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REPORT

TO

FRASERS BROADWAY

ON

GEOTECHNICAL ASSESSMENT

FOR

BLOCKS 3B, 3C, 10 – KENSINGTON STREET PRECINCT

AT

102-120 BROADWAY, SYDNEY, NSW

12 April 2012

Ref: 22905Srpt3b3c10

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Postal Address: PO Box 976, North Ryde BC NSW 1670

Tel: 02 9888 5000 • Fax: 02 9888 5001 • Email: engineers@jkgroup.net.au • ABN 17 003 550 801

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1 INTRODUCTION

This report presents the results of a compilation of geotechnical information obtained from geotechnical investigations undertaken within the Frasers Broadway site, for the proposed retail and student accommodation developments for Blocks 3b, 3c and 10, Kensington Street Precinct, Frasers Broadway. This geotechnical assessment was commissioned by Anthony Green of Frasers Property Australia Pty Ltd, in an email dated 8 September 2011. The scope of the work was set out in the proposal set out by Jeffery and Katauskas Pty Ltd (J&K) dated 8 September 2011 (Ref: 22905SBlocks3,6,7,10 prop).

Based on the supplied plans which have been prepared by Tonkin Zulaikha Greer, we understand that the proposed development comprises an eight storey building (Block 3b), a six storey building (Block 3c), and a five storey building (Block 10). We understand that there is to be a partial service basement (no vehicle access) beneath Block 3b, with the finished floor level for the ground floors to be RL17.5m. We understand that there is to be no basement beneath Block 10 development, with the finished floor level for the ground floor is to be RL17.19m. The ground floor levels of Blocks 3b, 3c and 10 comprise a mixture of commercial and retail use, with the upper levels largely being student accommodation.

The purpose of this assessment was to provide a compilation of information on the sub-surface conditions beneath Blocks 3b, 3c and 10 and to present our comments and recommendations on geotechnical aspects of the proposed development.

2 INVESTIGATION PROCEDURE

A number of previous investigations have been carried out on the site by ourselves and other contractors. The most relevant reports for this geotechnical assessment were carried out by Jeffery and Katauskas and covered the whole of Basement 2, 5

and 9 (Ref:22905rpt259, dated 28 November 2009) and a pavement investigation along Kensington Street and Kent Road (Ref:22905Sroadsrpt, dated 2 March 2010).

A previous geotechnical investigation was undertaken by URS (Ref: 43187193, dated 5 October 2006) which also contains boreholes drilled in the vicinity of Block 10.

We have shown the relevant approximate borehole locations on Figure 1 and have used the relevant information as part of this assessment. Copies of relevant borehole logs and explanatory notes which describe terms and symbols used as details of the exploratory techniques are attached with this report.

3 RESULTS OF INVESTIGATION

3.1 Site Description

The site is located at the Frasers Broadway development, Chippendale, NSW. The area of the current investigation lies on the eastern side of the main One Central complex, to the north of Outram Street between Kent Road and Goold Street.

During the time of writing Lot 3b, contained the main site shed complex for the Frasers Broadway site, which comprised approximately twelve demountable buildings linked with raised wooden walkways. Lot 3c contained approximately eight demountable buildings at the northern end, while the southern end of Lot 3c contained a holding pond for water pumped up from the main excavation. The holding pond was approximately 15m $\times$ 15m in plan area, and the depth unknown. Lot 10 contained a single storey brick warehouse building, with a full height shutter door off Outram Street. Goold Street bounds Lot 10 to the east.

The key elements of the topography of the site are that it lies on the northern side of an old creek which drained westwards to the river channel which originally occupied the area of Abercrombie Street and in turn drained northwards to Blackwattle Bay. The creeks were culverted and infilled a long time ago and an old brick ovoid culvert lies a little to the south of Outram Street. Ground slopes have been modified by the filling but fall gently to the south and south-west in the area of interest.

3.2 Subsurface Conditions

The geology of the site and subsurface conditions including groundwater have been discussed extensively in our previous report Ref:22905Srpt259, dated 28 November 2009 as well as the URS report Ref: 43187193, dated 5 October 2006. In brief there is filling in the old creek channel which ran near the southern edge of the site, overlying a shallow sandy deposit which infills the creek and covers the surrounding area to shallow depth and probably represents the margin of the aeolian (wind blown) deposits of the Botany Basin. Below the sands and elsewhere are silty clay soils, probably residual in origin overlying sandstone bedrock belonging to the Hawkesbury Formation.

Fill

Fill was only encountered within boreholes B10, B16, B21, B24, B28 and MW102 which had been drilled alongside and within the area of Block 3b, 3c and 10. Fill was encountered to maximum depths between 0.2m (MW102) and 2.4m (B16). The fill typically comprised a mixture of silty sand, silty gravelly sand and silty sandy gravel with some clay pockets, with sandstone, brick, concrete, steel and wood gravel fragments and cobbles. The fill was assessed to be poorly to moderately compacted.

With reference to the six pavement boreholes (P5, P6, P7, P12, P13 and P14) fill was encountered between depths of 0.5m (P5) to 1.5m (P7); the deeper fill could be associated with buried services.

Natural Sand

Natural silty sand and sand was encountered in all of the boreholes beneath the fill to depths of 2.1m (B10) and 5.2m (B24) and varied from very loose to loose becoming medium dense with depth.

Silty Clay

Silty (sandy) clay of medium to high plasticity was encountered beneath the natural sands, apart from B16 where it was encountered beneath the fill, to depths up to 6.2m (MW102). The clay was assessed to be firm to hard in strength.

Sandstone

Sandstone was encountered within all eight boreholes at depths between 3.8m (RL 11.53m) in B28, and 6.2m (RL11.57m) in MW102. The sandstone was assessed to be extremely to distinctly weathered and of extremely low to very low strength on initial contact, becoming medium to high strength with depth.

Groundwater

Groundwater was encountered at depths between 2m (RL13.3m) in B28 and 4m in B24 (RL13.3m) and MW102 (RL13.77m), within the natural sands. Groundwater seepage was noted within the fill in B16 at a depth of 1.3m (RL13.6m). Depending on the timing of future works the holding pond in the Lot 3c site may have an effect on groundwater levels.

4 COMMENTS AND RECOMMENDATIONS

4.1 Geotechnical Issues

A summary of some of the main geotechnical issues is presented below. Further details are provided in the following sections of this report.

1. Demolition of the original structures has been completed in Blocks 3b and 3c; however there may be some residual structure beneath the surface and in the vicinity of B16 there appears to be infilling of an old basement with poor quality fill containing concrete and demolition rubble, which may form obstructions during pile installation.
2. Reducing vibrations from subgrade preparation transmitted to the adjacent structures.
3. Due to the presence of deep fill within Lot 3b and the holding pond currently within Lot 3c subgrade conditions appear to be poor and are likely to require extensive reworking. A simpler option may be to suspend the floor slabs.
4. Groundwater is perched within the fill layer in B16, and generally encountered at RL13.3m in the natural sands. Due to the potential for collapse of the sands during pile installation a Continuous Flight Auger (CFA) piling system will need to be adopted.
5. The use of piled foundations as near-surface soils will not be capable of supporting substantial structures.
6. Within Lots 3b and 3c, piled foundations will need to be founded below a line at 45°, taken from the base of the adjacent excavation, unless geotechnical analysis shows this to be unnecessary.

4.2 Site Preparation and Earthworks

If the new ground floor slabs are to be suspended, the fill under the slab to bring the level up would not have to be engineered fill, although it should be free from topsoil, root affected soils or other deleterious materials.

