents show the lowest of the three basement levels will be cut into the slope to a depth of about RL 87 m, and be supported by columns above the old quarry level (approximately RL 77 m) to create an undercroft (see Plate 3).

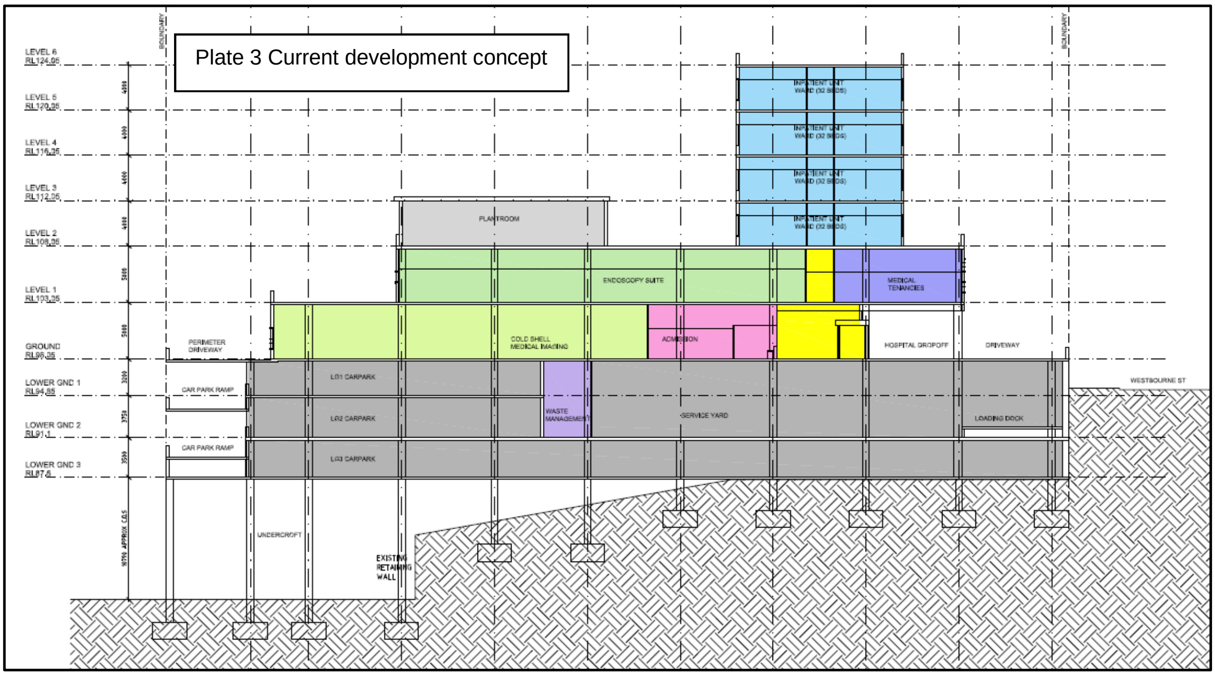

Plate 3 Current development concept

3. Drilling Investigation

Coffey's drilling investigation was undertaken on 15 to 18 of March, 2016. It consisted of the following boreholes at locations shown on Figure 1:

- A cored borehole BH01 drilled from helipad level (about RL 97.5m) to a depth of 25.4m (about RL 72.1m);
- An augered borehole BH04 drilled at current street level (about RL 97.5m) to termination at 9.1m depth (about RL 88.4m);
- Three cored boreholes (BH02, BH03 and BH05) drilled from the carpark decks at the north end of the Stage 1 site (about RL 77m) to depths of 6.6m to 8.9m (elevations RL 70.4m to 68.1m). Groundwater monitoring wells were installed to a depth of 6 m in BH02 and BH03
- Three hand augered holes (AH01 to AH03) completed to depths between 0.4m and 0.55m below ground level. These holes were for sampling soils for contamination assessment, results of which are reported separately.

A Coffey geotechnical engineer was present during fieldwork to direct drilling, record test results, log encountered ground conditions and box the rock core.

Solid flight augers were used to drill through the surficial soils and extremely/highly weathered bedrock. Standard Penetration Tests (SPTs) were undertaken during auger drilling at 1.5m intervals to assess in-situ strength and obtain soil samples.

Rock was cored using NMLC diamond core drilling techniques. Following fieldwork, Point Load Index Strength testing was conducted on rock core. The results are included on the borehole logs.

Appendix A contains borehole logs, rock core photographs and Coffey soil and rock description and explanation sheets.

4. Outcomes of the Drilling investigation

It is inferred that quarrying extended to the site boundaries. The quarry wall faces expose a typical residual soil and deeply weathered shale bedrock profile. The former quarry walls are steeply sloping, probably at slopes similar to those exposed to the north of the Stage 1 site below Reserve Road. Plate 2, above, shows an exposed rock face with a slope of about 70 to 80 degrees, with significant weathering causing deterioration of the slope, and an accumulation of debris at the toe of the slope.

These slopes within the Stage 1 site appear to have been buried by filling. The helipad appears to comprise deep fill that forms a level embankment at the helipad site and battered fill slope to the north (now thickly vegetated). BH01 encountered a total depth of fill of 19.5m (RL 78m), which is near the rock level encountered in borehole BH02, BH03 and BH05 (about RL 76m). The condition and batter angles present in the southern corner of site are unknown, and have only been partially identified by the borehole drilling.

The deep helipad embankment fill comprises variable clay with varying gravel content. The fill appears to be only loosely compacted to about 7m depth (SPT N values typically 4 and 5). N values increased to 10 to 12 from 7m to 13m depth, then ranged from 9 to 21 for the lower 6.5m of fill. On this basis, the lower two thirds of the embankment would be regarded as only moderately compacted. We did not detect evidence of global instability, but downslope creep movements could have occurred.

BH01 encountered dark grey to black siltstone beneath the fill (at RL 77.5 m). This is likely the Rouse Hill Siltstone member assessed in our original study. This material is massive and of medium strength. This unit was in the base of the cut faces along Westbourne Street and Reserve Road and was also observed in the boreholes referenced in Section 2.4

Sandstone representing the former quarry floor was encountered in BH02, BH03 and BH05 at about RL76.5 m to RL72.6 m. This material was typically fine to medium grained, high strength sandstone with dark grey laminations, interpreted to be Mittagong Formation, grading to Hawkesbury Sandstone at depth.

The ground water levels were measured at 1.055 m in BH02 and 1.398 m below ground level in BH03 on 1 April, 2015 (approximately RL 76 m). Observations in standpipes installed south of Westbourne Street indicated groundwater at about RL 87m in 2006. Based on this it is likely that the existing quarry exaction is draining the local area, lowering groundwater levels.

5. Geotechnical model for the Stage 1 site

5.1. Unit Stratigraphy

Figure 2 presents the inferred geotechnical model as a cross-section. This model has been based on the results of the borehole drilling. The unit boundaries and stratigraphy shown in Figure 2 are interpreted from site investigation results. Unit thicknesses and boundaries away from test locations may be different. In particular, the location of the quarry face (boundary of the Unit 1 and Unit 2 materials), and the boundary of the Ashfield Shale (Unit 2a, 2b and 2c boundaries) are currently not well understood and should be investigated further if deemed critical to design.

It should also be noted that the section cuts diagonally across the site through the geotechnical borehole locations, as shown in Figure 1, and not perpendicular to the former quarry walls (the direction of the architectural sections).

5.2. Geotechnical Units

The following summarises the geotechnical units, and presents a description of the units, and an assessment of the rock classification in accordance with Pells *et al* (1998) "Foundations on Sandstone and Shale in the Sydney Region" (Aust. Geomech. Jnl, Dec 1998).

Unit 1 Fill

Labelled in Figure 2 as Unit 1, fill on site is variable depending on location and likely origin of the fill. It is present under existing structures in the base of the excavation and through the slope that dominate the southern corner of site.

Unit 2 Shale

Unit 2 encompasses the weathering profile associated with the Ashfield Shale, and is observable in the cut faces along Westbourne Street and Reserve Road, and within BH04.

Unit 2a comprises residual clay evident only in the upper soil profile of the former quarry walls and beneath the fill in BH04.

Unit 2b comprises weathered shale detected in BH04. The weathered shale encountered in BH04 was extremely to highly weathered, red-brown, low strength shale with distinct horizontal bedding. Additional rock units will exist in this material, as observed in the boreholes for the nearby investigation (see Section 2.4), however these have not been defined here due to uncertainty with the ground conditions. The condition of rock varied significantly within the coring at these locations, hence it is considered reasonable that significant variation within the weathered shale will also be present at this site.

Unit 2c comprises is the fresh shale/siltstone observed BH01. The Unit 2c material observed is consistent with Class III Shale as per Pells et al (1998).

Unit 3 Sandstone

Unit 3 is the fresh Sandstone, which underlies the base of the quarry excavation, and appears in BH01, BH02, BH03 and BH05. The upper sandstone is consistent with the Mittagong Formation, based on defects observable in the rock core and the siltstone laminations/beds through the sandstone. This material is assessed as Class III Sandstone, as per Pells et al (1998). Deeper material, as observed below about 6 m in BH05, is Hawkesbury Sandstone. This rock may classify as Class I or Class II Sandstone, subject to further investigation.

6. Discussion & Recommendations

6.1. Material Excavatability

A summary of the excavatability of the encountered soil and rock is contained in Table 1, and is suggested as a guide only. Excavation contractors should inspect the rock core, engineering logs and core photographs to make their own judgement as to likely productivity and specific plant.

Table 1: Guidelines for Excavation

Material	Likely Minimum Plant Requirements
Units 1 & 2a	Bulldozer blade, excavator bucket
Unit 2b	Weaker rock may require bulldozer with ripper or toothed excavator bucket. Stronger zones may require a rock breaker or rock saw.
Units 2c & 3	Bulk excavation likely to require Cat D10 or equivalent bull dozer. Detail excavation likely to require rock breaker, rock hammer or rock saw.

The use of hydraulic impact hammers for bulk excavation, trimming the sides of excavations, and detailed excavation, will cause vibrations that could affect vibration sensitive structures and services. Assessment of the potential impacts of excavation induced vibrations sand noise should be considered as part of detailed design and excavation planning.

6.2. Groundwater

Groundwater was encountered approximately 1 m below ground level within the quarry excavation, approximately RL 76 m. The former quarry is likely acting as a local sump, lowering the groundwater level in the vicinity. For the current design basement level of RL87.6 m, it is expected that groundwater inflow will typically be limited to seepage through fissures in the residual soil and through joints and bedding planes in the rock mass. Based on this information, a drained basement is considered suitable for this development. A drained basement should be designed with suitable wall, and floor drainage, as well as sumps and pumps, to manage potential inflows.

6.3. Excavation support

Key geotechnical constraints for the Stage 1 development will be the support of the high slopes (5 to 10 m) in fill, residual soils and weathered bedrock, and the design of the vertical retention system around the basement levels, to retain soil and rock as well as protect the road way and services from damage due to ground movements.