For any new pavement areas, or if ground floor slabs are not suspended, the comments and recommendation provided below should be followed. Earthworks recommendations in this report should be read in conjunction with AS3798-2007: *'Guidelines on Earthworks for Commercial and Residential Developments'*.

Drainage

Good drainage should be provided both during construction and for the long term maintenance of the site. The principle aim of the drainage should be to promote run off but avoid erosion.

Subgrade Preparation

The following subgrade preparation is recommended under any new pavement areas or floor slabs if not suspended and prior to the placement of engineered fill. We note that this may require excavations that would undermine adjacent building or streets and would therefore necessitate the installation of temporary shoring. Clearly it would be more economical to suspend floor slabs than install shoring.

- Strip the subgrade of all hard surfacing and/or vegetation, root affected soils, fill or other deleterious materials.
- Following stripping, proof roll the subgrade using a minimum of 6 passes of a smooth drum roller with a static weight of no less than 6 tonnes. All proof rolling should be completed in the presence of an experienced geotechnical engineer or geotechnician.
- The purpose of proof rolling is to improve the near surface density of the soils and identify any soft or unstable areas. Any soft or unstable areas identified should be excavated down to a sound base and reinstated with engineered fill as described below.

Engineered Fill

Materials preferred for use as engineered fill are well graded granular materials, such as ripped or crushed sandstone or processed concrete, free of any deleterious substances and having a maximum particle size of 75 millimetres (mm). Such fill should be compacted in layers not greater than 200mm loose thickness, to a minimum density of 98% Standard Maximum Dry Density (SMDD).

Compaction Control

Compaction control should consist of density tests completed at a minimum frequency of 1 test/layer/300m^2 or 3 test/layer, whichever is greater. Level 2 is the lowest category of compaction control that may be completed. For localised backfill areas such as service trenches, excavated soft spots etc, the frequency of testing should be 1 test/2 layers/50m^2. These recommendations should be read in conjunction with AS3798-2007.

4.3 Excavation

Exact levels of the proposed partial basement within Blocks 3b and 3c have not been supplied; however we expect that excavations will be no greater than 2.5m deep. Such excavation will encounter a mixture of fill and natural sands, and excavation of these materials should be readily achievable using conventional means such as the bucket of hydraulic excavators. There may be larger obstructions within the fill towards the northern end of Block 3b where a previous building has now been demolished, which may cause slightly more problematic excavation.

Care must be taken to avoid undermining or disturbing the footing of the adjacent buildings. Test pits should be carried out under geotechnical supervision to assess such issues at the earliest practicable opportunity.

4.4 Vibration Management

With no rock excavation anticipated the magnitude of transmitted vibrations from tracked excavators will be unlikely to result in damage to nearby movement sensitive structures. However if slab on grade construction is proposed it is likely that substantial site preparation will be necessary which could involve the use of vibrating rollers.

It would be prudent to undertake dilapidation reports on buildings adjacent to the proposed excavations at Block 10 prior to commencement. The purpose of dilapidation reports is to provide a benchmark record of the condition of adjoining structures prior to the commencement of construction so that where allegations are raised of construction related damage a benchmark exists against which to compare the apparent change in condition of the structure. In this regard dilapidation reports are very useful in helping to prevent unfounded claims for construction related damage.

If vibrating rollers are to be used we recommend full time vibration monitoring on adjacent structures to the north of Block 10. It is unlikely that significant roller vibration can be used on such limited sites and static rolling will probably be necessary. As this is of limited effectiveness it may be easier to suspend floor slabs than rework significant thicknesses of fill.

4.5 Retention

Proposed basement offsets and dimensions have not been supplied to us at the time of writing, so preliminary advice for retention has been given until exact layout and offsets are known. The following recommendations are based on the assumption that excavation will not extend below the water table.

The use of temporary batters may be feasible, with permanent retaining walls constructed at the base of the batters and the walls subsequently backfilled. We recommend that batters only be considered where adjacent buildings of movement sensitive structures are located a horizontal distance from the crest of the batter of at least twice the height of the batter.

Where space permits, temporary batters within the fill and natural sands should be no steeper than 1 Vertical in 2 Horizontal (1V:2H). Such batters should remain stable in the short term provided all surcharge loads, including construction loads and adjoining structural loads etc. are kept well clear of the crest of the batters.

Where the above batters cannot be accommodated, the excavation will need to be supported by retention systems installed prior to the start of excavations. A contiguous pile retaining wall is likely to be appropriate for such walls. We recommend that the piles be socketed at least 0.3m into the underlying sandstone bedrock, but deeper as necessary for bearing capacity or lateral stability.

Given the limited depth of excavation, piled retaining walls with no structures or surcharge loads within a zone of influence of 2H:1V could be designed as cantilevered retaining walls. Cantilevered retaining walls (where some movement is acceptable) supporting the residual soils may be designed on the basis of an apparent triangular earth pressure distribution and an active earth pressure coefficient (K_a) of 0.35 and a bulk unit weight of 20kN/m^3. Where walls are propped, or anchored, or wall movements are to be reduced an 'at rest' earth pressure coefficient (K_o) of 0.55 should be used.

The above coefficients assume horizontal backfill surfaces and where inclined backfill is proposed the coefficients would need to be increased or the inclined backfill taken as a surcharge load. All surcharge loads, including adjacent structures, should be allowed for in the design. Full hydrostatic pressures should be considered unless

measures are undertaken to provide complete and permanent drainage of the ground behind the wall.

Passive toe resistance of pile walls may be estimated on a passive earth pressure coefficient (K_p) of 3 provided an adequate factor of safety is applied due to the large stains necessary to generate full passive resistance. Alternatively a maximum allowable lateral resistance of 200kPa may be assumed for rock of very low strength; this is not additional to passive toe pressures due to the large discrepancy in strains at which the resistance is mobilised.

Where batters are used, the space between the batters and the permanent retaining walls will need to be carefully backfilled to reduce further settlement of the backfill. Only light compaction equipment should be used for compaction behind retaining walls so that excessive lateral pressures are not placed on the walls. This will require the backfill to be placed in thin layers, say 100mm loose thickness, appropriate to the compaction equipment being used.

The compaction specification for the backfill will depend on whether paving or structures are to be supported on the fill. If the fill is supported paved areas in should be compacted to a density of at least 98% of Standard Maximum Dry Density (SMDD) for granular fill materials, but if it is only to support landscaped areas a lower compaction specification, say 95% of SMDD, may be appropriate, provided the risk of future settlement and maintenance can be expected. Alternatively a clean, hard, durable, single sized gravel may be used as backfill which would require much less compaction and would provide good drainage.

4.6 Foundations

Due to the existence of a poorly compacted deep fill profile, loose natural sands, perched water within the natural sands, and the large structural loads expected we

recommend that Blocks 3b, 3c and 10 be supported on piles founded within the sandstone bedrock.

4.6.1 Blocks 3b and 3c

From the boreholes contained within our previous geotechnical report (ref:22905Srpt259, dated 28 November 2009) Class III sandstone was encountered at the following depths/RLs:

Borehole Number	Surface RL (m)	Class III (or better)
B16	14.87	6.60m / RL10.27m
B21	17.62	7.73m / RL9.89m
B24	17.29	7.60m / RL9.69m
B28	15.33	4.66m / RL10.67m

Rock classification based upon the system described by Pells et al, Foundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics, Dec 1998.

Grout injected CFA piles socketed at least 0.3m into Class III sandstone may be provisionally designed for a maximum Allowable End Bearing Pressure (AEBP) of 3MPa. Further cored boreholes will need to be completed to assess the extent and competency of the underlying sandstone bedrock

The pile sockets should be founded below the zone of influence of the adjacent excavation, which is defined as a line drawn at 45° up from the base of the bulk excavation. Therefore the piles at the western side of the proposed Block 3b and 3c buildings (closest to the excavation) will need to be installed to a depth in the order of at least 10m (~RL7.5m).

We recommend that at least the initial stages of footing excavation be inspected by a geotechnical engineer to confirm that a suitable founding stratum is being

achieved, and that the footings are suitably founded below the zone of influence of the adjacent excavation.

4.6.2 Block 10

From the boreholes contained within the URS report Ref: 43187193, dated 5 October 2006, sandstone was encountered at the following depths/RLs:

Borehole Number	Surface RL (m)	Sandstone
SB207	17.35	5.3m / RL12.05m
SB208	17.19	5.2m / RL11.99m
MW102	17.77	6.2m / RL11.57m

It should be noted that the above boreholes only penetrated the top 0.2m of the underlying sandstone. The sandstone encountered in B21 was assessed to be of poor quality, either extremely low strength or containing multiple defects until a depth of 7.06m (RL10.56m). This poor quality sandstone can also be observed within B16 down to RL10.58m.

Due to the limited information on the strength and consistency of the underlying sandstone within the URS boreholes and the known poor quality sandstone observed within B16 and B21 to RL10.56m, it should be assumed that the Allowable End Bearing Pressure (AEBP) on the upper sandstone should be limited to 700kPa. Higher bearing pressures of say 1,000kPa may be used for piles founded within Class IV sandstone, typically encountered below RL10.56m. If higher bearing pressures are required further cored boreholes will need to be completed to assess the depth and competency of the underlying sandstone bedrock, but good quality Class 1 to 2 sandstone was generally encountered within about 6m to 8m of the surface in the basement excavation to the west.

Due to the presence of poorly compacted fill, sandy soils and the potential for the water table to be present within the sandy soils, it will be necessary to use either CFA grout injected piles or perhaps steel screw piles for lightly loaded structures.

Whatever preliminary foundation design is proposed, it should be noted that further site specific investigation should be carried out when site access permits.

We recommend that at least the initial stages of piling works be inspected by a geotechnical engineer to confirm that a suitable founding stratum is being achieved.

4.7 Slab On Grade Construction

Slab-on-grade construction is considered feasible on condition that the subgrade is prepared in accordance with the recommendations given in Section 4.2 above.

Where concrete slabs are formed on-grade they should be separated from all other building elements. The purpose of this separation is to permit differential movements. Joints in the on-grade floor slabs should be provided with keyed or dowelled joints to accommodate shear forces but not bending moments.

A subbase layer of minimum 100mm of DGB20, compacted to at least 98% of Modified Maximum Dry Density (MMDD) should be considered beneath any concrete on-ground floor slabs which will be subject to traffic.

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. In the event that these recommendations are not implemented, the general advice may become inapplicable and Jeffery and Katauskas Pty Ltd accept no responsibility whatsoever for the

performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, the subsurface conditions between the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

If there is any change in the proposed development described in this report then all recommendations should be reviewed.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. Copyright in this report is the property of Jeffery and Katauskas Pty Ltd. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

Should you have any queries regarding this report, please do not hesitate to contact the undersigned.

A MITCHELL
Senior Geotechnical Engineer

Reviewed by

P STUBBS
Principal

For and on behalf of
JEFFERY AND KATAUSKAS PTY LTD

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. B16 1/4

BOREHOLE LOG

Client: FRASERS PROPERTY

Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 14.87m

Date: 22-9-09 **Datum:** AHD

Logged/Checked by: T.M.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Sandy gravelly clay, low plasticity, brown, fine to coarse grained sand, fine to coarse grained angular ironstone, sandstone and igneous gravel, with sandstone cobbles, brick and concrete fragments.	MC≈PL			APPEARS POORLY COMPACTED
						1				M			NO SPT DUE TO RUBBLE IN FILL
						2			FILL: Silty sandy gravel, fine to coarse grained igneous and ironstone gravel, brown, with fine to coarse grained sand, sandstone cobbles and boulders, brick, concrete, steel and wood fragments.				NO SPT DUE TO RUBBLE IN FILL
▼ ON 29-9-09						3		CL	SANDY CLAY: low to medium plasticity, light grey mottled orange brown and red brown, fine to coarse grained sand.	MC > PL	(VSt)	-	NO SPT DUE TO COLLAPSING OF FILL (SEVERAL ATTEMPTS)
						4		-	SANDSTONE: fine to coarse grained, light grey and red brown, with iron indurated bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE WITH LOW BANDS
						5			REFER TO CORED BOREHOLE LOG SHALLOW STANDPIPE INSTALLED ADJACENET TO LOCATION B16. FOR DETAILS OF DEEP STANDPIPE PLEASE REFER TO CORED LOG PAGE 4/4 50mm CLASS 18 PVC STANDPIPE INSTALLED TO 4.1m, SLOTTED FROM 1.1m TO 4.1m, BACKFILLED WITH 2mm SAND FROM 1.1m TO 4.1m, WITH BENTONITE COLLAR FROM 0.3m TO 1.1m. A STEEL MONUMENT WITH CONCRETE CAP TO FINISH.				
						6							
						7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **B16** 2/4

CORED BOREHOLE LOG

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S | **Core Size:** NMLC | **R.L. Surface:** ≈ 14.87m
Date: 22-9-09 | **Inclination:** VERTICAL | **Datum:** AHD
Drill Type: JK500 | **Bearing:** - | **Logged/Checked by:** T.M./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ (EL VL L M H VH EH)	DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General
		4		START CORINGAT 4.29m					
FULL RET-URN		5		SANDSTONE: fine to medium grained, light grey, with red brown and orange brown stained bands, with grey and brown laminae, bedded at 0-25°.	DW	L			- XWS, 0°, 20mm.t - Be, 5-10°, P, S, HEALED - Be, 0°,P, S, IS - Be, 10°, P, S, IS
					FR	M			
		6		SANDSTONE: fine to coarse grained, light grey, with grey and brown laminae, bedded at 0-25°.					- Be, 15°, Un, S, IS - Be, 5°, P, S, IS
		7				H			- Be, 20°, Un, S
		8							
		9							
		10				M			

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CORED BOREHOLE LOG

Borehole No. B16 3/4

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S | **Core Size:** NMLC | **R.L. Surface:** ≈ 14.87m
Date: 22-9-09 | **Inclination:** VERTICAL | **Datum:** AHD
Drill Type: JK500 | **Bearing:** - | **Logged/Checked by:** T.M./[illegible]

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT DETAILS: DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General
FULL RETURN		12		SANDSTONE: fine to coarse grained, light grey, with grey and brown laminae, bedded at 0-25°.	FR	M			
		13				H			
		14		SANDSTONE: fine to medium grained, light grey, with grey, brown and dark grey laminae, bedded at 0-20°.					
		15							- XWS, 0-5°, 23mm.t
		16		SANDSTONE: fine to coarse grained, light grey, with grey, brown and dark grey laminae, bedded at 0-25°.					- XWS, 10°, 8mm.t - XWS, 0-5°, 7mm.t - CS, 0-5°, 11mm.t
		17				M			