Two support concepts have currently been proposed by Northrop (project structural engineers) for support of the Stage 1 site excavation. Drawings SKS-019 (Option A) and SKS-020 (Option B) prepared by Northrop show the two proposed designs for the retention system. Option A involves excavation to the site boundaries along Westbourne Street and Reserve Road. For Option B the excavation footprint is set-back from these boundaries, reducing the amount of material to be removed. The concept sketches for Option A and B are shown on Plates 4 and 5 overleaf.

Both options broadly involve

- Construction of an anchored pile wall to support the excavation to lower basement level (RL 87.6m) around southern and western perimeters.
- As the anchors are progressively installed in the pile wall, the fill associated with the existing helipad will be excavated to the slope indicated by the blue lines in Plates 4 and 5, and will be re-compacted to form a temporary berm against that slope, as indicated by the green dotted lines.
- The fill will be further redistributed to form temporary platforms for the site retention below lower basement level.

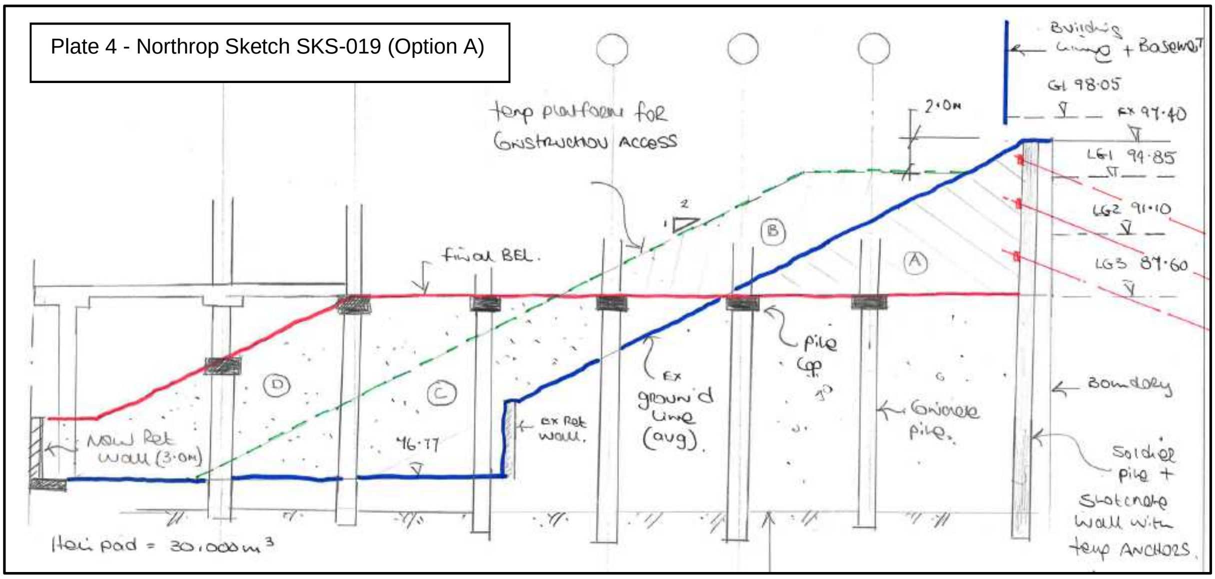

Plate 4 - Northrop Sketch SKS-019 (Option A)

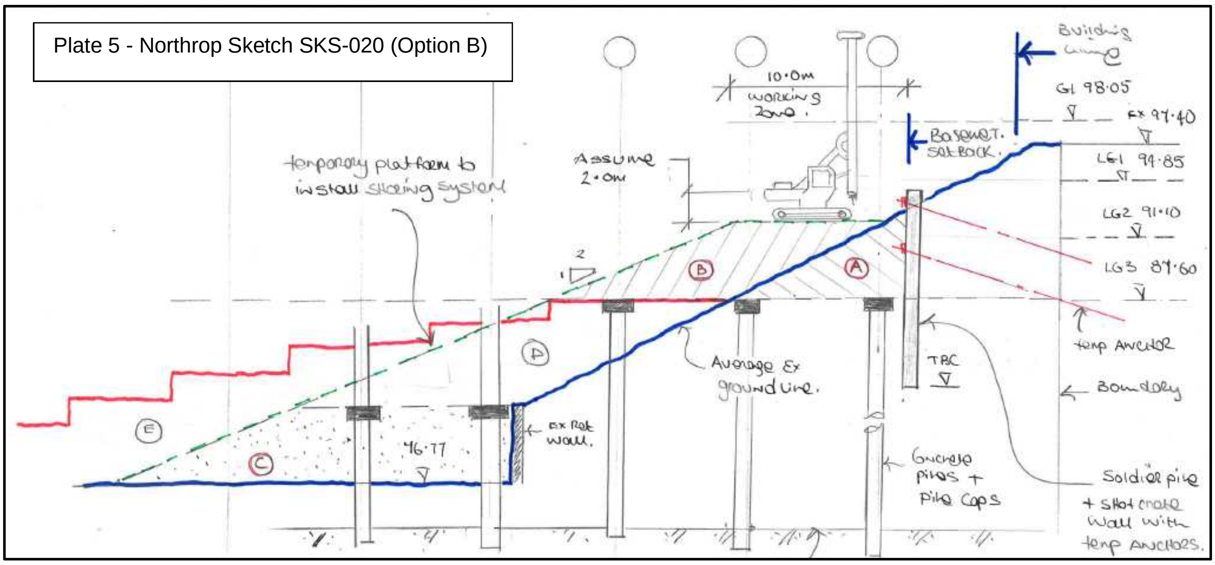

Plate 5 - Northrop Sketch SKS-020 (Option B)

These fill berms would be up to 18m high constructed from fill material won from the excavation of on-site materials. The slope on the sketches is shown as 2H:1V, but the actual slope would depend on the volume of excavated material available for re-use.

The stability of an 18m high fill embankment will depend on many factors such as the compaction of the berm embankment, the slope of the embankment, the impact of groundwater seepage (particularly along the sloping interface between existing fill and the constructed berm) and the construction surcharges due to plant and material stockpiles.

Whilst a 2H:1V slope may be “stable” with respect to temporary global stability, from a safety perspective it may be prudent to construct a benched slope, say 3m wide at 5m height intervals. It may be possible to adopt steeper slopes (say 1.5H:1V) between benches.

Slope stability will need to be assessed by specific slope analyses when material volumes and construction loads imposed on the embankment are known. Specific platform assessments for cranes and/or piling rigs will be required.

We recommend the following guidelines for berm construction:

- Fill for the berm is compacted in horizontal layers, approximately 300 mm thick, compacted to at least 95% Standard Maximum Dry Density (SMDD). Exclude unsuitable fill, such as that with high organic content or boulders greater than 200mm.
- The berm is benched into the existing fill or quarry faces at a slope not steeper than 1V:1H, with steps not deeper than 0.6m high. Subsurface drainage should be installed where seepage is detected or suspected.
- Surface drainage is installed to direct water away from slope and the berm slopes are protected from surface runoff and erosion

For Option B, based on available contour plans, the unsupported slope above the perimeter anchored pile wall may be about 1.3H:1V, and approximately 5 m in height. The slope is likely to be formed in residual soil and highly weathered shale and may be marginally stable. For long-term stability, slope stabilisation measures may be required. Treatment options may include installation of the non-tensioned soil nails/rock dowels in a grid, with the face covered with galvanised mesh and shotcrete, with the provision of vertical and/or horizontal drains. Notwithstanding these measures, such a steep slope may not be practicable if it is accessible to the public. A flatter batter may be prudent.

In the building undercroft areas, long term batter slopes of 2H:1V will likely be feasible, assuming compaction of the fill to 95% SMDD. If water ingress can occur, use of erosion protection is recommended.

Slope stability analyses should be undertaken to confirm exact requirements and details for all temporary and long term slopes when further details are available.

6.4. Retaining wall design

Current designs propose soldier pile walls, with reinforced shotcrete face panels between piles for the site retention around the perimeter of the structure. During construction, temporary rock anchors will be used to stabilise this wall, which will be propped internally by the structure for long-term stability. Table 2 below presents typical design parameters for retaining wall design.

Table 2: Parameters for retaining wall design

Unit	Bulk unit Weight γ (kN/m3)	'Active' Earth Pressure Coefficient, K_a	'At Rest' Earth Pressure Coefficient, K_0 [1]	'Passive' Earth Pressure Coefficient, K_p	C' (kPa)	ϕ' (deg)
1 – Existing Fill	17	0.4	0.5	2.5	0	25
2a Residual Soil & Engineered Fill	20	0.4	0.5	2.5	5	25
2b - Class IV/V Shale	23	0.33	0.5	3.0	25	30
2c - Class III Shale	24	-	0.5	-	100	40

1. K_0 values assume some wall movement and relaxation of horizontal stress will occur due to the excavation.
2. In-situ K_0 values in rock can be greater than 1 due to the release of locked-in stresses due to geological formation. At this location it is expected that locked-in stresses will have substantially dissipated during quarrying.

Earth pressure distributions will depend on anchor patterns and construction sequences. Active earth pressure coefficients should be adopted where wall movements of about 1% of the wall height can be tolerated. At rest pressure coefficients should be adopted where less movement can be tolerated, but even a well-designed and well-constructed wall will undergo movements of the order of 0.1% to 0.3% of the wall height where at rest pressures are adopted.

Retaining walls should be designed for hydrostatic pressures if present, unless permanent and effective drainage can be provided. Applicable surcharge loads should be added to earth pressures. Application of hydrostatic loads may be applicable to the lower portion of the wall (below RL 86.9 m) given water was encounter in previous investigations adjacent to the proposed development. These should be reviewed during detailed design.

Notwithstanding the stress relief in the rock experienced during previous quarrying, the proposed excavation will likely cause some lateral ground movements that may affect the existing roads and services. The adjacent buildings may be sufficiently remote and/or have existing basement levels that will limit the impact of stress relief due to excavation. This should be confirmed during the design stage.

Given sensitive services are likely located in the road, a relatively stiff shoring with bracing and/or tie-back anchors designed to resist pressures higher than active earth pressures may be appropriate. Such cases should be specifically addressed during detailed design. Depending on the complexity of the problem, analytical methods would range from a simple empirical assessment, through to 3-dimensional finite element analyses and consultation with the project structural engineers will be required to assess possible load influences, resulting ground movements/stresses, and additional support requirements.

6.5. Rock anchors

Temporary anchors should be designed to anchor into Class IV shale or better. Preliminary design of anchors may be based on an allowable (working) bond stress value of:

- 100 kPa in Class IV Shale.
- 300 kPa in Unit 2c (Class III Shale).
- 500 kPa in Unit 3 (Class III Sandstone.)

These values assume the anchor bond length are between 3 m and 7 m, and each anchor is proof loaded to 1.3 times the working load before locking off at the working load.

Anchor designs should be based on an allowing effective bonding with to be developed behind an 'active zone' determined by drawing a line 45° from the base of the wall to intersect the ground surface behind the excavated face.