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. B16 4/4

CORED BOREHOLE LOG

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S | **Core Size:** NMLC | **R.L. Surface:** ≈ 14.87m
Date: 22-9-09 | **Inclination:** VERTICAL | **Datum:** AHD
Drill Type: JK500 | **Bearing:** - | **Logged/Checked by:** T.M./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ (EL VL L M H VH EH)	DEFECT DETAILS: DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
FULL RET URN		19		SANDSTONE: fine to coarse grained, light grey, with grey and brown laminae, bedded at 0-25°.	FR	H			- J, 45-90°, Un, R - J, 70°, P,S
		20							- Be, 20°, P, S
		21							- Be, 0°, P, S
		22							
		23		END OF BOREHOLE AT 22.57m					50mm CLASS 18 PVC STANDPIPE INSTALLED TO 9.1m, SLOTTED FROM 6.1m TO 9.1m, BACKFILLED WITH 2mm SAND FROM 6.1m TO 9.1m, WITH BENTONITE COLLAR FROM 0.4m TO 6.1m. A STEEL MONUMENT WITH CONCRETE CAP TO FINISH.
		24							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. B21 1/5

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 17.62m
Date: 24-9-09 **Datum:** AHD
Logged/Checked by: T.M./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			ASPHALTIC CONCRETE: 60mm.t	-	-	-	NO OBSERVED REINFORCEMENT
									CONCRETE: 120mm.t				
									CONCRETE: 170mm.t				
								-	FILL: Silty sand, fine to medium grained, dark grey brown, with a trace of fine to medium grained angular ironstone and igneous gravel.	M	-	-	
					N = 7 4,3,4			SP	SAND: fine to medium grained, grey.	M	L	-	
						1							
					N = 14 4,6,8				SAND: fine to medium grained, light brown, with a trace of silt fines.		MD		
						2			SAND: fine to medium grained, light grey.				
					N = 27 12,12,15	3							
ON 1-10-09						4							
					N = 2 1,1,1			CH	SILTY CLAY: high plasticity, grey mottled orange brown, with a trace of fine to medium grained sub angular ironstone gravel.	MC > PL	F	70 70 70	
						5							
					SPT 23/150mm REFUSAL			-	SANDSTONE: fine to coarse grained, light grey, with orange and red brown bands and L strength bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE WITH LOW BANDS
						6			SANDSTONE: fine to coarse grained, orange brown, with XW seams.	DW	M		LOW TO MODERATE RESISTANCE WITH VERY LOW BANDS
						7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. B21 2/5

Client: FRASERS PROPERTY

Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 17.62m

Date: 24-9-09 **Datum:** AHD

Logged/Checked by: T.M./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									SANDSTONE: fine to coarse grained, orange brown, with XW seams.	DW	M		
									REFER TO CORED BOREHOLE LOG SHALLOW STANDPIPE INSTALLED ADJACENET TO LOCATION B21. FOR DETAILS OF DEEP STANDPIPE PLEASE REFER TO CORED LOG PAGE 5/5 50mm CLASS 18 PVC STANDPIPE INSTALLED TO 5.9m, SLOTTED FROM 2.9m TO 5.9m, BACKFILLED WITH 2mm SAND FROM 2.7m TO 5.9m, WITH BENTONITE COLLAR FROM 0.4m TO 2.7m. A STEEL MONUMENT WITH CONCRETE CAP TO FINISH.				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

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CORED BOREHOLE LOG

Borehole No. B21 3/5

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S | **Core Size:** NMLC | **R.L. Surface:** ≈ 17.62m
Date: 24-9-09 | **Inclination:** VERTICAL | **Datum:** AHD
Drill Type: JK500 | **Bearing:** - | **Logged/Checked by:** T.M.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ (EL VL L M H VH EH)	DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General
		7		START CORING AT 7.06m	DW	M			- Be, 0°, P, S - CS, 0°, 15mm.t - CS, 0°, 12mm.t - CS, 0°, 12mm.t - CS, 0°, 3mm.t
				SANDSTONE: fine to coarse grained, light grey, with orange brown and red brown stained bands and grey and brown laminae, bedded at 0-20°.					- Be, 0-5°, Un, S, IS, CLAY INFILL 2mm.t
		8			FR	H			
				SANDSTONE: fine to coarse grained, light grey, with grey and brown laminae, bedded at 0-25°.					
		9							- Be, 10°, P, S, IS - XWS, 0°, 4mm.t - Be, 0°, P, S
FULL RET URN		10							- XWS, 0°, 26mm.t
		11							
		12				M			
		13							- J, 75°, P, S

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CORED BOREHOLE LOG

Borehole No. B21 4/5

Client: FRASERS PROPERTY

Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S | **Core Size:** NMLC | **R.L. Surface:** ≈ 17.62m

Date: 24-9-09 | **Inclination:** VERTICAL | **Datum:** AHD

Drill Type: JK500 | **Bearing:** - | **Logged/Checked by:** T.M./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ EL VL L M H VH EH	DEFECT DETAILS DEFECT SPACING (mm) 600 300 100 50 30 10	DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
FULL RET-URN		15		SANDSTONE: fine to coarse grained, orange brown, with XW seams.	FR	M			- XWS, 0°, 20mm.t - XWS, 0°, 23mm.t - CS, 0°, 3mm.t
		16		SANDSTONE: fine to medium grained, light grey with grey and dark grey laminae, bedded at 0-15°.		H			- Be, 10°, P, S - CS, 0°, 18mm.t - CS, 0°, 2mm.t
		17							- XWS, 0°, 7mm.t - XWS, 0°, 4mm.t
		18		SANDSTONE: fine to coarse grained, light grey, with grey laminae, bedded at 0-25°.					- Be, 10°, P, S
		19							- Be, 0-5°, P, S
		20							- XWS, 0-10°, 7mm.t

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Borehole No. **B21** 5/5

CORED BOREHOLE LOG

Client: FRASERS PROPERTY

Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Core Size:** NMLC **R.L. Surface:** ≈ 17.62m

Date: 24-9-09 **Inclination:** VERTICAL **Datum:** AHD

Drill Type: JK500 **Bearing:** - **Logged/Checked by:** T.M.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ EL VL L M H VH EH	DEFECT DETAILS DEFECT SPACING (mm) 600 300 100 50 30 10	DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
FULL RETURN		22		SANDSTONE: fine to coarse grained, light grey, with grey laminae, bedded at 0-25°.	FR	H	×		- XWS, 0-5°, 15mm.t
							×		- Be, 0°, P, S - Be, 15°, P, S
		23					×		
							×		
		24					×		- CS, 15°, 4mm.t
							×		- CS, 0-5°, 23mm.t
		25		END OF BOREHOLE AT 24.87m					50mm CLASS 18 PVC STANDPIPE INSTALLED TO 10.7m, SLOTTED FROM 7.7m TO 10.7m, BACKFILLED WITH 2mm SAND FROM 7.8m TO 10.7m, WITH BENTONITE COLLAR FROM 0.3m TO 7.8m. A STEEL MONUMENT WITH CONCRETE CAP TO FINISH.
		26							
		27							

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Borehole No. B24 1/4

BOREHOLE LOG

Client: FRASERS PROPERTY

Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 17.29m

Date: 10-9-09 **Datum:** AHD

Logged/Checked by: T.M./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty gravelly sand, fine to coarse grained, brown grey, fine to coarse grained sub angular to angular sandstone and igneous gravel, with concrete and brick fragments.	D			APPEARS POORLY COMPACTED
										M			
						1			FILL: Silty sand, fine to medium grained, grey brown, with concrete fragments.				NO SPT DUE TO BRICK AND CONCRETE IN FILL
					N = 3 3,1,2	2		SP	SAND: fine to medium grained, light brown.	M	VL	-	
								SM	SILTY SAND: fine to medium grained, brown to dark brown,				
					N = 12 3,4,8	3		SP	SAND: fine to medium grained, light yellow brown.		MD		
						4				W			
					N = 3 2,1,2	5		SM	SILTY SAND: fine grained, light orange brown.		VL		NO SPT SPLIT TUBE RECOVERY
								CL	SILTY CLAY: medium plasticity, grey.	MC>PL	(F)		
						6		-	SANDSTONE: fine to medium grained, orange brown, with XW bands.	DW	L	-	LOW TO MODERATE 'TC' BIT RESISTANCE WITH VERY LOW BANDS
									REFER TO CORED BOREHOLE LOG				

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Borehole No. **B24** 2/4

CORED BOREHOLE LOG

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S | **Core Size:** NMLC | **R.L. Surface:** ≈ 17.29m
Date: 10-9-09 | **Inclination:** VERTICAL | **Datum:** AHD
Drill Type: JK500 | **Bearing:** - | **Logged/Checked by:** T.M.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ (EL VL L M H VH EH)	DEFECT DETAILS: DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General
		6		START CORING AT 6.94m					
FULL RETURN		7		SANDSTONE: fine to coarse grained, orange brown, with grey and brown laminae, bedded at 0-25°.	DW / FR	M			- CS, 10°, 10mm.t - CS, 0°, 10mm.t
		8		as above, but light grey.		H			- CS, 10°, 8mm.t - CS, 0°, 10mm.t - CS, 0°, 7mm.t
		9							
		10							- XWS, 0°, 10mm.t
		11							
		12							

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Borehole No. B24 3/4

CORED BOREHOLE LOG

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Core Size:** NMLC **R.L. Surface:** ≈ 17.29m
Date: 10-9-09 **Inclination:** VERTICAL **Datum:** AHD
Drill Type: JK500 **Bearing:** - **Logged/Checked by:** T.M./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 600 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific	General
FULL RET-URN		14		SANDSTONE: fine to coarse grained, light grey, with grey and brown laminae, bedded at 0-25°.	FR	H	×		- XWS, 0°, 11mm.t	
		15		SANDSTONE: fine to medium grained, light grey to grey, with dark grey laminae, bedded at 0-15°.			×			
		16					×			
		17					×			
		18		SANDSTONE: fine to coarse grained, light grey, with grey laminae, bedded at 0-25°			×			
		19					×		- CS, 0°, 5mm.t - XWS, 0-5°, 13mm.t	

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Borehole No. **B24** 4/4

CORED BOREHOLE LOG

Client: FRASERS PROPERTY

Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Core Size:** NMLC **R.L. Surface:** ≈ 17.29m

Date: 10-9-09 **Inclination:** VERTICAL **Datum:** AHD

Drill Type: JK500 **Bearing:** - **Logged/Checked by:** T.M./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT DETAILS DEFECT SPACING (mm) 500 300 100 50 30 10	DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
FULL RET-URN		21		SANDSTONE: fine to coarse grained, light grey, with grey laminae, bedded at 0-25°	FR	H			- Be, 5°, P, S - Be, 5-10°, P, S
		22							- XWS, 5°, 3mm.t - CS, 0-5°, 5mm.t
		23							
		24							- CS, 0-5°, 13mm.t
		25		END OF BOREHOLE AT 25.05m					
		26							

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BOREHOLE LOG

Borehole No. B28 1/4

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Method:** SPIRAL AUGER JK500 **R.L. Surface:** ≈ 15.33m
Date: 21-9-09 **Datum:** AHD
Logged/Checked by: T.M./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty sandy clay, low to medium plasticity, brown, fine to coarse grained sand, with fine to coarse grained igneous and sandstone gravel and concrete fragments.	MC>PL			
					N = 11 2,4,7			SM		M	MD		
						1		SP	SILTY SAND: fine to medium grained, brown.				
									SAND: fine to medium grained, light grey.	W			
▼ ON 29-9-09					N = 23 7,10,13	2		SC	CLAYEY SAND: fine to medium grained, orange brown.				
					N = 7 2,3,4	3		CH	SILTY CLAY: high plasticity, grey mottled light brown and red brown, with a trace of fine to medium grained angular ironstone gravel.	MC>PL	St	120 120 120	
						4		-	SANDSTONE: fine to coarse grained, interbedded red brown and light grey, with L strength bands and iron indurated bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE WITH LOW BANDS
						5			REFER TO CORED BOREHOLE LOG SHALLOW STANDPIPE INSTALLED ADJACENET TO LOCATION B28. FOR DETAILS OF DEEP STANDPIPE PLEASE REFER TO CORED LOG PAGE 4/4 50mm CLASS 18 PVC STANDPIPE INSTALLED TO 4.1m, SLOTTED FROM 1.1m TO 4.1m, BACKFILLED WITH 2mm SAND FROM 1.1m TO 4.1m, WITH BENTONITE COLLAR FROM 0.4m TO 1.1m. A STEEL MONUMENT WITH CONCRETE CAP TO FINISH.				
						6							
						7							

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Borehole No. **B28** 2/4

CORED BOREHOLE LOG

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Core Size:** NMLC **R.L. Surface:** ≈ 15.33m
Date: 21-9-09 **Inclination:** VERTICAL **Datum:** AHD
Drill Type: JK500 **Bearing:** - **Logged/Checked by:** T.M./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ EL VL L M H VH EH	DEFECT DETAILS: DEFECT SPACING (mm) 500 200 100 60 30 10	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
		4		START CORING AT 4.66m					
FULL RET-URN		5		SANDSTONE: fine to coarse grained, red brown and orange brown, with grey and brown laminae, bedded at 0-25°.	DW	M			
				SANDSTONE: fine to coarse grained, light grey, with grey laminae, bedded at 0-25°	FR	H			- CS, 0°, 5mm.t
		6							
		7							- CS, 0°, 8mm.t - XWS, 0-10°, 15mm.t - XWS, 0-5°, 13mm.t - Be, 10°, P, S, CLAY INFILL 3mm.t
		8							- Be, 15°, P, S
		9							
		10							

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Borehole No. **B28** 3/4

CORED BOREHOLE LOG

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Core Size:** NMLC **R.L. Surface:** ≈ 15.33m
Date: 21-9-09 **Inclination:** VERTICAL **Datum:** AHD
Drill Type: JK500 **Bearing:** - **Logged/Checked by:** T.M.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General
FULL RET-URN		12		SANDSTONE: fine to coarse grained, light grey, with grey laminae, bedded at 0-25°	FR	H			- XWS, 0°, 20mm.t - XWS, 0°, 40mm.t - CS, 0°, 10mm.t
		13		SANDSTONE: fine to medium grained, light grey to grey, with dark grey laminae, bedded at 0-10°.					- HEAVILY BEDDED ZONE, 0-5°, P, S
		14		SANDSTONE: fine to coarse grained, light grey with grey laminae, bedded at 0-25°.					
		15							
		16							- Be, 0°, P, S
		17							

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Borehole No. **B28** 4/4

CORED BOREHOLE LOG

Client: FRASERS PROPERTY
Project: FRASERS BROADWAY, BLOCK 2, 5 AND 9
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905S **Core Size:** NMLC **R.L. Surface:** ≈ 15.33m
Date: 21-9-09 **Inclination:** VERTICAL **Datum:** AHD
Drill Type: JK500 **Bearing:** - **Logged/Checked by:** T.M.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_S(50)$ (EL VL L M H VH EH)	DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General
FULL RET-URN		19		SANDSTONE: fine to coarse grained, light grey with grey laminae, bedded at 0-25°.	FR	H			- XWS, 10°, 25mm.t - J, 70°, P, S - J, 75°, P, S, PARTIALLY HEALED - J, 30°, P, S - J, 70°, P ,S - CS, 0°, 6mm.t
		20							
		21							
		22							- Be, 20°, Un, S - CS, 10°, 8mm.t
		23		END OF BOREHOLE AT 22.39m					50mm CLASS 18 PVC STANDPIPE INSTALLED TO 9.4m, SLOTTED FROM 6.4m TO 9.4m, BACKFILLED WITH 2mm SAND FROM 6.4m TO 9.4m, WITH BENTONITE COLLAR FROM 0.3m TO 6.4m. A STEEL MONUMENT WITH CONCRETE CAP TO FINISH.
		24							