No coring has been undertaken within the profile of the Ashfield Shale directly adjacent to the excavation. It is recommended to complete additional investigation within this material to advice detailed design. Based on the nearby investigation (see Section 2.4), material consistent with Class IV shale may occur below about RL 90 m.

The actual design load capacity of anchors should be based on a performance specification, verified by proof-testing.

6.6. Construction Induced Vibrations

The use of excavation plant such as impact hammers will generate vibrations that may affect any surrounding sensitive structures and buried services. Measures to mitigate the risks associated with vibration such as the use of rock saws or rock grinders should be considered. Table 3 presents commonly recommended vibration limits to reduce the risk of vibration damage to sensitive receptors.

Table 3: Ground Vibration Limits for Various Types of Structures

Type of Structure	Peak Particle Velocity (mm/s)
Historic buildings or monuments	2
Residential or low rise buildings in good condition	10
Reinforced concrete commercial and industrial buildings in good condition	25

It is recommended that a limit is selected considering the structure of concern. It should be noted that limits set by the relevant authorities may override these recommendations.

It is not expected that significant amount of high strength material will be required to be excavated. However, allowance should be made to possibility given cored boreholes have yet to be undertaken within the Ashfield Shale at the boundary of the site.

It is recommended a Vibration Monitoring Plan (VMP) and a Geotechnical Excavation Monitoring Plan (GEMP) be completed prior to construction being undertaken. These plans will outline the measures required to monitoring the excavations, and establish trigger levels for excessive vibrations or wall movements.

6.7. Foundations

It is expected that pad and pile footings into will be founded within Unit 2c or Unit 3 material. The fill, and upper shale units are unlikely to have sufficient capacity to for the proposed development. Designs indicate that piles and pad footing will be founded within the sandstone encountered beneath the quarry level, however it may be possible to construct foundation with sufficient capacity within the Class III shale encountered above this level.

Table 4 below presents serviceability and Limit State geotechnical design parameters that may be used for design of pad footings and bored piles into the different classes of sandstone.

Table 4: Geotechnical Foundation Design Parameters for Sandstone

Unit	Serviceability End Bearing Pressure (MPa)	Ultimate End Bearing Capacity (MPa)	Ultimate Shaft Adhesion (kPa)	Vertical Modulus (MPa)
Class III Shale	3.5 [B]	15 [B]	500 [A]	500
Class III Sandstone	6 [B]	30 [B]	1000 [A]	700

a) *For piles, shaft adhesion should only be assumed where piles have a minimum socket of at least 3 pile diameters and a socket of roughness category R2 or better is required. Values may have to be reduced if wall smear or polish is present.*

b) *Assumes construction stage assessment of the portion of material at foundation depth (pile and footing inspections)*

For the use of geotechnical design parameters for Class III or better sandstone or shale, geotechnical proving of foundation conditions for some individual footings will be required. Such proving would require construction stage geotechnical inspections to confirm rock quality.

Installation of piles or piers to Hawkesbury Sandstone below the Mittagong Formation may enable the use of higher design bearing capacity; however this would also require additional investigation at the proposed locations.

For pad footings and piles either a working stress or limit state design method could be adopted. Footings designed using the serviceability end bearing pressures given above should result in settlements of less than 1% of the least footing dimension.

For piles, a limit state design method should be used if the design is to comply with AS2159-2009 “Piling – Design and installation”. Using a limit state design method will typically result in a more efficient design.

For limit state design, the design ultimate geotechnical pile capacity is derived by applying a geotechnical strength reduction factor (ϕ_g) to the ultimate geotechnical pile capacity assessed using the ultimate shaft resistance and end bearing values shown in Table 4.

In accordance with AS2159-2009, ϕ_g is dependent on an Average Risk Rating (ARR) which takes into account various geotechnical uncertainties, foundation system redundancy, construction supervision, quantity and type of pile testing.

Below is a preliminary assessment of ARR and ϕ_g values given the extent of geotechnical investigations performed and findings at this site, based on the following assumptions:

- Low redundancy foundation system
- The design will be carried out by an experienced geotechnical professional using well-established and soundly based methods

- Well established construction processes will be adopted and detailed professional geotechnical supervision will be provided during pile construction
- Performance of the supported structure is not monitored.

Based on our current understanding of the project and the above assumptions, the following preliminary values have been assessed:

- Average Risk Rating = 3
- Geotechnical strength reduction factor, ϕ_g, 0.48 assuming no pile testing is undertaken.

Testing may provide the degree of confidence required to achieve a higher ϕ_g value and more economical design. Coffey will review the final ϕ_g selection at the detailed design stage.

Limit state design also requires assessment of the serviceability performance of the foundation system, including pile group interaction effects. This should be carried out by experienced geotechnical professional using well-established and soundly based methods. The modulus values given in Table 4 can be used, though the accuracy of settlement prediction is dependent on construction methods as well as material stiffness, both of which can involve considerable uncertainty. Settlement predictions can have a large margin for error. Serviceability pile load testing should be completed when foundation settlement is critical to performance.

If foundations are to resist uplift, the shaft adhesion should be reduced by a factor of 0.7, in addition to the application of the geotechnical strength reduction factor, ϕ_g. Uplift piles should also be checked for an inverted cone pull-out mechanism.

7. Additional geotechnical support

Coffey can provide additional geotechnical support, including:

- Additional geotechnical investigation (particularly focused on the condition of Ashfield Shale directly adjacent to the site boundary).
- Detailed geotechnical design for footings and retention systems
- Provision of construction stage advice, pile and footing inspections, excavation mapping, vibration monitoring and construction vibration and monitoring plans.

8. Closure

The descriptions of subsurface conditions described in this report are based on a limited number of test locations. This site is geologically complex and ground conditions can change over relatively short distances. The recommendations of this report should be confirmed additional geotechnical investigation, and assessment during construction by appropriate input from an experienced Geotechnical Engineer.

The document entitled “Important Information About Your Coffey Report” presents additional information on the uses and limitations of this report.

LEGEND

- BOREHOLE LOCATION
- HAND AUGER LOCATION
- APPROXIMATE SITE BOUNDARY
- SECTION LINE

no.	description	drawn	approved	date
A	ORIGINAL ISSUE	KW	RH	04/04/16

revision

10 0 10 20 30 40

Scale (metres) 1:750

drawn	KW / FA
approved	RH
date	04 / 04 / 16
scale	AS SHOWN
original size	A3

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client:	DEXUS PROJECTS PTY LTD
project:	GEOTECHNICAL INVESTIGATION PLAN 12 FREDRICK ST, ST LEONARDS
title:	BOREHOLE LOCATION PLAN
project no:	GEOTLCOV25513AB-AB
figure no:	FIGURE 1
rev:	A

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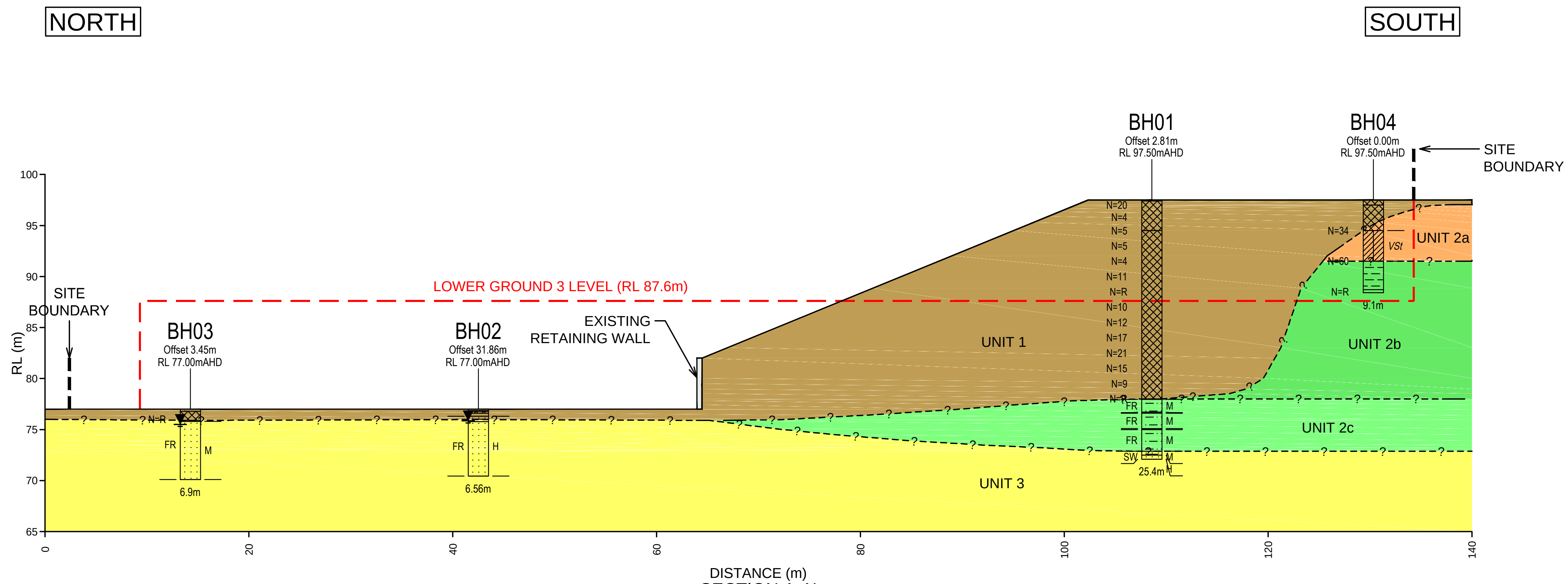


SECTION A-A'

LEGEND

- TOPSOIL
- FILL
- SILTY CLAY
- SILTSTONE
- NO CORE
- INTERBEDDED SILTSTONE & SANDSTONE
- SANDSTONE
- CONCRETE
- SHALE
- EXISTING GROUND SURFACE
- – –?– – INFERRED GEOLOGICAL BOUNDARY
- WATER LEVEL
- N*=17 STANDARD PENETRATION TEST RESULT

UNIT LEGEND

- UNIT 1 - FILL
- UNIT 2a - RESIDUAL SOIL
- UNIT 2b - WEATHERED SHALE BEDROCK
- UNIT 2c - FRESH SHALE/SILTSTONE
- UNIT 3 - SANDSTONE

NOTES:
1. ELEVATION ARE APPROXIMATED FROM CLIENT PROVIDED SURVEY PLANS.
2. BOREHOLES ARE OFFSET FROM SECTION LINE.
3. ALL MATERIAL BOUNDARIES ARE INTERPOLATED FROM INVESTIGATION LOCATIONS, SITE CONDITIONS MAY VARY FROM INFERRED GEOLOGICAL BOUNDARIES.