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Borehole No. P4 1/1

BOREHOLE LOG

Client: FRASERS PROPERTY

Project: PROPOSED STAGE 1 & 2 INFRASTRUCTURE

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905Sroads **Method:** SPIRAL AUGER JK300 **R.L. Surface:** ≈ 17.0m

Date: 19-1-10 **Datum:** AHD

Logged/Checked by: T.M./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0		SM	SILTY SAND: fine to medium grained, dark grey brown.	M	(L)		
								SP	SAND: fine to medium grained, light grey.		L		
					N = 7 4,4,3	0.5							
						1		SC	SILTY CLAYEY SAND: fine to medium grained, brown and orange brown.				
						1.5			END OF BOREHOLE AT 1.5m				
						2							
						2.5							
						3							
						3.5							

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Borehole No. P5 1/1

BOREHOLE LOG

Client: FRASERS PROPERTY

Project: PROPOSED STAGE 1 & 2 INFRASTRUCTURE

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905Sroads **Method:** SPIRAL AUGER JK300 **R.L. Surface:** ≈ 17.2m

Date: 19-1-10 **Datum:** AHD

Logged/Checked by: T.M./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Sandy silty gravel, fine to medium grained angular igneous, green grey, fine to medium grained sand.	M			
									FILL: Silty clay, medium to high plasticity, red brown mottled light grey, with a trace of fine to medium grained angular ironstone gravel.	MC>PL			
					N = 10 5,5,5	0.5		SP	SAND: fine to medium grained, grey, with a trace of silt.	M	L-MD		
						1							
						1.5			END OF BOREHOLE AT 1.5m				
						2							
						2.5							
						3							
						3.5							

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Borehole No. P6 1/1

BOREHOLE LOG

Client: FRASERS PROPERTY

Project: PROPOSED STAGE 1 & 2 INFRASTRUCTURE

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905Sroads **Method:** SPIRAL AUGER JK300 **R.L. Surface:** ≈ 17.9m

Date: 19-1-10 **Datum:** AHD

Logged/Checked by: T.M./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty sand, fine to coarse grained, brown, with fine to coarse grained angular igneous gravel and brick, wood and ceramic fragments.	M			APPEARS MODERATELY COMPACTED
					N = 8 5,4,4	0.5							
						1		SP	SAND: fine to medium grained, light grey.	M	L-MD	-	
								SM	CLAYEY SILTY SAND: fine to medium grained, dark brown, with yellow brown bands.				
					N = 10 6,4,6	1.5							
						2			END OF BOREHOLE AT 1.95m				
						2.5							
						3							
						3.5							

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Borehole No. **P7** 1/1

BOREHOLE LOG

Client: FRASERS PROPERTY

Project: PROPOSED STAGE 1 & 2 INFRASTRUCTURE

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905Sroads **Method:** SPIRAL AUGER JK300 **R.L. Surface:** ≈ 18.2m

Date: 19-1-10 **Datum:** AHD

Logged/Checked by: T.M.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty sand, fine to coarse grained, brown, with fine to coarse grained sub angular igneous, sandstone and ironstone gravel, brick and concrete fragments and sandstone cobbles and boulders.	M			NO SPT DUE TO OBSTRUCTIONS IN FILL
						0.5							
						1							
					N = 9 5,5,4	1.5		SP	SAND: fine to medium grained, light brown, with a trace of silt.	M	L	-	
						2			END OF BOREHOLE AT 1.95m				
						2.5							
						3							
						3.5							

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Borehole No. **P12** 1/1

BOREHOLE LOG

Client: FRASERS PROPERTY

Project: PROPOSED STAGE 1 & 2 INFRASTRUCTURE

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905Sroads **Method:** SPIRAL AUGER JK350 **R.L. Surface:** N/A

Date: 20-1-10 **Datum:**

Logged/Checked by: L.Y./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			ASPHALTIC CONCRETE: 200mm.t				
									CONCRETE: 170mm.t	-	-	-	NO OBSERVED REINFORCEMENT
					N = 3 1,1,2	0.6		-	FILL: Sand, fine to medium grained, brown and grey, with a trace of tile fragments and fine to medium grained sandstone gravel.	M	-	-	APPEARS POORLY COMPACTED
						1							
						1.5			END OF BOREHOLE AT 1.5m				
						2							
						2.5							
						3							
						3.5							

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Borehole No. P13 1/1

BOREHOLE LOG

Client: FRASERS PROPERTY

Project: PROPOSED STAGE 1 & 2 INFRASTRUCTURE

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905Sroads **Method:** SPIRAL AUGER JK350 **R.L. Surface:** N/A

Date: 20-1-10 **Datum:**

Logged/Checked by: T.M./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
ON COMPLETION						0			ASPHALTIC CONCRETE: 50mm.t				
									CONCRETE: 190mm.t	-	-	-	NO OBSERVED REINFORCEMENT
								-	FILL: Sand, fine to medium grained, brown and grey, with fine to medium grained igneous and sandstone gravel.	M	-	-	APPEARS POORLY TO MODERATELY COMPACTED
					N = 7 5,4,3	0.5		SP	SAND: fine to medium grained, brown and grey.	M	L		
						1							
						1.5			END OF BOREHOLE AT 1.5m				
						2							
						2.5							
						3							
						3.5							

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Borehole No. P14 1/1

BOREHOLE LOG

Client: FRASERS PROPERTY

Project: PROPOSED STAGE 1 & 2 INFRASTRUCTURE

Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905Sroads **Method:** SPIRAL AUGER JK350 **R.L. Surface:** N/A

Date: 20-1-10 **Datum:**

Logged/Checked by: L.Y./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			ASPHALTIC CONCRETE: 95mm.t				
									CONCRETE: 200mm.t	-	-	-	NO OBSERVED REINFORCEMENT
					N = 9 5,4,5	0.5		-	FILL: Sand, fine to medium grained, brown and grey, with a trace of fine to medium grained sandstone gravel and cobbles	M	-	-	APPEARS MODERATELY COMPACTED
						1							
						1.5			END OF BOREHOLE AT 1.5m				
						2							
						2.5							
						3							
						3.5							

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Borehole No. **P15** 1/1

BOREHOLE LOG

Client: FRASERS PROPERTY
Project: PROPOSED STAGE 1 & 2 INFRASTRUCTURE
Location: 20-102 BROADWAY, SYDNEY, NSW

Job No. 22905Sroads **Method:** SPIRAL AUGER JK350 **R.L. Surface:** N/A
Date: 20-1-10 **Datum:**
Logged/Checked by: L.Y./[illegible]

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			ASPHALTIC CONCRETE AND CONCRETE: 255mm.t				CORE LEFT IN THE BOREHOLE
								-	VOID: 200mm.t	-	-	-	
					N = 0 SUNK	0.5		-	FILL: Sand, fine to medium grained, brown and grey, with fine to medium grained sandstone and igneous gravel.	M	-	-	APPEARS POORLY COMPACTED
						1							
						1.5			END OF BOREHOLE AT 1.5m				
						2							
						2.5							
						3							
						3.5							

URS

Sheet 1 of 1

SOIL BOREHOLE SB207

URS Australia Pty Ltd	Phone / Fax	Project Reference: GUST	Client: GUST
Drilling Contractor: Terratest, Engineering Exploration		Project No.: 31503-016	Location: Chippendale, NSW
Logged By: DD	Bore Size: 150 mm	Relative Level: 17.35 mRL	Drill Type: Solid stem auger
Checked By: JS	Total Depth: 5.40 m	Coordinates: 6249073.94 mN	Drill Model: Explorer
Date Started: 23-07-03	Casing Size: mm	333722.02 mE	Drill Fluid: NA
Date Finished: 23-07-03		Permit No:	

Depth (m)	Graphic Log	Classification	USC DESCRIPTION OF STRATA Type, plasticity / particle size, colour, secondary / minor components (e.g., "trace"), additional observations	Moisture Condition	Consistency Relative Density	Sample Interval	PID (ppm)	Sample ID
0			CONCRETE					
		SW	SAND, coarse grained, brown - light orange, dry, loose	D	L		1.3	SB207_0.2-0.3
1							1.1	SB207_0.9-1.1 QC107, QC108
2							0.9	SB207_1.9-2.1
3							1.1	SB207_2.9-3.1
			As above, moist	M	L			
			As above, wet	W	L			
4							0.9	SB207_3.9-4.1
5		CLS	Sandy CLAY, moderate plasticity, orange mottled red, soft, wet, with coarse sand	W	S		0.9	SB207_4.9-5.1
			SANDSTONE, coarse, hard					
			EOH@5.4m.					
6								
7								
8								

Method | Casing | Penetration (S M HR) | Ground Water Data and Comments

ENVR_MELB LOGS.GPJ WCC_AUS.GDT 27/10/03

URS

SOIL BOREHOLE SB208

URS Australia Pty Ltd	Phone / Fax	Project Reference: GUST	Client: GUST
Drilling Contractor: Terratest, Engineering Exploration		Project No.: 31503-016	Location: Chippendale, NSW
Logged By: DD	Bore Size: 150 mm	Relative Level: 17.19 mRL	Drill Type: Solid stem auger
Checked By: JS	Total Depth: 5.40 m	Coordinates: 6249067.05 mN 333722.47 mE	Drill Model: Explorer
Date Started: 23-07-03	Casing Size: mm	Permit No:	Drill Fluid: NA
Date Finished: 23-07-03			

Method	Casing	Penetration (S M HR)	Ground Water Data and Comments	Depth (m)	Graphic Log	Classification	USC DESCRIPTION OF STRATA Type, plasticity / particle size, colour, secondary / minor components (e.g., "trace"), additional observations	Moisture Condition	Consistency Relative Density	Sample Interval	PID (ppm)	Sample ID
				0			CONCRETE					
						SW	SAND, coarse grained, light brown, loose, dry	D	L		0.7	SB208_0.2-0.3
				1			As above, dark brown				0.6	SB208_0.9-1
							As above, light brown	D	L			
				2							0.7	SB208_1.9-2.1 QC109, QC110
							As above, off white	D	L			
				3							0.5	SB208_2.9-3.1
			▽				As above, wet	W	L			
				4							0.6	SB208_3.9-4.1
						CL	CLAY, orange, some trace of shale, moist, soft, becoming weathered sandstone	M	S			
				5							0.6	SB208_4.9-5.1
							SANDSTONE, white, hard	D	H			
							EOH@5.4m.					
				6								
				7								
				8								

ENVR_MELB LOGS.GPJ WCC_AUS.GDT 27/10/03

URS

MONITORING WELL MW102

URS Australia Pty. Ltd.
Level 3, 116 Miller Street, North Sydney
Phone
Fax

Project Reference: GUST

Project No.: 31503-016

Client: GUST

Location: Chippendale, NSW

Drilling Contractor: Terratest, Engineering Exploration

Logged By:	DD	Bore Size: 200 mm	Relative Level: 17.77 mRL
Checked By:	JS	Total Depth: 6.20 m	Coordinates: 6249077.46 mN
Date Started:	23-07-03	Casing Size: 50 mm	333739.86 mE
Date Finished:	23-07-03		Permit No:

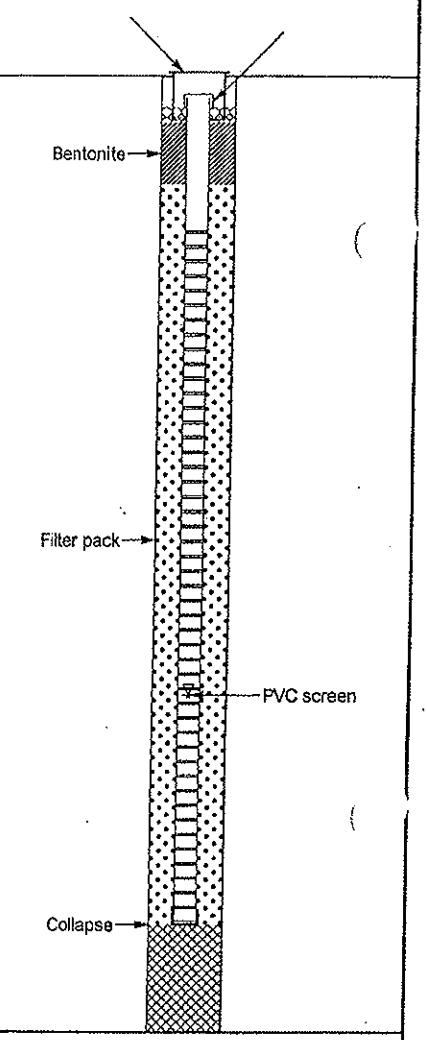
Drill Type: Continuous flight hollow stem auger