revision

no.	description	drawn	approved	date
A	ORIGINAL ISSUE	KW	RH	04/04/16

5 0 5 15 25
Horizontal Scale (metres) 1:500

5 0 5 15 25
Vertical Scale (metres) 1:500

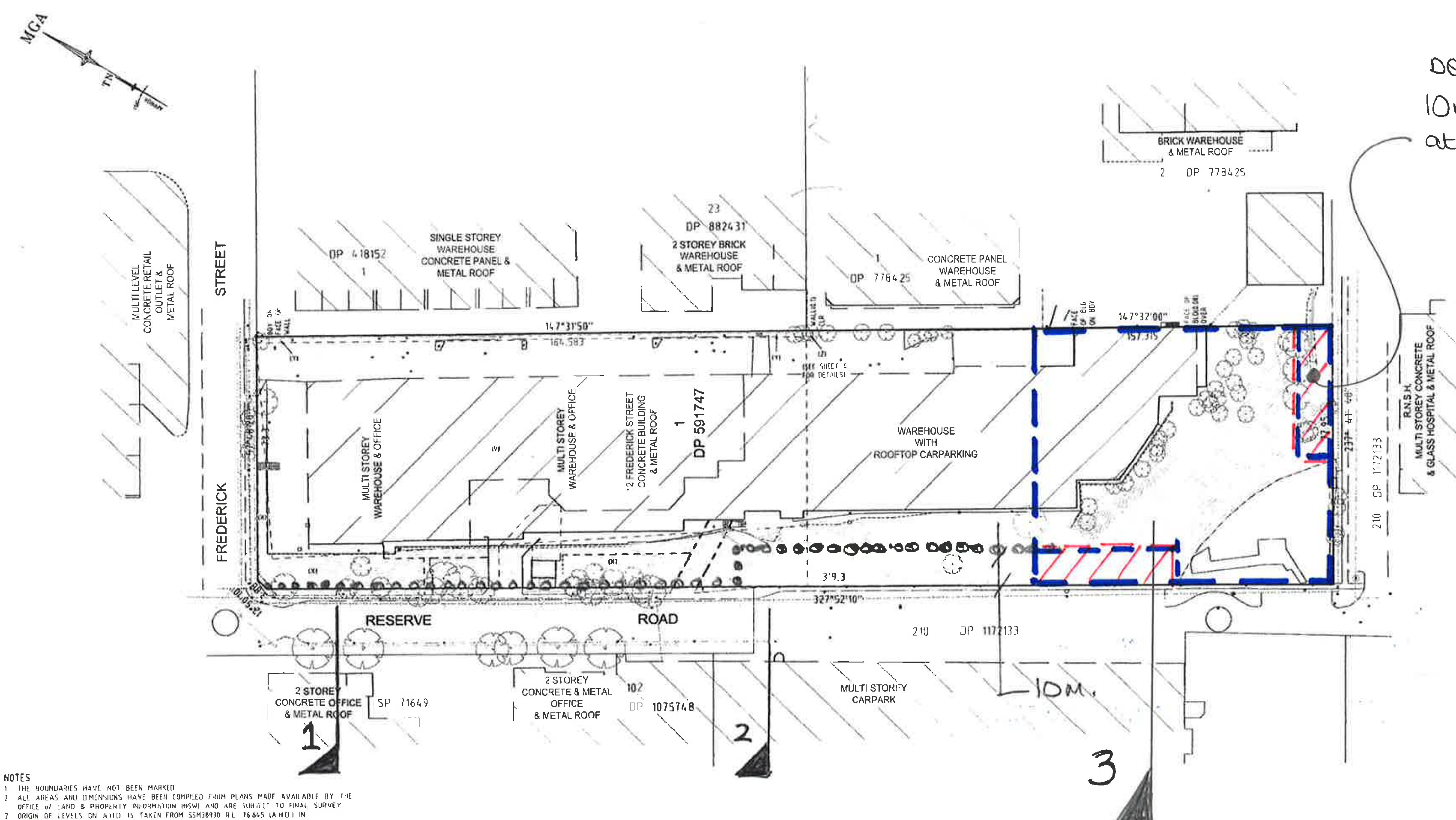
drawn	KW / FA
approved	RH
date	04 / 04 / 16
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	DEXUS PROJECTS PTY LTD
project:	GEOTECHNICAL INVESTIGATION PLAN 12 FREDRICK ST, ST LEONARDS
title:	SECTION A-A'
project no: GEOTLCOV25513AB-AB	figure no: FIGURE 2 · rev: A

PLOT DATE: 4/04/2016 11:35:22 AM DWG FILE: \\CHATFS01.CORP.COFFEY.COM.AU\DATA$\GEOTECHNICS\1.PROJECTS\GEOTLCOV\GEOTLCOV255\GEOTLCOV25513AB 12 FREDERICK ST ST LEONARDS\CAD\GEOTLCOV25513AB-AB.DWG

Dendros
10m Set Back
at LG3, LG2, LG1



LEGEND

BENCH MARK	▲
OPTUS PIT	OP
TELSTRA PILLAR	TP
COMMS PIT	COM
TELSTRA PIT	TEL
ELECTRIC LIGHT POLE	ELP
ELECTRIC LIGHT BOLLARD	LB
ELECTRICITY PIT	EPIT
ELECTRICITY BOX	EL
POWER POLE	PP
SERVICE PIT	PIT
PIT WITH CONCRETE LID	CLID
PIT WITH METAL LID	MLID
TRAFFIC LIGHT	TL
STREET SIGN	SS
BOLLARD	BOL
ROAD TRAFFIC AUTHORITY	RTA
GRATED INLET PIT	GIP
KERB INLET PIT	KIP
SEWER INSPECTION POINT	SIP
SEWER MANHOLE	SMH
STOP VALVE	SV
HYDRANT	HYD
FIRE HYDRANT	FH
FIRE SERVICE	FHST
WATER METER	WM
WATER VALVE	WV
GAS VALVE	GM
GAS VALVE	GAS
VEHICLE CROSSING	(VC)
PRAM CROSSING	(PC)
WINDOW	W
DOOR	D
HEAD/SILL	H/S
GAS (DBYD)	
TELSTRA (DBYD)	
WATER (DBYD)	
STORMWATER (DBYD)	
SEWER (DBYD)	
ELECTRICITY (OVERHEAD)	
ELECTRICITY (U/GROUND) (DBYD)	
NATIONAL BROADBAND NETWORK (DBYD)	
GAS (DETECTED)	
TELSTRA (DETECTED)	
OPTICAL FIBRE (DETECTED)	
WATER (DETECTED)	
STORMWATER (DETECTED)	
SEWER (DETECTED)	
ELECTRICITY (DETECTED)	
UNKNOWN SERVICE (DETECTED)	UKN

NOTES

1. THE BOUNDARIES HAVE NOT BEEN MARKED
2. ALL AREAS AND DIMENSIONS HAVE BEEN COMPILED FROM PLANS MADE AVAILABLE BY THE OFFICE of LAND & PROPERTY INFORMATION (NSW) AND ARE SUBJECT TO FINAL SURVEY
3. ORIGIN OF LEVELS ON A.H.D. IS TAKEN FROM SSM38990 R.L. 76.645 (A.H.D.) IN HERBERT STREET
4. CONTOUR INTERVAL 0.5m
5. CONTOURS ARE INDICATIVE ONLY. ONLY SPOT LEVELS SHOULD BE USED FOR CALCULATIONS **OF QUANTITIES WITH CAUTION**
6. ONLY SPOT LEVELS SHOULD BE USED FOR CALCULATIONS OF QUANTITIES WITH CAUTION
7. KERB LEVELS ARE TO THE TOP OF KERB UNLESS SHOWN OTHERWISE
8. FLOOR LEVELS SHOWN ARE THRESHOLD LEVELS. NO INVESTIGATION OF INTERNAL FLOOR LEVELS HAS BEEN UNDERTAKEN
9. NO INVESTIGATION OF UNDERGROUND SERVICES HAS BEEN MADE. SERVICES HAVE BEEN PLOTTED FROM RELEVANT AUTHORITIES INFORMATION AND HAVE NOT BEEN SURVEYED. ALL RELEVANT AUTHORITIES SHOULD BE NOTIFIED PRIOR TO ANY EXCAVATION ON OR NEAR THE SITE
10. 8/.4/7 DENOTES TREE SPREAD OF 8m, TRUNK DIAMETER OF 0.4m & APPROX HEIGHT OF 7m
11. SHOWS APPROXIMATE POSITION OF ROAD LINEMARKING AND IS INDICATIVE ONLY
12. BEARINGS SHOWN ARE MGA (MAP GRID OF AUSTRALIA) ADD APPROX 1°00' FOR TRUE NORTH

EASEMENTS

(V) - COVENANT (DP 591747 & H 542568)
(X) - EASEMENT FOR SUPPORT (DP 591747 & H 542567)
(Y) - EASEMENT FOR DRAINAGE (DP 591747 & H 542568)
(Z) - EASEMENT FOR DRAINAGE (DP 591747)

DIAL BEFORE YOU DIG www.1100.com.au

REFER TO NOTES AND LEGEND

0 12 18 24 36 48 60
SCALE 1:600 @ A1

Revision	Date	Description	Reference
D	00/00/00		00
C	00/00/00		00
B	00/00/00		00
A	03/08/15	initial draft plan completed	00

THIS IS THE PLAN REFERRED TO IN MY LETTER DATED

Registered Surveyor NSW

LTS LOCKLEY Registered Surveyors NSW www.lts.com.au
Suite 1, Level 1, 810 Pacific Highway Gordon NSW 2072
P 1300 587 000
F 02 9499 7760

Client: DEXUS PROPERTY GROUP
Drawing title: PLAN OF DETAIL AND LEVELS OVER LOT 1 IN DP591747 KNOWN AS 12 FREDERICK STREET ST LEONARDS

datum: AHD
site Area: 2.478ha
LGA: WILLOUGHBY
scale: 1:600 @A1
reference number: 42243DT
date of survey: 30/08/15
SHEET 1 OF 7 SHEETS

DATE	REV	ISSUE AMENDMENT	VER	APP
7/9/15	1	preliminary		SM
29/3/16	2	"		SM

PROJECT:

12 FREDERICK STREET
ST LEONARDS

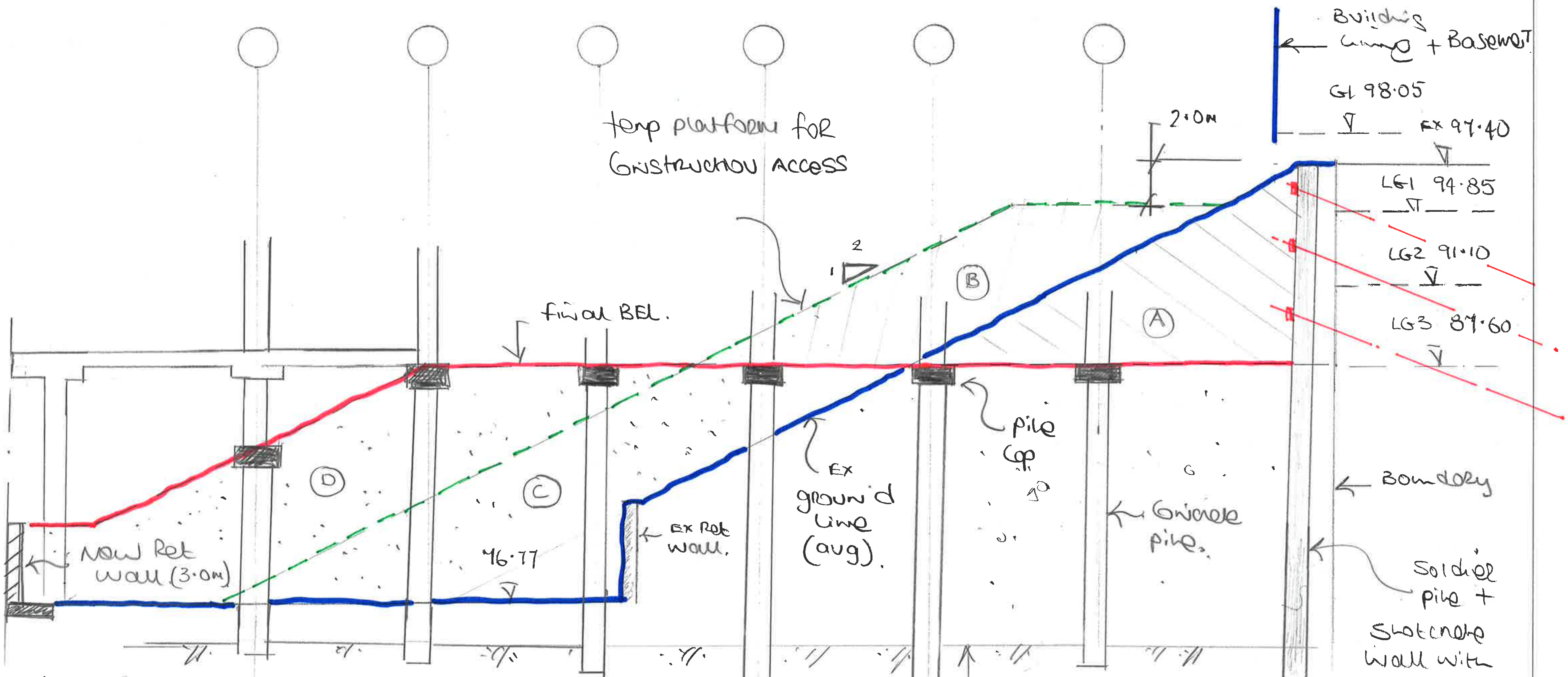
DRAWING TITLE:

SECTION LOCATIONS

All dimensions to be verified on site before making shop drawings or commencing any work. Drawing not to be used for construction unless verification signature has been added.

NORTHROP
CONSULTING ENGINEERS
SYDNEY NEWCASTLE CANBERRA WOLLONGONG
Northrop Consulting Engineers Pty Ltd ABN 81 094 433 100
Tel: (02) 9241 4188 Fax: (02) 9241 4324

DATE: 4/9/15
DRAWN: SM
SCALE: NTS
JOB No: 151627
DRAWING No/Rev: SKS-004



Heli pad = 30,000 m³

Class III sandstone.

Piling done from street.

(A) = $\left(\frac{18}{2} \times 10\right)$ = 90 m³/m run

(B) = 5 × 18 = 150 m³/m run

(C) = 5 × 27 = 135 m³/m run.

(D) = 6 × 22 × 132 m³/m run.

- (B) + (C) won from Heli pad fill
- (A) + (B) move to (D) to create construction platform + retain material on site.

DATE	REV	ISSUE AMENDMENT	VER	APP
29/3/16	1	prelim	SW.	

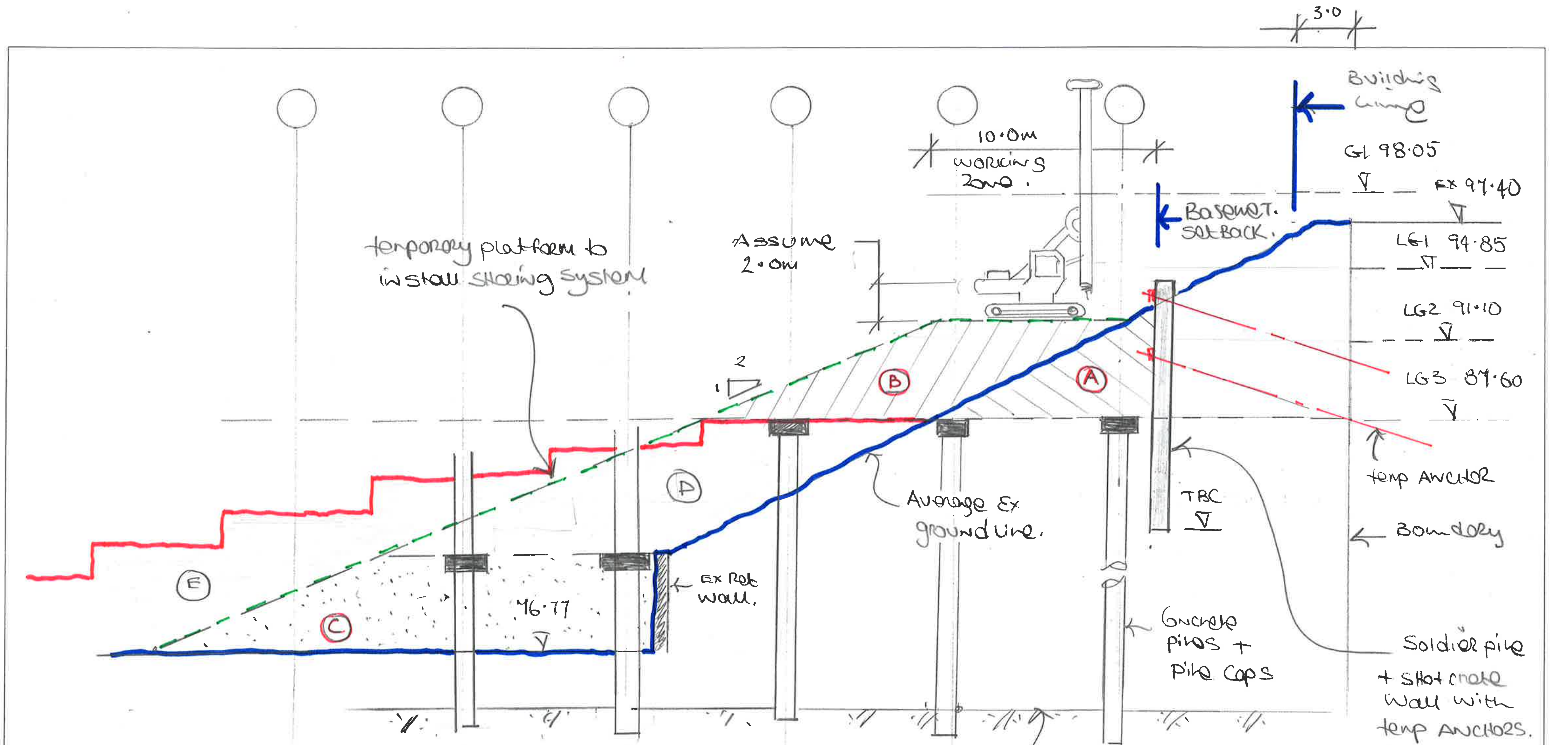
PROJECT:

DRAWING TITLE: Section (3) – option (A) Excavate to the Boundary.

All dimensions to be verified on site before making shop drawings or commencing any work. Drawing not to be used for construction unless verification signature has been added.

NORTHROP CONSULTING ENGINEERS
SYDNEY NEWCASTLE CANBERRA WOLLONGONG
Northrop Consulting Engineers Pty Ltd ABN 81 094 433 100
Tel: (02) 9241 4188 Fax: (02) 9241 4324

DATE: 29/3/16
DRAWN: SW
SCALE: 1:200 A3
JOB NO: 151027
DRAWING No/Rev: SKS-019



Heli pad = 30,000 m^3

- (B) (D) + (C) won from Heli-pad
- (A) + (B) move to (E) to create benched construction platform.

DATE	REV	ISSUE AMENDMENT	VER	APP
29/3/16	1	prelim.		SM

PROJECT: 12 Frederick Street ST LEONARDS

DRAWING TITLE: Section (3) - Option (B) Setback from Boundary

All dimensions to be verified on site before making shop drawings or commencing any work. Drawing not to be used for construction unless verification signature has been added.

NORTHROP
CONSULTING ENGINEERS
SYDNEY NEWCASTLE CANBERRA WOLLONGONG
Northrop Consulting Engineers Pty Ltd ABN 81 094 433 100
Tel: (02) 9241 4188 Fax: (02) 9241 4324

DATE: 29/3/16
DRAWN: SM
SCALE: 1:200 @ A3
JOB No: 151027
DRAWING No/Rev: SKS-020

Important information about your Coffey Report

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

Your report is based on project specific criteria

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

Subsurface conditions can change

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

Interpretation of factual data

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

For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

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

Your report is prepared for specific purposes and persons

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

Interpretation by other design professionals

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

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples.

These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

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

Rely on Coffey for additional assistance

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

Responsibility

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

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Appendix A - Borehole Logs, Soil and Rock Description Sheets

Soil Description Explanation Sheet (1 of 2)

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

CLASSIFICATION SYMBOL & SOIL NAME

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

PARTICLE SIZE DESCRIPTIVE TERMS

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

MOISTURE CONDITION

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

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

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

CONSISTENCY OF COHESIVE SOILS

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

DENSITY OF GRANULAR SOILS

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

MINOR COMPONENTS

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

SOIL STRUCTURE

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

GEOLOGICAL ORIGIN WEATHERED IN PLACE SOILS

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

TRANSPORTED SOILS

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

Soil Description Explanation Sheet (2 of 2)

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES USC (Excluding particles larger than 60 mm and basing fractions on estimated mass)							**USC**	**PRIMARY NAME**
COARSE GRAIINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.36 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.			GP	GRAVEL
			GRAVELS WITH FINES Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)			GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.36 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm					
		SILTS & CLAYS Liquid limit less than 50	**DRY STRENGTH**		**DILATANCY**	**TOUGHNESS**		
			None to Low		Quick to slow	None	ML	SILT
			Medium to High		None	Medium	CL	CLAY
			Low to medium		Slow to very slow	Low	CL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium		Slow to very slow	Low to medium	MH	SILT
			High		None	High	CH	CLAY
			Medium to High		None	Low to medium	OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture.				PT	PEAT

● Low plasticity – Liquid Limit w_L less than 35%. ● Medium plasticity – w_L between 35% and 50%. ● High plasticity – w_L greater than 50%.

COMMON DEFECTS IN SOIL

TERM	**DEFINITION**	**DIAGRAM**	**TERM**	**DEFINITION**	**DIAGRAM**
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.		SOFTENED ZONE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	
JOINT	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.		TUBE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
SHEARED ZONE	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length		TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
SHEARED SURFACE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.		INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

Rock Description Explanation Sheet (1 of 2)

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

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

Rock Substance In engineering terms rock substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic.

Defect Discontinuity or break in the continuity of a substance or substances.