Drill Model: Explorer

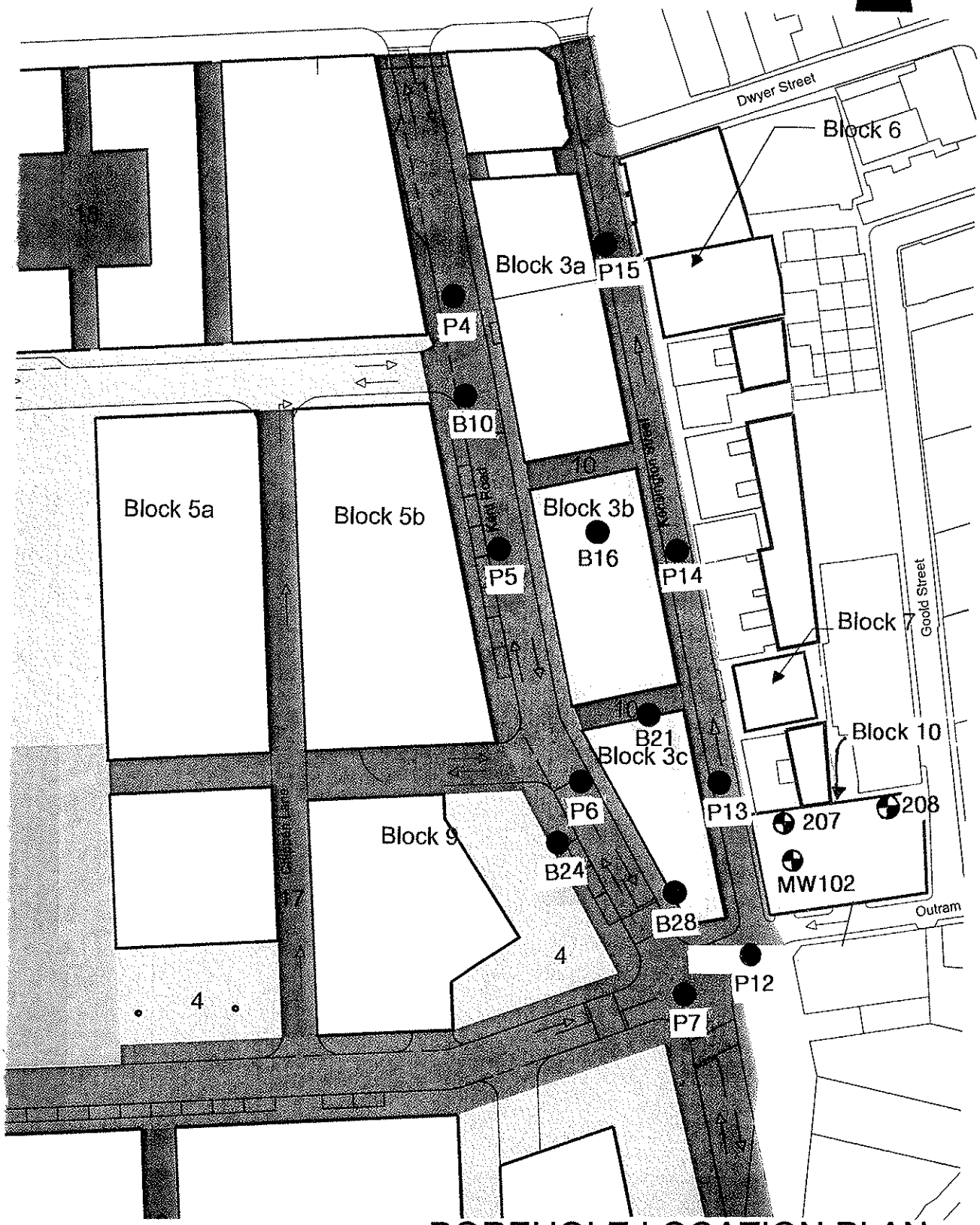
Drill Fluid: NA

Sample Interval	PID (ppm)	Sample ID	Legend	USC DESCRIPTION OF STRATA Type, plasticity / particle size, colour, secondary / minor components (e.g., "trace"), moisture content, consistency / density, and additional observations	Classification	Depth (m)	Moisture Condition
G	0.3	MW102_0.1-0.2		CONCRETE		0	
				FILL, rubble, sand			
				SAND, coarse grained, light brown, dry, loose	SW		D
	0	MW102_0.9-1.1				1	
	0	MW102_1.9-2.1				2	
	0.2	MW102_2.9-3.1				3	
	0.3	MW102_3.9-4.1		CLAY, moderate plasticity, dark grey, wet, soft	CL	4	W
				CLAY, moderate plasticity, orange mottled, trace coarse grained sand, wet, soft, becoming weathered sandstone	CL		W
	0	MW102_4.9-5.0				5	
	0.1	MW102_5.9-6.0				6	
				EOH@6.2m. Refusal on Sandstone.		7	
						8	

WELL CONSTRUCTION DETAILS



Inverted triangle symbol denotes depth of groundwater encountered during drilling.



BOREHOLE LOCATION PLAN

SCALE (m)

0 50

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Report No. 22905S **Figure No. 1**

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ABN 17 003 550 801

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

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

DESCRIPTION AND CLASSIFICATION METHODS

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

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (eg sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

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

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

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.

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

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

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration.

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

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

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

The test results are reported in the following form:

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

  N = 13
  4, 6, 7

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

  N>30
  15, 30/40mm

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

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

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

Static Cone Penetrometer Testing and Interpretation: Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

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

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various Road Authorities.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

LOGS

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

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

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

GROUNDWATER

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

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

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

FILL

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

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

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soil for Engineering Purposes'*. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg to a twenty storey building). If this happens, the company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

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

SITE ANOMALIES

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

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

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

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. License to use the documents may be revoked without notice if the Client is in breach of any objection to make a payment to us.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

SITE INSPECTION

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

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or

iii) full time engineering presence on site.

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GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

SOIL


FILL


TOPSOIL


CLAY (CL, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CH)


SILTY CLAY (CL, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML)


PEAT AND ORGANIC SOILS

ROCK


CONGLOMERATE


SANDSTONE


SHALE


SILTSTONE, MUDSTONE, CLAYSTONE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

DEFECTS AND INCLUSIONS


CLAY SEAM


SHEARED OR CRUSHED SEAM


BRECCIATED OR SHATTERED SEAM/ZONE


IRONSTONE GRAVEL


ORGANIC MATERIAL

OTHER MATERIALS


CONCRETE

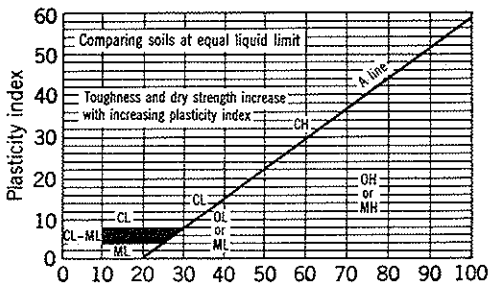

BITUMINOUS CONCRETE, COAL


COLLUVIUM

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

UNIFIED SOIL CLASSIFICATION TABLE

Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)						Group Symbols [a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils: More than half of material is *larger* than 75 μm sieve size[b] (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels: More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	Use grain size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP* More than 12% *GM, GC, SM, SC* 5% to 12% *Borderline* cases requiring use of dual symbols $C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *GW* Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits above "A" line, with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		
	Sands: More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *SW* Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits below "A" line with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines		
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures		
Fine-grained soils: More than half of material is *smaller* than 75 μm sieve size	Identification Procedures on Fraction Smaller than 380 μm Sieve Size								
	Silts and clays: liquid limit less than 50		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				
			None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)	
			Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity		
	Silts and clays: liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays		
			Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity		
Highly Organic Soils			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils		



Plasticity chart
for laboratory classification of fine grained soils

NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. GW-GC, well graded gravel-sand mixture with clay fines).

2) Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

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ABN 17 003 550 801

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown.
		Extent of borehole collapse shortly after drilling.
		Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos screening.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)	MC > PL	Moisture content estimated to be greater than plastic limit.
	MC ≈ PL	Moisture content estimated to be approximately equal to plastic limit.
	MC < PL	Moisture content estimated to be less than plastic limit.
(Cohesionless Soils)	D	DRY - runs freely through fingers.
	M	MOIST - does not run freely but no free water visible on soil surface.
	W	WET - free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT - Unconfined compressive strength less than 25kPa
	S	SOFT - Unconfined compressive strength 25-50kPa
	F	FIRM - Unconfined compressive strength 50-100kPa
	St	STIFF - Unconfined compressive strength 100-200kPa
	VSt	VERY STIFF - Unconfined compressive strength 200-400kPa
	H	HARD - Unconfined compressive strength greater than 400kPa
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** / **SPT 'N' Value Range (Blows/300mm)**
	VL	Very Loose: <15 / 0-4
	L	Loose: 15-35 / 4-10
	MD	Medium Dense: 35-65 / 10-30
	D	Dense: 65-85 / 30-50
	VD	Very Dense: >85 / >50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten carbide wing bit.
	T 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

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LOG SYMBOLS

ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered 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 rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL	0.03	Easily remoulded by hand to a material with soil properties.
Very Low:	VL	0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.
Low:	L	0.3	A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
Medium Strength:	M	1	A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
High:	H	3	A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
Very High:	VH	10	A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	