Mass Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

SUBSTANCE DESCRIPTIVE TERMS:

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

CLASSIFICATION OF WEATHERING PRODUCTS

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

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

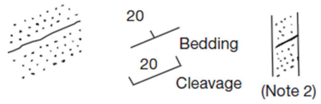
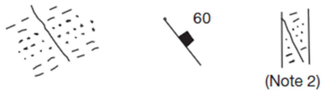
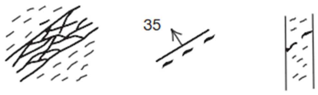
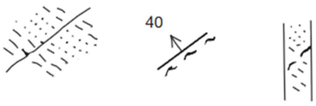
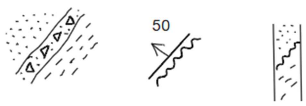
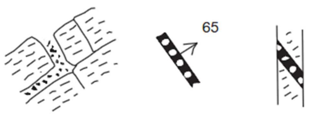
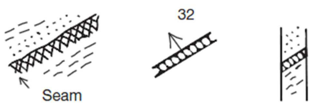
ROCK SUBSTANCE STRENGTH TERMS

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

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

Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES

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

Notes on Defects:

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

DEFECT SHAPE TERMS

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

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

ROUGHNESS TERMS

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

COATING TERMS

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

BLOCK SHAPE TERMS

Blocky	Approximately equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section

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Engineering Log - Hand Auger

Borehole ID.	***AH01***
sheet:	1 of 1
project no.	***GEOTLCOV25513AB***
date started:	***16 Mar 2016***
date completed:	***16 Mar 2016***
logged by:	***KW***
checked by:	***AJH***

client: ***Dexus Projects Pty Ltd***

principal:

project: ***Geotechnical & Contamination Investigation***

location: ***12 Fredrick Street, St Leonards***

position: Not Specified | surface elevation: 97.50 m (AHD) | angle from horizontal: 90°

drill model: Hand Auger | drilling fluid: | hole diameter :

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA		Not Observed	E					**Silty CLAY**: low plasticity, dark grey, with rootlets, fine to medium grained, angular to sub-angular gravel, brick pieces, concrete pieces, rock fragments.	M			**TOPSOIL** No odour, staining observed PID: 4.7 ppm
			E					**FILL: Silty CLAY**: high plasticity, dark grey with brown-red-orange mottling and pale grey, with some gravel and cobble sized shale pieces, low strength, highly weathered, dark grey.	~Wp			**FILL** No odour, staining observed PID: 5.5 ppm
								FILL: Sandy CLAY: low to medium plasticity, pale brown, sand is fine to medium grained, with some fine to coarse grained, angular to sub-angular gravel.	<Wp			
								Hand Auger AH01 terminated at 0.4 m				
				97	0.5							
					1.0							
				96	1.5							
					2.0							
				95	2.5							
					3.0							
				94	3.5							

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

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

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

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

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

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Engineering Log - Hand Auger

Borehole ID.	**AH02**
sheet:	1 of 1
project no.	**GEOTLCOV25513AB**
client:	**Dexus Projects Pty Ltd**
principal:	
project:	**Geotechnical & Contamination Investigation**
location:	**12 Fredrick Street, St Leonards**
date started:	**16 Mar 2016**
date completed:	**16 Mar 2016**
logged by:	**KW**
checked by:	**AJH**

position: Not Specified | surface elevation: 97.50 m (AHD) | angle from horizontal: 90°
drill model: Hand Auger | drilling fluid: | hole diameter :

drilling information / **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA			E					**Silty CLAY**: low plasticity, dark grey, with rootlets, with some gravel, fine to medium, angular to sub-angular, brick pieces, rock fragments, shells.	M			**TOPSOIL** No odour, staining observed PID: 5.9 ppm
			E					**FILL: Silty CLAY**: medium plasticity, pale grey, pale brown with red-brown and yellow-brown mottling, with some gravel, fine to medium, angular to sub-angular.	<Wp			**FILL** No odour, staining observed PID: 6 ppm
			E	97	0.5			0.3 m: with some fine to medium grained sand				PID: 6.5 ppm
								Hand Auger AH02 terminated at 0.55 m				
					1.0							
				96	1.5							
					2.0							
				95	2.5							
					3.0							
				94	3.5							

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger
* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

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

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

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Engineering Log - Hand Auger

Borehole ID.	**AH03**
sheet:	1 of 1
project no.	**GEOTLCOV25513AB**
date started:	**16 Mar 2016**
date completed:	**16 Mar 2016**
logged by:	**KW**
checked by:	**AJH**

client: ***Dexus Projects Pty Ltd***

principal:

project: ***Geotechnical & Contamination Investigation***

location: ***12 Fredrick Street, St Leonards***

position: Not Specified | surface elevation: 97.50 m (AHD) | angle from horizontal: 90°

drill model: Hand Auger | drilling fluid: | hole diameter :

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA			E					**Silty CLAY**: low plasticity, dark grey, with rootlets, angular to sub-angular gravel, brick pieces, concrete pieces, rock fragments.	M			**TOPSOIL** No odour, staining observed PID: 9.6 ppm
			E					**FILL: Silty CLAY**: medium plasticity, pale grey, dark grey, pale brown with yellow-brown mottling, with some gravel, fine to medium, angular to sub-angular, concrete pieces, rock pieces, brick pieces.	<Wp			**FILL** No odour, staining observed PID: 6.5 ppm
			E	97	0.5			0.3 m: becoming pale red, pale grey and dark grey with yellow-brown mottling				PID: 7.9 ppm
								Hand Auger AH03 terminated at 0.55 m				
					1.0							
				96	1.5							
					2.0							
				95	2.5							
					3.0							
				94	3.5							

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method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

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

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

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

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

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Engineering Log - Borehole

Borehole ID.	**BH01**
sheet:	1 of 5
project no.	**GEOTLCOV25513AB**
date started:	**15 Mar 2016**
date completed:	**16 Mar 2016**
logged by:	**KW**
checked by:	**AJH**

client: ***Dexus Projects Pty Ltd***

principal:

project: ***Geotechnical & Contamination Investigation***

location: ***12 Fredrick Street, St Leonards***

position: Not Specified | surface elevation: 97.50 m (AHD) | angle from horizontal: 90°

drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD, CASING		Not Observed	E					**Silty CLAY**: low to medium plasticity, dark grey, with some fine to medium grained sand, rootlets, brick pieces.	M			TOPSOIL
								FILL: Silty CLAY: low plasticity, red brown, pale grey, with some sand, fien to medium grained, trace gravel, angular to sub-angular, fine to medium, trace rock fragments.	D			FILL
			SPT 5, 8, 12 N*=20	97								PID: 1.1 ppm
					1.0							
			SPT 4, 2, 2 N*=4	96				1.5 m: becoming pale grey				PID: 0.6 ppm
								1.8 m: becoming pale brown				
					2.0							
				95								
			SPT 2, 2, 3 N*=5		3.0			**FILL: Silty CLAY**: high plasticity, pale grey, red-brown, with some gravel, angular to sub-angular, fine to medium.	~Wp			HP 160 - 260 kPa PID: 0.5 ppm
				94								HP 190 - 160 kPa
					4.0							
			SPT 2, 2, 3 N*=5	93								SPT 100mm recovered HP 200 kPa
					5.0							
				92								
			SPT 2, 2, 2 N*=4		6.0			6.0 m: becoming pale grey, red-brown, dark grey with orange-brown mottling				HP 180 kPa PID: 0.5 ppm
				91								HP 100 kPa
					7.0							
			SPT 3, 5, 6 N*=11	90								SPT 200mm recovered PID: 0.4 ppm HP 150 kPa

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

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

support
M mud N nil
C casing

penetration
1 2 3
no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

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

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

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Engineering Log - Borehole

Borehole ID.	**BH01**
sheet:	2 of 5
project no.	**GEOTLCOV25513AB**
date started:	**15 Mar 2016**
date completed:	**16 Mar 2016**
logged by:	**KW**
checked by:	**AJH**

client: ***Dexus Projects Pty Ltd***

principal:

project: ***Geotechnical & Contamination Investigation***

location: ***12 Fredrick Street, St Leonards***

position: Not Specified | surface elevation: 97.50 m (AHD) | angle from horizontal: 90°

drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm

drilling information — method & support: AD, CASING; penetration: 1 2 3; water: Not Observed

material substance

depth (m)	RL (m)	samples & field tests	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
					FILL: Silty CLAY: high plasticity, pale grey, red-brown, with some gravel, angular to sub-angular, fine to medium. *(continued)*	~Wp			**FILL**
	89								
9.0		SPT 3/6mm, 6/5mm, 3 N*=R							PID: 0.3 ppm
								150	HP 150 kPa
	88								
10.0									
	87	SPT 3, 3, 7 N*=10						160	HP 160 kPa
					10.5 m: becoming pale grey				PID: 0.5 ppm
11.0									
	86								
12.0		SPT 4, 5, 7 N*=12							No SPT sample recovered
	85								
13.0									
	84	SPT 4, 6, 11 N*=17			13.5 m: becoming pale grey and red-brown with yellow-brown, dark grey, dark red mottling				PID: 0.1 ppm
14.0									
	83								
15.0		SPT 7, 11, 10 N*=21						150	HP 150 kPa
								400	HP 400 kPa
	82							200	HP 200 kPa

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

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

support
M mud N nil
C casing

penetration
1 2 3 — no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

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

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

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Engineering Log - Borehole

Borehole ID.	**BH01**
sheet:	3 of 5
project no.	**GEOTLCOV25513AB**
date started:	**15 Mar 2016**
date completed:	**16 Mar 2016**
logged by:	**KW**
checked by:	**AJH**

client: ***Dexus Projects Pty Ltd***

principal:

project: ***Geotechnical & Contamination Investigation***

location: ***12 Fredrick Street, St Leonards***

position: Not Specified | surface elevation: 97.50 m (AHD) | angle from horizontal: 90°

drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description **SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD — CASING		Not Observed						**FILL: Silty CLAY**: high plasticity, pale grey, red-brown, with some gravel, angular to sub-angular, fine to medium. *(continued)*	~Wp			**FILL**
			SPT 5, 7, 8 N*=15	81				16.6 m: becoming brown and dark grey with pale grey, black and pale red mottling, with some fine to coarse grained, angular to sub-angular gravel			X X	Light rotten odour HP 150 kPa HP 150 kPa
				80	17.0							
			SPT 4, 4, 5 N*=9	79	18.0			18.4 m: becoming dark grey with pale grey and yellow-brown mottling with fine to medium grained, angular to sub-angular gravel			X	PID: 3.2 ppm HP 130 kPa Light diesel odour
					19.0			Borehole BH01 continued as cored hole				
			SPT 17/50mm N*=R	78				**SILTSTONE**: fine grained, dark grey, low strength, extremely to highly weathered.				**WEATHERED BEDROCK** PID: 3.3 ppm
				77	20.0							
				76	21.0							
				75	22.0							
				74	23.0							

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

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

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
WI liquid limit

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

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Engineering Log - Cored Borehole

client:	*Dexus Projects Pty Ltd*	Borehole ID.	*BH01*
principal:		sheet:	4 of 5
project:	*Geotechnical & Contamination Investigation*	project no.	*GEOTLCOV25513AB*
location:	*12 Fredrick Street, St Leonards*	date started:	*15 Mar 2016*
		date completed:	*16 Mar 2016*
		logged by:	*KW*
		checked by:	*AJH*

position: Not Specified | surface elevation: 97.50 m (AHD) | angle from horizontal: 90°
drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm | vane id.:

method & support	water	RL (m)	depth (m)	material description (ROCK TYPE: grain characteristics, colour, structure, minor components)	weathering & alteration	samples, field tests & Is(50) (MPa) (a = axial; d = diametral)	core run & RQD	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) — particular	general
		81							
			17.0						
		80							
			18.0						
		79							
			19.0						
		78		start coring at 19.55m					
NMLC	Not Observed			**SILTSTONE**: dark grey-black, massive.	FR	a=1.57 d=0.98	53%	JT, 30 - 50°, PL, SO - RO, SN	Defects are: PT, 0 - 10°, PL, SO - RO, CN, unless otherwise described
			20.0			a=3.37 d=0.77		CS, 10 - 20°, PL, SO - RO, rock fragments	
		77						JT, 20 - 40°, PL, SO - RO, SN	
								JT, 20 - 40°, PL, SO - RO, SN - CO, rock fragments	
				NO CORE: 0.10 m			0%	JT, 80 - 90°, PL, SO - RO, SN	
			21.0	**SILTSTONE**: dark grey-black, massive.	FR			JT, 20 - 40°, PL, SO - RO, CN	
								JT, 20 - 40°, PL, SO - RO, SN	
								CS, 10 - 20°, IR, SO - RO, SN, rock fragments	
		76				a=1.43 d=1.22		JT, 70 - 80°, PL, SO, CN	
							22%	PT, 0 - 10°, PL, SO - RO, CN	Defects are: JT, 10 - 20°, PL, SO - RO, CN, unless otherwise described
			22.0					PT, 0 - 10°, PL, SO - RO, CO, rock fragments	
								JT, 10 - 20°, PL, SO - RO, CO, rock fragments	
		75		**NO CORE**: 0.10 m				JT, 10 - 20°, PL, SO - RO, CO, rock fragments	
				SILTSTONE: dark grey-black, massive.	FR	a=1.69 d=0.52			
			23.0			a=1.18 d=1.19			
						a=1.01 d=0.85	63%		
		74						JT, 40 - 60°, PL, SO - RO, CN	
								PT, PL, SO - RO, Silty clay CO, rock	
								PT, 0 - 10°, PL, SO - RO, CN	
								CS, 0 - 10°, PL, SO - RO, 60 mm, rock fragments	

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test
HA hand auger

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stain
VN veneer
CO coating

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Engineering Log - Cored Borehole

Borehole ID. **BH01**

project no. **GEOTLCOV25513AB**

client: **Dexus Projects Pty Ltd**
principal:
project: **Geotechnical & Contamination Investigation**
location: **12 Fredrick Street, St Leonards**

date started: **15 Mar 2016**
date completed: **16 Mar 2016**
logged by: **KW**
checked by: **AJH**

position: Not Specified | surface elevation: 97.50 m (AHD) | angle from horizontal: 90°
drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm | vane id.:

method & support	water	RL (m)	depth (m)	material description (ROCK TYPE: grain characteristics, colour, structure, minor components)	weathering & alteration	samples, field tests & Is(50) (MPa) (a = axial; d = diametral)	core run & RQD	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other)
NMLC	Not Observed	73		**SILTSTONE**: dark grey-black, massive. *(continued)*	FR			CS, 0 - 10°, PL, SO - RO, 20 mm; JT, 10 - 20°, PL, SO - RO, CO; PT, 0 - 10°, PL, SO - RO, CN; CS, 0 - 10°, PL, SO - RO, 30 mm, rock fragments
			25.0	**INTERBEDDED SILTSTONE & SANDSTONE**: dark grey and pale grey, siltstone is 50%, sandstone 50%, sandstone is fine to medium grained, indistinctly bedded at 0°-20°.	SW	a=0.66 d=0.44	63%	JT, 10 - 20°, PL, SO - RO, CO, rock fragments; JT, 10 - 20°, PL, SO - RO, CO, rock fragments
				SANDSTONE: fine to medium grained, pale grey, indistinctly bedded at 0°-20°.		a=4.33 d=2.35		CS, 0 - 10°, PL, SO - RO, 50 mm, rock fragments; SM, 0 - 10°, PL, SO - RO, Sandy clay CO, 50 mm
		72		Borehole BH01 terminated at 25.40 m				
		71	26.0					
		70	27.0					
		69	28.0					
		68	29.0					
		67	30.0					
		66	31.0					

estimated strength & Is50: × = axial; O = diametral; VL L M H VH EH
defect spacing (mm): 30 100 300 1000 3000

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test
HA hand auger

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stain
VN veneer
CO coating

PointID : BH01 Depth Range: 19.55 - 25.40 m

drawn	RH		client:	Dexus Projects Pty Ltd
approved	RH		project:	Geotechnical & Contamination Investigation 12 Fredrick Street, St Leonards
date	04/04/2016		title:	**CORE PHOTOGRAPH** **BH01**
scale	N.T.S.			
original size	A4		project no: GEOTLCOV25513AB	fig no: **PHOTO 1** rev:

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Engineering Log - Borehole

Borehole ID.	**BH02**
sheet:	1 of 2
project no.	**GEOTLCOV25513AB**

client:	***Dexus Projects Pty Ltd***	date started:	***17 Mar 2016***
principal:		date completed:	***17 Mar 2016***
project:	***Geotechnical & Contamination Investigation***	logged by:	***KW***
location:	***12 Fredrick Street, St Leonards***	checked by:	***AJH***

position: Not Specified | surface elevation: 77.00 m (AHD) | angle from horizontal: 90°

drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T, CASING		Not Observed		77				**CONCRETE**.				**CONCRETE**
			E					**SAND**: medium to coarse grained, pale brown.	M			**FILL** PID: 2.3 ppm
			E					**Sandy CLAY**: low plasticity, dark grey, sand is fine to medium grained, with some fine to coarse, sub-angular to sub-rounded gravel, rock pieces, roots.	<Wp			No odour, staining observed PID: 3.1 ppm
				76	1.0			**SILTSTONE**: dark grey, slightly weathered, low to medium strength.				**WEATHERED BEDROCK**
								Borehole BH02 continued as cored hole				
				75	2.0							
				74	3.0							
				73	4.0							
				72	5.0							
				71	6.0							
				70	7.0							

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method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

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

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

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

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

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Engineering Log - Cored Borehole

Borehole ID.	**BH02**
sheet:	2 of 2
project no.	**GEOTLCOV25513AB**
date started:	**17 Mar 2016**
date completed:	**17 Mar 2016**
logged by:	**KW**
checked by:	**AJH**

client: ***Dexus Projects Pty Ltd***

principal:

project: ***Geotechnical & Contamination Investigation***

location: ***12 Fredrick Street, St Leonards***

position: Not Specified | surface elevation: 77.00 m (AHD) | angle from horizontal: 90°

drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm | vane id.:

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description ROCK TYPE: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		77			start coring at 0.70m						
NMLC	18/03/16, 12:20pm	76	1.0		**INTERBEDDED SILTSTONE AND SANDSTONE**: pale grey and dark grey, siltstone is 50%, sandstone 50%, sandstone is fine to medium grained, indistinctly bedded at 0°-30°.	FR		a=5.12 d=5.50	51%		PT, 0 - 10°, PL, RO, CO PT, 0 - 10°, PL, SO - RO, Clay CO, rock fragments JT, 20 - 30°, PL, RO, CN PT, 10 - 20°, IR, RO, CN CS, 0 - 10°, IR, RO, SN, 110 mm, rock fragments
					SANDSTONE: pale grey and dark grey, fine to medium grained, distinctly bedded at 0°-20°, with dark grey laminations.			a=3.27 d=2.26			
		75	2.0						100%		
								a=2.70 d=1.35			
		74	3.0		2.80 m: becoming distinctly bedded at 10°-20°						
	Not Observed				3.10 m: becoming fine to coarse grained			a=1.54 d=1.25			
									90%		
		73	4.0								PT, 0 - 10°, PL, SO - RO, Clay CO, rock fragments
								a=1.67 d=1.68			
		72	5.0						100%		JT, 10 - 20°, PL, SO - RO, CN
								a=1.63 d=1.26			
		71	6.0						100%		
								a=1.51 d=1.25			JT, 10 - 20°, PL, SO - RO, CN
					Borehole BH02 terminated at 6.56 m						
		70	7.0								

Defects are: PT, 0 - 10°, PL, SO - RO, CN, unless otherwise described

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test
HA hand auger

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stain
VN veneer
CO coating

PointID : BH02 Depth Range: 0.70 - 6.56 m

drawn	RH		client:	Dexus Projects Pty Ltd
approved	RH		project:	Geotechnical & Contamination Investigation 12 Fredrick Street, St Leonards
date	04/04/2016		title:	**CORE PHOTOGRAPH** **BH02**
scale	N.T.S.			
original size	A4		project no: GEOTLCOV25513AB	fig no: **PHOTO 2** rev:

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Engineering Log - Borehole

Borehole ID.	**BH03**
sheet:	1 of 2
project no.	**GEOTLCOV25513AB**
client:	**Dexus Projects Pty Ltd**
date started:	**17 Mar 2016**
principal:	
date completed:	**17 Mar 2016**
project:	**Geotechnical & Contamination Investigation**
logged by:	**KW**
location:	**12 Fredrick Street, St Leonards**
checked by:	**AJH**

position: Not Specified | surface elevation: 77.00 m (AHD) | angle from horizontal: 90°
drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA / AD/T; CASING		Not Observed		77				**CONCRETE**.				**CONCRETE**
			E					**FILL: SILTY SAND**: fine to coarse grained, brown, with some fine to coarse grained gravel, angular to sub-anguIar, rock pieces.	M			**FILL** PID: 4 ppm No odour, staining observed
			E					0.5 m: becoming pale brown, pale orange				PID: 5.2 ppm
			SPT 25/50mm N*=R	76	1.0							PID: 5.6 ppm
								SANDSTONE: fine to medium grained, pale grey, dark grey, slightly weathered, low to medium strength.				**WEATHERED BEDROCK**
								Borehole BH03 continued as cored hole				
				75	2.0							
				74	3.0							
				73	4.0							
				72	5.0							
				71	6.0							
				70	7.0							

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method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger
* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

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

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

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Engineering Log - Cored Borehole

client:	*Dexus Projects Pty Ltd*	Borehole ID.	**BH03**
		sheet:	2 of 2
		project no.	**GEOTLCOV25513AB**
principal:		date started:	**17 Mar 2016**
		date completed:	**17 Mar 2016**
project:	*Geotechnical & Contamination Investigation*	logged by:	**KW**
location:	*12 Fredrick Street, St Leonards*	checked by:	**AJH**

position: Not Specified | surface elevation: 77.00 m (AHD) | angle from horizontal: 90°

drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm | vane id.:

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description — ROCK TYPE: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) — particular	general
		77										
		76	1.0		start coring at 1.20m							
NMLC	18/03/16				**SANDSTONE**: fine to medium grained, pale grey and dark grey, with dark grey laminations, distinctly bedded at 0°-20°.	FR		a=4.23 d=2.41	83%		PT, 0 - 10°, PL, SO - RO, SN PT, 0 - 10°, PL, SO - RO, SN PT, 0 - 10°, PL, SO - RO, SN PT, 0 - 10°, PL, SO - RO, SN - CO, rock fragments	Defects are: PT, 0 - 10°, PL, SO - RO, CN, unless otherwise described
		75	2.0									
					2.60 m: becoming distinctly bedded at 10°-20°			a=1.81 d=0.90				
		74	3.0		2.90 m: becoming fine to corase grained				93%			
	Not Observed							a=1.88 d=1.18				
		73	4.0								JT, 10 - 20°, PL, SO - RO, CN JT, 10 - 20°, PL, SO - RO, CN	
								a=1.75 d=1.38	100%			
		72	5.0								PT, 0 - 10°, IR, RO, CN	
								a=1.99 d=1.39			PT, 10 - 20°, PL, SO - RO, CN	
		71	6.0						100%			
								a=1.88 d=1.29 a=2.89 d=1.38				
		70	7.0		Borehole BH03 terminated at 6.90 m							

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test
HA hand auger

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stain
VN veneer
CO coating

PointID : BH03 Depth Range: 1.20 - 6.90 m

drawn	RH		client:	Dexus Projects Pty Ltd
approved	RH		project:	Geotechnical & Contamination Investigation 12 Fredrick Street, St Leonards
date	04/04/2016		title:	**CORE PHOTOGRAPH** **BH03**
scale	N.T.S.			
original size	A4		project no: GEOTLCOV25513AB	fig no: **PHOTO 3** rev:

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Engineering Log - Borehole

Borehole ID.	**BH04**
sheet:	1 of 2
project no.	**GEOTLCOV25513AB**
date started:	**18 Mar 2016**
date completed:	**18 Mar 2016**
logged by:	**KW**
checked by:	**AJH**

client: **Dexus Projects Pty Ltd**
principal:
project: **Geotechnical & Contamination Investigation**
location: **12 Fredrick Street, St Leonards**

position: Not Specified | surface elevation: 97.50 m (AHD) | angle from horizontal: 90°
drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter :

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA		Not Observed	E					**FILL: Silty CLAY**: low plasticity, dark grey, with some gravel, fine to medium, angular to sub-angular, tree rootlets.	M <Wp			**TOPSOIL** PID: 7.5 ppm No odour, staining observed
			E	97				**FILL: Silty CLAY**: high plasticity, grey, dark red, pale grey, yellow-brown and dark grey mottling, with some gravel, fine to coarse grained, angular to sub-angular, tree rootlets.				**FILL** PID: 5.1 ppm No odour, staining observed
AD/T			E		1.0			becoming pale grey with dark red and orange-brown mottling				PID: 7.3 ppm
				96					D			
				95	2.0							
			SPT 2, 13, 21 N*=34	94	3.0		CH	**Silty CLAY**: high plasticity, pale grey, with some gravel, fine to medium, angular to sub-angular, indistinct horizontal bedding.		VSt		**RESIDUAL SOIL** PID: 5.3 ppm
				93	4.0							
				92	5.0							
			SPT 4, 22, 38 N*=60	91	6.0			**SILTSTONE**: red-brown, highly weathered, low strength, distinct horizontal bedding. becoming pale red-brown with pale grey mottling stained rock fragments				**WEATHERED BEDROCK** PID: 7.2 ppm
				90	7.0							

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

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

support
M mud N nil
C casing

penetration
1 2 3
no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

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

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

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Engineering Log - Borehole

Borehole ID.	**BH04**
sheet:	2 of 2
project no.	**GEOTLCOV25513AB**
date started:	**18 Mar 2016**
date completed:	**18 Mar 2016**
logged by:	**KW**
checked by:	**AJH**

client: **Dexus Projects Pty Ltd**

principal:

project: **Geotechnical & Contamination Investigation**

location: **12 Fredrick Street, St Leonards**

position: Not Specified | surface elevation: 97.50 m (AHD) | angle from horizontal: 90°

drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter :

drilling information / **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T		Not Observed		89				**SILTSTONE**: red-brown, highly weathered, low strength, distinct horizontal bedding. *(continued)*	D			**WEATHERED BEDROCK**
			SPT 28/100mm, 12/mm HB N*=R		9.0							
				88				Borehole BH04 terminated at 9.10 m				
					10.0							
				87								
					11.0							
				86								
					12.0							
				85								
					13.0							
				84								
					14.0							
				83								
					15.0							
				82								

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method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

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

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

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

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

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Engineering Log - Borehole

client:	***Dexus Projects Pty Ltd***	date started:	***18 Mar 2016***
principal:		date completed:	***18 Mar 2016***
project:	***Geotechnical & Contamination Investigation***	logged by:	***KW***
location:	***12 Fredrick Street, St Leonards***	checked by:	***AJH***

Borehole ID. ***BH05***

project no. ***GEOTLCOV25513AB***

position: Not Specified | surface elevation: 77.00 m (AHD) | angle from horizontal: 90°
drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm

drilling information / **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
CASING		Not Observed		77				**CONCRETE**.				**CONCRETE**
			E					**FILL: CLAYEY SAND**: fine to coarse grained, dark grey, with some gravel, fine to coarse, angular to sub-angular, some rock pieces.	M			**FILL** PID: 6.3 ppm No odour staining observed
			E					**FILL: SILTY SAND**: fine to coarse grained, pale brown, yellow-brown and pale grey, with some rock fragments.				PID: 7.2 ppm
				76	1.0			Borehole BH05 continued as cored hole				
				75	2.0							
				74	3.0							
				73	4.0							
				72	5.0							
				71	6.0							
				70	7.0							

method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger
* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

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

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

classification symbol & soil description
based on Unified Classification System

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

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

coffey
A TETRA TECH COMPANY

Engineering Log - Cored Borehole

Borehole ID.	**BH05**
sheet:	2 of 3
project no.	**GEOTLCOV25513AB**

client:	**Dexus Projects Pty Ltd**	date started:	**18 Mar 2016**
principal:		date completed:	**18 Mar 2016**
project:	**Geotechnical & Contamination Investigation**	logged by:	**KW**
location:	**12 Fredrick Street, St Leonards**	checked by:	**AJH**

position: Not Specified | surface elevation: 77.00 m (AHD) | angle from horizontal: 90°

drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm | vane id.:

drilling information | **material substance** | **rock mass defects**

RL (m)	depth (m)	material description (ROCK TYPE: grain characterisics, colour, structure, minor components)	weathering & alteration	samples, field tests & Is(50) (MPa) (a = axial; d = diametral)	core run & RQD	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other)
77		start coring at 0.95m				
76	1.0	**SILTSTONE**: dark grey, massive.	FR		67%	
		INTERBEDDED SILTSTONE & SANDSTONE: dark grey, pale grey, siltstone 50%, sandstone 50%, sandstone is fine to medium grained, indistinctly bedded at 0°-30°.		a=6.64 d=4.17		JT, 10 - 20°, PL, SO - RO, CN; PT, 0 - 10°, IR, RO, CN
75	2.0	**SANDSTONE**: fine to medium grained, pale grey, with dark grey laminations, distinctly bedded at 0°-10°.		a=2.99 d=2.45	75%	
74	3.0	3.20 m: becoming distinctly bedded at 10°-20°				JT, 10 - 20°, PL, SO - RO, CN; JT, 10 - 20°, PL, SO - RO, CN
		3.70 m: becoming fine to coarse grained		a=1.12 d=1.28	94%	JT, 10 - 20°, PL, SO - RO, CN
73	4.0			a=1.63 d=1.47		JT, 10 - 20°, PL, SO - RO, CN; JT, 10 - 20°, PL, SO - RO, CN; JT, 20 - 30°, PL, SO - RO, CN
72	5.0			a=1.30 d=1.83	100%	
71	6.0			a=1.71 d=1.41		
70	7.0				88%	JT, 10 - 20°, PL, SO - RO, CN
				a=1.69 d=1.56	87%	

water: Not Observed

general: Defects are: PT, 0 - 10°, PL, SO - RO, CN, unless otherwise described

estimated strength & Is50: VL L M H VH EH; X = axial; O = diametral. defect spacing (mm): 30 100 300 1000 3000

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test
HA hand auger

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stain
VN veneer
CO coating

coffey
A TETRA TECH COMPANY

Engineering Log - Cored Borehole

Borehole ID.	**BH05**
sheet:	3 of 3
project no.	**GEOTLCOV25513AB**
client:	**Dexus Projects Pty Ltd**
principal:	
project:	**Geotechnical & Contamination Investigation**
location:	**12 Fredrick Street, St Leonards**
date started:	**18 Mar 2016**
date completed:	**18 Mar 2016**
logged by:	**KW**
checked by:	**AJH**

position: Not Specified | surface elevation: 77.00 m (AHD) | angle from horizontal: 90°

drill model: Geo Probe 6600, Truck mounted | drilling fluid: | hole diameter : 50 mm | vane id.:

method & support	water	RL (m)	depth (m)	graphic log	material description (ROCK TYPE: grain characterisics, colour, structure, minor components)	weathering & alteration	estimated strength & Is50	samples, field tests & Is(50) (MPa)	core run & RQD	defect spacing (mm)	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other)
	Not Observed	69			**SANDSTONE**: fine to medium grained, pale grey, with dark grey laminations, distinctly bedded at 0°-10°. *(continued)*	FR	H-VH	a=1.94 d=1.59	87%		JT, 10 - 20°, PL, SO - RO, CN; JT, 10 - 20°, PL, SO - RO, CN
		68	9.0		Borehole BH05 terminated at 8.90 m						
		67	10.0								
		66	11.0								
		65	12.0								
		64	13.0								
		63	14.0								
		62	15.0								

method & support
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AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
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partial drilling fluid loss
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graphic log / core recovery
core recovered (graphic symbols indicate material)
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core run & RQD
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RQD = Rock Quality Designation (%)

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XW extremely weathered
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FR fresh
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L low
M medium
H high
VH very high
EH extremely high

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stain
VN veneer
CO coating

PointID : BH05 Depth Range: 0.95 - 8.90 m

drawn	RH		client:	Dexus Projects Pty Ltd
approved	RH		project:	Geotechnical & Contamination Investigation 12 Fredrick Street, St Leonards
date	04/04/2016		title:	CORE PHOTOGRAPH BH05
scale	N.T.S.			
original size	A4		project no: GEOTLCOV25513AB	fig no: PHOTO 4 rev: