Douglas Partners
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Report on
Geotechnical Investigation

Alterations and Additions
20 Illawong Avenue, Tamarama

Prepared for
Strata Plan 1731

Project 72261.06
November 2018

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	72261.06	Document No.	R.003.Rev0
Document title	Report on Geotechnical Investigation Alterations and Additions		
Site address	20 Illawong Avenue, Tamarama		
Report prepared for	Strata Plan 1731		
File name	72261.06.R.003.Rev0.Geotechnical Investigation Report		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Huw Smith	John Braybrooke	23 November 2018

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Onofrio Marzulli (Midson Group Pty Ltd, on behalf of Strata Plan SP1731)
Revision 0	1	0	Christine Smetsers (Smetsers Pty Ltd, on behalf of Strata Plan 1731)

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		23/11/2018
Reviewer		23/11/18

bsi. ISO 9001 Quality Management
FS 604853

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1. Introduction

This report presents the results of a geotechnical investigation undertaken for the construction of a proposed underground car park, as well as alterations and additions to a residential unit block at 20 Illawong Avenue, Tamarama. The investigation was commissioned by GK Strata Management Pty Ltd on 25 September 2018, on behalf of Strata Plan SP1731, and was undertaken in accordance with Douglas Partners' proposal SYD180941 (Rev 1) dated 24 September 2018.

Architectural drawings prepared by GroupGSA Architects (i.e. drawings A2002 (Rev 3) and A3100 (Rev A), dated 21 April 2017 and 13 January 2017 respectively), indicates that the proposed underground car park will have two to three basement levels, with a final finished level of RL46.23 m, relative to the Australian Height Datum (AHD). Excavation depths are anticipated to range between 6 m and 10.6 m below the current ground surface. The drawings also indicate that the south-western / seaward-side of the building will be extended by between 3.1 m and 5.18 m, to create balconies for each of the units which overlook Tamarama beach. It is understood that the proposed alterations and additions includes the construction of up to two levels of residential 'penthouse' apartments on the top of the existing residential unit block.

A geotechnical investigation was undertaken to provide information on the subsurface conditions within the footprint of the proposed basement, and to investigate the depth and extent of potential weathered seams and voids beneath the proposed balcony footing locations. The investigation included a site walkover by an engineering geologist, drilling of boreholes within both the car park and some of the existing ground-level balconies / terraces, geological mapping traverses of the cliff on the south-western side of the existing building, and laboratory testing. Details of the field work and laboratory testing completed at the site for the current scope of work is presented in this report.

The results of historical geotechnical investigations and laboratory testing were also considered in the preparation of this report, including boreholes within the proposed basement car park footprint, test pit footing exposures, geological mapping traverses of the cliff, and photographs / site observations of the trenched sewer diversion excavation. The results of previous site investigations have been included in Appendix F and G for ease of reference.

2. Site Description and Geology

The site is located at the western end of Illawong Avenue, Tamarama, and comprises an irregularly-shaped parcel of land totalling approximately 4,353 m^2 (refer to Drawing 1 in Appendix C, and site photographs 1 to 11 in Appendix B). The site is occupied by a six-storey block of units, located towards the southern boundary, with an asphalt-surfaced car park on the northern side of the building. A free-standing, brick laundry block is present on the northern side of the entrance from Illawong Avenue. The south-western part of the site, which is vacant and covered with grass, slopes

down towards a laneway and the southern property boundary. It is understood that recent excavation / trenching work has been completed on the western and south-western property boundary, to re-align the sewer. A selection of site photographs obtained during the sewer diversion works is included in Appendix F.

The ground floor of the existing unit block is at an elevation of approximately RL55.6 m, and the balconies / terraces (hereafter referred to as 'terraces': on the ground floor level only) have an elevation of approximately RL55.5 m. The ground surface of the site generally slopes from the northern corner (elevation of RL56.8 m) towards the south, at an average surface angle of about 3.5 degrees, whilst the area of grass at the western end of the building slopes moderately steeply to the south at about 12 degrees.

An exposure of massive, high strength sandstone was observed adjacent to the car park, near the south-western end of the unit block (refer Photo 12 in Appendix B). A sandstone cliff is present along most of the south-western boundary (i.e. on the side furthest from the proposed basement excavation and closest to the gully above Tamarama Park), having a height between 4 - 8 m and being mostly obscured by vegetation. The terraces of the building are supported by a brick retaining wall up to about 3.4 m high, curved in places, which has been constructed adjacent to and set-back from the cliff crest by between 0 - 5 m.

The width of the terraces between Unit 1 and Unit 5 (i.e. the distance between the building and the brick retaining wall at the northern end of the building) is between 2.5 - 3 m, widening to 8 m at Unit 8 and Unit 9, then narrowing again to 4 m at Unit 10. It is noted that the terraces of Units 2 and 3, which are surfaced with timber decking, have been constructed to overhang the brick retaining wall by between 0.5 - 1 m (refer Photo 13 in Appendix B). Some of the other terraces were also partially or entirely surfaced with timber decking or tiles, over concrete slabs (e.g. Photos 17 and 18 in Appendix B).

Residential buildings are present on all sides of the site, either individual houses or unit blocks (including at the base of the cliff).

Reference to the Sydney 1:100 000 Geological Series Sheet (Reference 1) indicates that the site is underlain by Quaternary sand deposits over Hawkesbury Sandstone. The Quaternary sands comprise medium to fine "aeolian" sand of a transgressive dune environment, as well as possible deposits within the head of the gully above Tamarama Park. Hawkesbury Sandstone is generally a medium to coarse grained, massive and cross-bedded quartz sandstone, horizontally bedded and vertically jointed, with minor shale and laminite layers.

Geological mapping for the Eastern Suburbs Railway by the Snowy Mountains Hydro Electric Authority in 1969 identified a 2.5 m wide, decomposed igneous dyke within Tamarama Park, trending west-northwest.

The regional joint pattern for Hawkesbury Sandstone typically comprises two regional sets of steeply dipping (70 – 90 degrees) joints, typically trending at 010 degrees ("north-south") and 110 degrees ("east-west"), relative to magnetic north. Apart from these main defect sets there are likely to be some other joints or faults with moderate dip angles (40 - 60 degrees) and possibly thrust faults dipping at 0 - 30 degrees.

Hawkesbury Sandstone was observed outcropping within the cliff line along the south-western property boundary, exposed adjacent to the car park and within the sewer diversion trenches. Shallow thicknesses of soil were encountered over the top of rock within the site, with the exception of a portion of the site near Borehole BH101: in this area of the site (south of the existing building) the filling is indicated to be up to about 2 m thick, and the level of the top of rock was noted to "step down" within the sewer diversion trench in this area (refer Plate F5 in Appendix F).

3. Background Information

Background geotechnical information for the site includes the following geotechnical reports:

- Douglas Partners Pty Ltd: "Geotechnical Investigation, Proposed Car Park, Alterations and Additions, 20 Illawong Avenue, Tamarama", report reference 72261, dated 8 April 2011 (Reference 2);
- Douglas Partners Pty Ltd: "Supplementary Geotechnical Investigation of Existing Footings, Proposed Car Park, Alterations and Additions, 20 Illawong Avenue, Tamarama", report reference 72261.03, dated 8 December 2014 (Reference 3);
- Douglas Partners Pty Ltd: "Supplementary Geotechnical Assessment of Southern Cliff Line, Proposed Car Park, Alterations and Additions, 20 Illawong Avenue, Tamarama", report reference 72261.04, dated 3 March 2017 (Reference 4); and
- Public Works Advisory, NSW Government: "Dimension Sandstone Investigation, 20 Illawong Avenue, Tamarama", report reference 17-GT37A, dated 7 July 2017 (Reference 5).

The locations of boreholes, test pits and cliff mapping traverses undertaken as part of the previous investigations described above are shown on the site plan, Drawing 1 (in Appendix C).

The historical building footing exposures (test pits), which were completed on three of the four sides of the building, indicate that the footings are founded below sand and rubble filling on medium strength sandstone, at elevations ranging between RL52.5 m (south-western corner) and RL53.95 m (northern corner). Ponded water was observed in two of the test pits on the northern end of the building (i.e. TP1 and TP2), at the soil-rock interface.

The geotechnical information previously obtained by Douglas Partners Pty Ltd (DP) and by Public Works Advisory ("Public Works Department": PWD), including borehole logs, core photographs and laboratory testing data, has been reproduced with permission within Appendices F and G of this report.

It is noted that the PWD report identified a "clay-infilled … sub-vertical joint" within the sewer diversion trench, in the vicinity of boreholes BH3, BH5 and BH103. Site observations by DP of this feature interpreted it to be a thin (100-150 mm thick), sub-vertical vein of igneous material which had weathered to clay (refer to Plates F3 and F4 within Appendix F). The orientation of this feature was measured to have a dip and dip direction of 85-90°/200°. This feature was not encountered in any of the boreholes, and was not observed within the cliffline on the south-eastern side of the unit block. In the few cases where sub-vertical joints were encountered in boreholes, thick clay coatings were not observed.

A brief, informal interview with the resident of Unit 2 was undertaken on 30 November 2018, who recounted his observations (from some years ago) of the internal floor and external terrace of Unit 2, following the reported release of water from a broken pipe. According to the resident, the water flowing from the damaged pipe on the western side of the building created a 1-2 m deep hole which extended between the eastern and western sides of Unit 2 (including the terrace), being most of the width of the larger room which overlooks Tamarama beach. The resident also recalled that the remedial works included the filling of the void with pumped concrete (unreinforced). It is noted that Borehole BH202 was drilled within the area indicated to have been affected by the release of water.

4. Field Work Methods

4.1 General

Geotechnical field work for the current phase of work was undertaken within the proposed footprint of the basement car park, selected areas of the ground floor terraces, and along the cliff line. The field work included:

- An inspection of the site by an engineering geologist:
- Drilling of four cored boreholes within the proposed basement car park (Boreholes BH101 to BH104), over the period 18 - 19 October 2018;
- Purging of drilling water from two completed (open) boreholes within the car park, and measurement (on 19 October 2018) of their water levels;
- Drilling of seven cored boreholes within the ground floor terraces (Boreholes BH201: Unit 1, BH202: Unit 2, BH204: Unit 4, BH205: Unit 5, BH206: Unit 6, BH208: Unit 8 and BH210: Unit 10), over the period 29 October - 2 November 2018; and
- Geological mapping of nine traverses down the cliff (Traverses 101 to 109) over the period 29 - 30 October 2018, with the assistance of industrial rope access technicians.

The locations of the current and historical tests, and the locations of site photographs, are shown on Drawing 1 in Appendix C.

The locations of the boreholes within the terraces were measured relative to site features and calculated using Google Earth Pro software. The locations of the current boreholes within the proposed basement car park were measured using a differential GPS, which has a nominal accuracy of 0.1 m for surface levels and co-ordinates. These positions were checked against a recent aerial photograph image obtained from Nearmap.com and by site observations, with the levels cross-checked against a site survey plan (document reference 40041DT, dated 2 February 2011, prepared by Harrison Friedmann & Associates Pty Ltd).

Based on this checking, the surface levels for the boreholes within the car park and the terraces, and the co-ordinates for the boreholes within the car park, are considered to be accurate to 0.1 m. The co-ordinates of the boreholes within the terraces are considered to be accurate to 1 m.

4.2 Proposed Basement Car Park

The boreholes within the car park were drilled using either a bobcat-mounted or truck-mounted auger/rotary drilling rig, and were taken to the top of rock (including through the car park asphalt surfacing) using auger drilling techniques. The boreholes were then advanced into the underlying sandstone using rotary coring techniques, to obtain 50 mm diameter, continuous samples of the rock for identification and strength testing purposes. The depths of these cored boreholes ranged between 14.25 and 14.68 m (terminating at RL41.2 m to RL42.7 m).

Standard penetration tests (SPTs) and disturbed auger samples were collected at regular intervals within the soils to assist with strata identification and for possible laboratory testing. Details of the SPT procedure is given in the notes included in Appendix D, with the penetration "N" values shown on the borehole logs.

Following completion of the drilling of Boreholes BH103 and BH104 on 18 October 2018, the water within each open borehole (introduced as part of the drilling process) was pumped out until the holes were 'dry'. The water levels in both boreholes were measured the following morning, after which time the boreholes were backfilled.

Photography of the rock cores was undertaken two days following completion of the drilling, with an additional set of photographs obtained about 21 days following completion of the drilling. Both sets of core photographs are presented in this report (in Appendix D), together with the borehole logs.

4.3 Ground Floor Terraces

The boreholes within the ground floor terraces were completed using a combination of drilling methods, including:

- dia-core drilling through concrete slabs, followed by hand auger drilling in soils;
- advancing the hole through rubble filling and mortared bricks using dia-core drilling, hand tools and a man-portable drilling rig; and
- drilling of sandstone using a man-portable, rotary, triple tube drilling rig.

Dynamic cone penetrometer (DCP) testing was undertaken within rubble filling at three borehole locations (i.e. BH206, BH208 and BH210), to indicate the density of the filling, and to probe for buried obstacles and the top of rock. The DCP test results are presented in Appendix D. Premature refusal on buried obstructions was encountered in two of the boreholes (i.e. BH206 and BH208), with the third DCP test terminated at 1.5 m depth within loose sand filling. Further insitu testing (e.g. SPT testing) was not undertaken within these boreholes.

Access to the borehole sites was obtained either through the residential units (i.e. Units 2, 4, 6 and 7), or from side access gates and over low-height dividing walls (i.e. Units 1, 5 and 10). The boreholes were advanced into the underlying rock (below the rubble filling, mortared bricks and buried concrete slabs) using rotary coring techniques, to obtain 50 mm diameter, continuous samples of the rock for identification and strength testing purposes. The depths of these cored boreholes ranged between 5.06 m and 6.25 m (terminating at elevations of between RL49.2 m and RL50.4 m). It is noted that

borehole depths are measured from current surface levels, which includes the timber decking (where present).

The boreholes were grouted to the top of rock following the completion of each borehole, then backfilled with spoil to the underside of the surface concrete slabs (with nominal compaction), and then topped with grout. It is noted that grouting of an approximate 0.5 m length of each borehole where voids and/or seams were encountered was accomplished using a thick bentonite-cement grout mixture. Timber decking at the boreholes sites was re-attached following hole re-instatement, and (where possible) the tops of the boreholes in tiled areas were disguised using circular tile fragments.

Groundwater was not observed in the boreholes prior to the introduction of water for drilling purposes. It is noted that water loss from the drilling flush was encountered in boreholes BH201, BH202, BH204 and BH206, corresponding with the depth at which seams of clayey sand and inferred voids were encountered. The rate of seepage over the cliff edge (through vegetated areas of the cliff) was observed to increase (particularly during drilling of BH204) following encountering these seams and voids.

Photography of the rock cores was undertaken about 14 days following completion of drilling, and it is noted that some sections of the bedded rock core in boreholes BH201 and BH202 changed colour over this time period, from pale grey to yellow-orange. The core photographs are presented in Appendix D after the respective borehole log.

4.4 Cliff Geological Mapping Traverses

With the assistance of industrial rope access technicians, nine geological mapping traverses were completed between the edge of the building and the base of the cliff. The locations of the mapping traverses were selected to align with the proposed balcony footing positions and near to the terrace borehole locations. Geological mapping of the area of cliff below Units 2 and 3 was completed in 2017 (i.e. Cross Sections 1 to 3, reproduced in Appendix F). Extension of the mapping south-westwards below the cliff and into Tamarama Gully (i.e. beyond about 6 - 10 m below the base of the cliff) was outside the scope of work.

Groundwater seepage from or just below the cliff crest was recorded at Traverses 101 and 102, from approximate elevations (respectively) of RL53 m and RL52 m. At Traverse 103, a sandy soil layer with thick vegetation was observed at RL52 m (indicative of moist conditions). Some seepage of groundwater down the rock face and steady dripping onto the roof of a ‘granny flat’ was also observed at this elevation.

Site photographs and cross-sections from each mapping traverse are presented in Appendix D, with the mapping photographs presented after each respective mapping traverse. It is noted that these sections incorporate the geotechnical information obtained from boreholes drilled within the terraces.

5. Field Work Results

5.1 General

The subsurface conditions encountered at the investigation locations and mapping traverses during the current phase of site investigation are presented in the borehole logs in Appendix D, together with notes defining descriptive terms and the classification methods used. Photographs of the rock cores sampled from each borehole are presented with each log for reference, including 'detailed photographs' of the concrete core, mortared bricks and rubble filling encountered within Borehole BH202. A second set of core photographs for each borehole drilled within the car park, taken approximately 21 days following the completion of drilling to enable the assessment of potential 'Yellow Block' sandstone, are also included after each borehole log.

Historical field work results for the site are included in Appendix F. This data includes:

- Borehole logs, core photographs, and DCP test results for the site investigation work completed by DP in 2011 (Reference 2);
- Test pit footing exposures completed by DP in 2014 (Reference 3);
- Cliff mapping traverses completed by DP in 2017 (Reference 4);
- Site photographs from the sewer diversion trench; and
- Borehole logs and core photographs for the drilling completed by PWD in 2017 (Reference 5). It is noted that information on soils within the PWD holes was not recorded.

5.2 Proposed Basement Car Park

Based on the results of the investigation, the subsurface profile within the proposed basement car park can be summarised as:

CAR PARK PAVEMENT:	asphalt wearing course 0.05 m thick (car parking area only), underlain by road base aggregate and sand filling;
FILLING:	grey-brown sand with some sandstone and brick fragments (possibly crushed sandstone) to depths ranging from 0.15 m to 0.8 m (sandstone fragments not present at all locations), with deeper filling (including sandstone cobbles and steel fragments) in boreholes drilled close to the sewer trench (i.e. Boreholes BH101 and BH103). A piece of asbestos fibre cement was identified in a previously excavated test pit, TP5 (see Reference 3);
SAND:	grey-brown sand (borehole BH5 only), possibly re-worked by the original development works; then
SANDSTONE:	medium to high and high strength, slightly weathered to fresh, light grey-brown and orange-brown, massive and cross-bedded, medium to coarse grained sandstone, encountered from auger refusal depths (ranging between 0.15 m to 2 m) to the termination depths of all boreholes. Some possible iron leaching in Boreholes BH101 to BH103, with iron stained liesegang rings within massive sandstone below depths of 0.8 m to 3 m below current surface level.

Defects in the rock core typically comprised breaks along bedding (sub-horizontal and some at 10 to 25 degrees along cross-bedding laminations), with some sub-vertical joints (e.g. Borehole BH1 at 5.75 m) and occasional joints at 25 to 60 degrees (i.e. in Boreholes BH1, BH2 and BH104 below depths of 8.5 - 9 m). Thin seams / bands of very low strength sandstone and clay were encountered in three of the current boreholes (i.e. BH101, BH102 and BH104), below 11.5 - 12 m depth, which is below the base of the proposed basement excavation.

Dynamic cone penetrometer (DCP) testing was completed in 2011 at ten locations within areas which were not accessible to the drilling rig. These tests encountered refusal at depths ranging from 0.35 m to 1.97 m below the ground surface. DCP refusal is often inferred to represent the level of the top of rock, which for this site is generally considered to be a reasonable inference.

Table 1 summarises the elevations at which sandstone was encountered at the current and historical investigation locations, with filling materials, aeolian sand and/or asphalt encountered between surface level and the top of the residual soil / sandstone.

Table 1: Summary of Depths / Elevations of Soil and Rock Materials

Test ID	Top of Stratum		
	Top of Test Location	Sandstone	
	Elevation (RL)	Depth (m)	Elevation (RL)
BH101	56.2	2.0	54.2
BH102	56.5	0.15	56.3
BH103	56.9	0.7	56.2
BH104	55.8	0.8	55.0
BH1	55.5	1.4	54.1
BH2	55.6	0.6	55.0
BH3	56.7	0.8	55.9
BH4	55.6	0.4	55.2
BH5	57.0	0.65	56.3
BH6	56.5	0.55	56.0
BH7	56.1	0.35*	57.7*
PWD1	56.6^	0.7#	55.9#
PWD2	56.4^	0.7#	55.7#
PWD3	55.9^	0.35#	55.5#
PWD4	56.3^	1.3#	55.0#
DCP8	55.7	1.55	54.2
DCP9	55.8	0.35	55.5
DCP10	55.5	1.97	53.5

Test ID	Top of Stratum		
	Top of Test Location	Sandstone	
	Elevation (RL)	Depth (m)	Elevation (RL)
DCP11	53.7	0.45	53.3
DCP12	53.0	0.55	52.5
DCP13	52.0	1.15	50.9
DCP14	53.5	0.38	53.1
DCP15	56.5	0.47	56.0
DCP16	56.7	0.55	56.2
DCP17	56.4	0.98	55.4

Notes: ' * ' indicates termination on possible filling, '^' indicates elevation interpolated based on site survey drawing and cross-sections within the PWD report, '#' indicates elevation of the start of coring. DCP 'top of rock' depths are indicative only.

Groundwater was not observed during augering of the boreholes, with the use of drilling fluid precluding subsequent observations during and following core drilling. As noted in Section 4, groundwater levels were obtained within two boreholes (i.e. BH103 and BH104) on the day following the completion of drilling (which may not have given sufficient time for the groundwater level in the boreholes to stabilise), as summarised in Table 2. Rainfall was observed in the Sydney region prior to and on the days of the field work, including the day the groundwater measurements were obtained on 19 October 2018.

Table 2: Groundwater Observations within Boreholes Drilled Within Existing Car Park

Borehole ID	Surface RL (AHD)	Standing Water Level Measurement	
		19 October 2018	
		Depth (m)	RL (AHD)
BH103	56.9	9.0	47.9
BH104	55.8	8.3	47.5

5.3 Investigation of Ground Floor Terraces

Based on the results of the investigation, and with reference to Drawing 1, the subsurface profile within the terraces can be summarised as:

CONCRETE SLABS, TILES or TIMBER FLOORING: reinforced or unreinforced concrete to between 0.6 m to 1.55 m deep (Units 1 and 2, respectively), and grey concrete slabs (with or without tiles or timber decking / joists) between Units 3 to 10, to depths ranging between 0.06 m and 0.3 m;

FILLING: brown sand, cement/mortar and concrete/brick rubble filling with trace of glass and fibre cement sheeting (0.55 m to 1.86 m thick), with some cobbles and boulders, over buried concrete (0.27 m thick: in Borehole BH201 only); over

dark brown silty sand filling (up to 1.27 m thick at the northern end, but not encountered south of Borehole BH208), over mortared bricks (1.0 to 1.65 m thick: Boreholes BH201 and BH202 only);

SANDSTONE: medium and high strength, massive then bedded, orange-brown then light grey, medium grained sandstone with some quartz clasts. North of mapping traverse 104 (i.e. Boreholes 201 to BH206) the sandstone is highly and moderately weathered, whereas south of this traverse the sandstone is slightly weathered. It is noted that the colour of the bedded sandstone encountered below 5.2 m depth within Boreholes BH201 and BH202 changed from grey to yellow within 14 days of drilling.

Defects within the rock cores north of Traverse 104 (i.e. Boreholes BH201, BH202, BH204 and BH206) were typically sub-horizontal bedding parting defects (0-20°), with some occasional inclined joints at 40 to 60 degrees. A zone of core loss was encountered within these boreholes (70 mm to 250 mm thick), with a rapid drop in the drill within this zone noted in boreholes BH204 and BH206. A decomposed seam and a clayey bedding parting defect were encountered within Borehole BH205 (a total of 65 mm thick). The core loss zones are interpreted to be either seams of soil strength material or voids. South of Traverse 104, the defects encountered were widely spaced, clay-coated bedding parting defects, and a sub-vertical, undulating joint.

Table 3 summarises the elevations at which rubble filling and sandstone were encountered within the terrace boreholes. It is noted that silty sand filling, concrete and mortared bricks were encountered below the rubble filling in some of the boreholes (refer Drawing 6 in Appendix C, and Photographs D1 to D3 in Appendix D), and that a piece of fibre cement (possibly containing asbestos minerals) was encountered within the rubble filling within Borehole BH210.

Table 3: Summary of Depths / Elevations of Soil and Rock Materials

Test ID	Top of Stratum				
	Top of Test Location	Rubble Filling		Sandstone	
	Elevation (RL)	Depth (m)	Elevation (RL)	Depth (m)	Elevation (RL)
BH201	55.5	0.6	54.9	3.0	52.5
BH202	55.5	1.55	54.0	3.95	51.5
BH204	55.5	0.3	55.2	2.33	53.2
BH205	55.5	0.16	55.3	2.0	53.5
BH206	55.5	0.06	55.4	1.62	53.9
BH208	55.3	0.2	55.1	1.57	53.7

Test ID	Top of Stratum				
	Top of Test Location	Rubble Filling		Sandstone	
	Elevation (RL)	Depth (m)	Elevation (RL)	Depth (m)	Elevation (RL)
BH210	55.5	0.24	55.3	2.1	53.4

5.4 Cliff Geological Mapping Traverses

Based on the geological mapping traverses (presented in Appendix D), the terraces are retained by a brick wall (retained height of between 1 m to 2.6 m), which is inferred to be founded on medium strength sandstone. Sandy filling and colluvial soils (and some household garbage) obscured the base of the retaining wall along most of the wall length. Seepage from the base of the wall was observed at Traverse 101, at an elevation of about RL52.8 m.

Cobbles and boulders (with dimensions of up to 1.3 x 1.1 x 0.5 m) were observed in places below the wall, on a relatively flat, soil covered bench of rock. Outcrops of medium to high strength, massive sandstone were observed below this bench (to elevations ranging between approximately RL48.3 m to RL50.1 m), overlying medium to high strength, bedded and cross-bedded sandstone.

Between mapping traverses 101 and 103 (and up to traverse 104), the massive sandstone is characterised by sub-horizontal seams and voids / caves, with lateral continuity over tens of metres and with a vertical spacing between seams of about 1.5 m. Tight, discontinuous, sub-horizontal bedding planes were also observed, with vertical spacing of between approximately 0.5 m and 1 m. The voids were measured with a tape measure, to be between 0.4 m and 2 m deep (vertical aperture ranging between 50 mm and 300 mm). Weathered seams and voids were encountered in boreholes at similar elevations.

Between mapping traverses 104 and 109, the massive sandstone has occasional discontinuous bedding planes (associated with siltstone lenses) and widely spaced (>2 m), thin weathered seams (clayey sand: 30-40 mm thick). A few voids / caves were observed within short lengths of this section of cliff (i.e. near the crest of Traverse 105 and Traverse 109).

The cross-bedded and bedded sandstone between Traverses 101 to 109 has a series of sub-vertical and low-angle rock faces, with closely spaced, inclined bedding parting defects and bedding planes intersecting with sub-vertical joints to form multiple overhangs and caves. Some mortar and sandstone underpins were observed within the bedded sandstone (e.g. Traverse 109: underpin over 1 m in height). Debris and rubbish accumulations were observed at the base of the cliff, along with large angular boulders of bedded sandstone (inferred to have detached from near the base of the cliff, to form caves and overhangs).

A few undulating and curved, iron-stained, rough, sub-vertical joints (inferred to be associated with the regional “north-south” joint set), continuous over many metres, were observed within some of the cliff traverses. Another joint set (sub-vertical, planar and rough) was observed within some of the cliff traverses (inferred to be associated with the regional “east-west” joint set). The joints from both sets appeared to terminate (above and below) on bedding planes. Orientation measurements of the main

rock defects (completed from the base of the cliff and relative to magnetic north) are tabulated in Table 4.

Table 4: Summary of Geological Mapping Data from Cliff Mapping Traverses

Geological Mapping Traverse	Defect Type	Measured Orientation (Dip / Dip Direction, relative to Magnetic North)	Strike / Dip (relative to Magnetic North)	Corresponding Regional Joint Set
Traverse 104	Joint	83 / 071	161 / 83 E	East-West
	Joint	72 / 071	161 / 72 E	East-West
Traverse 105	Joint	65 / 123	033 / 65 E	North-South
	Joint	85 / 318	048 / 85 N	North-South
Traverse 107	Bedding Parting	30 / 080	170 / 30 E	-
	Joint	75 / 298	028 / 75 NW	North-South
Traverse 108	Bedding Parting	23 / 017	107 / 23 N	-
Traverse 109	Joint	56 / 305	035 / 56 NW	North-South
	Bedding Parting	24 / 216	126 / 24 S	-

Based on the small data set of measured joint defect orientations, it appears that there is a swing in the regional joint sets of between 18 – 38 degrees to the north-east (i.e. in a positive direction), with joints trending to the north-east (about 040 degrees, relative to magnetic north) and south-east (about 160 degrees).

6. Laboratory Testing

6.1 Rock Core

For the current and historical DP investigations, selected samples of the rock cores were tested in the laboratory to determine the Point Load Strength Index (Is_{50}) values to assist with rock strength classification (axial tests only). The test results are shown on the borehole logs at the appropriate depths, with a total of 121 tests completed (including 39 tests from boreholes BH1 to BH3 from the 2011 investigation, and 28 tests from Boreholes BH201 to BH210).

The range of Is_{50} values for the massive sandstone is:

- Proposed basement car park: 0.47 MPa to 2.8 MPa (37 tests) – indicating medium to high strength rock; and
- Terraces: 0.22 MPa to 1.6 MPa (15 tests) – indicating low to high strength rock.

The range of Is_{50} values for the bedded sandstone is:

- Proposed basement car park: 0.38 MPa to 3.6 MPa (56 tests) – indicating medium to very high strength rock; and
- Terraces: 0.52 MPa to 2.8 MPa (13 tests) – indicating medium to high strength rock.

A summary of the UCS test results compared with the nearest Point Load Strength Index test result (axial or diametral) for corresponding "massive" sandstone samples completed by PWD (both tested in a dry condition) are presented in Table 5.

Table 5: Summary of UCS and Point Load Strength Index Tests from PWD boreholes

Borehole ID	Depth interval (m)	UCS (MPa)	Is_{50} (MPa)	Tested Ratio of Is_{50} : UCS
PWD3	4.42-4.55	73.0	1.06 (d)	68.9 : 1
	5.72-5.85	71.3	1.88 (d)	37.9 : 1
PWD4	3.27-3.40	68.4	1.81	37.8 : 1
	8.74-8.87	67.0	2.19 (d)	30.6 : 1

Note: '(d)' indicates diametral point load strength test.

Based upon laboratory testing of better quality specimens of drill core, the oven-dried unconfined compressive strength for the massive sandstone is up to 73 MPa, with the ratio of UCS to point load strength index tests (i.e. Is_{50} : UCS) in the range 30:1 to 69:1 (refer Table 5). Based on the above data for dry samples, a potential conversion value between point load strength and UCS of 30:1 could be adopted, which gives an inferred range of oven-dried UCS (based on the range of point load strength index test results given above) of 11 MPa to 108 MPa. It is noted that for wet samples the potential conversion value between point load strength and UCS is between 15 and 20.

For the historical PWD investigation, a total of 58 point load tests were completed (including diametral and axial tests), with the results within the range of test results outlined above for the completed DP boreholes. The results of the PWD point load tests are included in Appendix G.

6.2 Exposure of Rock Core Samples

The rock core obtained during the current investigation was stored within metal core boxes and out of the weather: the core from the proposed basement boreholes was photographed the day following the completion of drilling and then re-photographed three weeks later, whereas the terrace boreholes were photographed about two weeks following the completion of drilling.

It was noted that much of the deeper rock core from the basement car park boreholes that had been initially 'grey' in colour had changed to yellow in colour. The '21-day' core photographs are presented together with the relevant borehole log and 'as-drilled' core photos in Appendix D.

A summary of the depths at which massive and bedded sandstone were encountered, and whether a change of colour in the drill core occurred (to a yellow colour), two to three weeks after the completion of drilling, are summarised in Table 6.

Table 6: Summary of Massive and Bedded Sandstone Depths and Colour Changes (post-drilling)

Borehole ID	Depth interval (m)	Lithological Description	Colour change occurred 2-3 weeks after drilling
BH101	2.0-5.75	Massive sandstone	No
	5.75-14.5	Bedded sandstone	Yes
BH102	0.15-6.96	Massive sandstone	No
BH102	6.96-14.68	Bedded sandstone	Yes
BH103	0.7-5.18	Massive sandstone	No
	5.18-9.7	Massive sandstone	Yes
	9.7-14.25	Bedded sandstone	Yes
BH104	0.8-2.3	Massive sandstone	No
	2.3-6.15	Massive sandstone	Yes
	6.15-14.6	Bedded sandstone	Yes
BH201	3.00-5.2	Bedded sandstone	No
	5.2-5.88	Bedded sandstone	Yes
BH202	3.95-5.24	Bedded sandstone	No
	5.24-6.25	Bedded sandstone	Yes
BH204	2.33-4.74	Massive sandstone	No
	4.74-5.48	Bedded sandstone	No
BH205	2.0-4.5	Massive sandstone	No
	4.5-5.21	Bedded sandstone	No
BH206	1.62-4.7	Massive sandstone	No
BH206	4.7-6.0	Bedded sandstone	No
BH208	1.57-5.78	Massive sandstone	No
BH210	2.1-5.06	Massive sandstone	No

It is noted from the PWD report that sections of massive sandstone from DP Boreholes BH1 and BH2 remained a light grey colour a number of weeks after the completion of drilling, which is consistent with the most recent drill core observations. From close inspection of the most recently drilled core, it appears that the upper section of massive sandstone, which appears to be “bedded”, is slightly leached of iron, with possible liesegang rings (bands of iron chemical precipitates – not bedding) formed within the sandstone below. The liesegang rings also appear to be present within the PWD core (logged as bedded sandstone).

6.3 Chemical Analysis

Two (2) soil samples selected from the boreholes were submitted for analysis at a NATA-accredited laboratory. Analysis for soil aggressiveness to buried concrete and steel elements was completed, including pH, electrical conductivity, sulfate and chloride ion concentrations.

The aggressivity results are summarised in Table 7, with the laboratory test reports included in Appendix E.

Table 7: Laboratory Test Results for Aggressiveness to Buried Concrete and Steel

Sample ID	Sample Description	Elevation of Sample[1] (RL m)	pH	EC[2] (µS/cm)	Chloride (mg/kg)	Sulphate (mg/kg)
BH102, 0.3 m	Sandstone	56.2	9.1	87	< 10	27
BH104, 0.5 m	Sand Filling	55.3	8.2	95	<10	110

Notes: (1) Elevation quoted is for the 'top' of the samples. (2) EC = Electrical Conductivity. (3) Analysed soils were tested as a 1:5 mixture of soil:water.

In accordance with Australian Standard AS 2159-2009 (Reference 4), the results of the chemical laboratory testing indicate that the filling materials and sandstone are non-aggressive to both concrete and buried steel.

6.4 Geotechnical Testing

Historical laboratory testing of rock core specimens from PWD boreholes (excluding point load index strength testing, described in Section 6.1) included the following tests:

- Absorption, apparent porosity and bulk specific gravity, conducted in accordance with ASTM C97/C 97M-09 ("Modified Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone"):
  - 4 tests from Borehole PWD3 (specimen pairs from depths of 4.15 m & 4.35 m, 5.45 m & 5.65 m); and
  - 4 tests from Borehole PWD4 (specimen pairs from depths of 3.00 m & 3.20 m, 8.43 m & 8.55 m).
- Compressive strength of dimension stone (wet and dry strength), conducted in accordance with test method ASTM C170/C 170M-09 ("Standard Test Method for Compressive Strength of Building Stone", using test specimens with a length 2.5 times their diameter):
  - 3 tests from Borehole DP Borehole BH1 (one 'dry' test specimen and two 'wet' test specimens, depths not recorded);
  - 4 tests from Borehole PWD3 ('dry' test specimens from depths 4.42-4.55 m, 5.72-5.85m, and 'wet' test specimens from depths 4.22-4.35 m, 5.52-5.65 m); and
  - 4 tests from Borehole PWD4 ('dry' test specimens from depth 3.27-3.40 m, 8.74-8.87 m, and 'wet' test specimens from depth 3.07-3.20 m, 8.50-8.63m).

- Resistance to Salt Attack, a 15 wet/dry cycle test conducted in accordance with AS/NZ 4456.10:2003 ("Method A – Masonry Units and Segmented Pavers: Resistance to Salt Attack – Sodium Sulphate"):
  - 5 tests on massive sandstone from Borehole PWD4.

The geotechnical test results are summarised in Table 8 to Table 10, with the laboratory test reports included in Appendix G.

Table 8: Historical Laboratory Test Results for Absorption, Apparent Porosity and Bulk Specific Gravity

Sample ID[1]	Sample Description	Elevation of Top of Sample[2] (RL m)	Water Absorption (% by weight)	Apparent Porosity (% by volume)	Bulk Specific Gravity (t/m^3)
PWD3, 4.15 m	Medium grained massive sandstone	52.6	4.152	9.318	2.244
PWD3, 4.35 m		52.4	3.493	8.059	2.307
PWD3, 5.45 m		51.3	3.204	7.518	2.346
PWD3, 5.65 m		51.0	3.052	7.216	2.364
PWD4, 3.00 m	Medium grained laminated sandstone	52.6	3.629	8.391	2.313
PWD4, 3.20 m		52.4	3.712	8.562	2.306
PWD4, 8.43 m		47.2	3.384	7.856	2.321
PWD4, 8.55 m		47.1	3.455	8.048	2.329

Notes: (1) For clarity, sample names have been modified to "PWD.." rather than "BH..", and (2) Elevation quoted is for the 'top' of the samples.

As per the PWD report, the low apparent porosities indicate that the "samples tested are largely unaffected by weathering".

Table 9: Historical Laboratory Test Results for Compressive Strength of Dimension Stone

Sample ID[1]	Sample Description	Elevation of Sample[2] (RL m)	Compressive Strength (MPa)	Average Compressive Strength (MPa)	Ratio of Wet to Dry Strength
DP Borehole BH1(dry)[3]	"Yellow block" sandstone	Unknown	67.9	67.9	0.59
DP Borehole BH1 (Test 1: wet)[3]			42.2	40.0	
DP Borehole BH1(Test 2: wet)[3]			37.9		

Sample ID[1]	Sample Description	Elevation of Sample[2] (RL m)	Compressive Strength (MPa)	Average Compressive Strength (MPa)	Ratio of Wet to Dry Strength
PWD3, 4.42-4.55 m (dry)	Medium grained massive sandstone	52.3	73.0	72.1	0.55
PWD3, 5.72-5.85 m (dry)		51.0	71.3		
PWD3, 4.22-4.35 m (wet)		52.5	37.9	39.5	
PWD3, 5.52-5.65 m (wet)		51.2	41.1		
PWD4, 3.27-3.40 m (dry)	Medium grained massive sandstone	52.3	68.4	68.4	0.68
PWD4, 3.07-3.20 m (wet)		52.5	46.2	46.2	
PWD4, 8.74-8.87 m (dry)	Medium grained laminated sandstone	46.9	67.0	67.0	0.93
PWD4, 8.50-8.63 m (wet)		47.1	62.0	62.0	

Notes: (1) For clarity, sample names from PWD boreholes have been modified to "PWD.." rather than "BH..", (2) Elevation quoted is for the 'top' of the samples, and (3) DP Borehole rock sample possibly taken from depths of between 2.5 m - 5.6 m).

As per the PWD report, as a guide it is considered that a "minimum unconfined compressive strength of 30 MPa (wet) and 50 MPa (dry) … (is) a reasonable 'benchmark' for the potential use of Sydney sandstones as dimension stone in all applications. Although the strength parameters for all of the UCS samples tested are above these minimum values, it should be noted that (the deeper samples) from borehole BH4 (PWD4) exhibited some banding (i.e. cross-beds) and may not satisfy the aesthetic requirements for use as dimension stone in all applications."

It is noted that for the massive sandstone in Boreholes BH101 to BH104 which did not change colour, point load strength index (Is_{50}) test results are marginally below 1.5 MPa (i.e. a dry UCS of less than 45 MPa when using a multiplier of 30 to convert from Is_{50}), whereas the massive sandstone which did change colour (i.e. noted as "Yellow Block" on the borehole logs) all have Is_{50} test results greater than or equal to 1.5 MPa.

Table 10: Historical Laboratory Test Results for Resistance to Salt Attack

Sample ID[1]	Sample Description	Elevation of Sample[2] (RL m)	Damage Description	Mass Loss at 15 cycles (%)	Disintegration at Cycle
PWD4, 5.60 m	Medium grained massive sandstone	50.0	Some residue	0.2	-
PWD4, 5.65 m		50.0	Some residue	0.2	-
PWD4, 5.70 m		49.9	Some residue	0.2	-

Sample ID[1]	Sample Description	Elevation of Sample[2] (RL m)	Damage Description	Mass Loss at 15 cycles (%)	Disintegration at Cycle
PWD4, 5.75 m	Medium grained massive sandstone	49.9	Some residue	0.2	-
PWD4, 5.80 m		49.8	Some residue	0.2	-

Notes: (1) For clarity, sample names have been modified to "PWD.." rather than "BH..", and (2) Elevation quoted is for the 'top' of the samples, and (3) Test specimen 50 mm cube.

As per the PWD report, "a loss of less than 1% is regarded … as the minimum standard for the sodium sulphate soundness (resistance to salt attack)" for dimension stone.

7. Geotechnical Model

7.1 Proposed Basement Car Park

The geotechnical model for the car park area of the site is a shallow thickness of filling (up to 2 m thick, adjacent to the re-aligned sewer in the southern part of the site near Borehole BH101), over a slightly sloping sandstone profile.

The sandstone is initially generally moderately to slightly weathered, very low to medium strength, bedded or massive, rapidly becoming slightly weathered or fresh and high strength. The elevation and thickness of massive and bedded sandstone varies across the site, and is depicted on cross-sections A-A' to D-D' in Appendix C, which show the interpreted extent of the massive sandstone (including "yellow block") and cross-bedded sandstone units.

As shown in the cross-sections, a continuous band of massive sandstone is present within the footprint of the proposed car park basement, ranging in thickness from 4 – 10.6 m on Sections A-A' and B-B': south-west to north-east, and 9 - 10 m and 7 - 3.5 m on Sections C-C' and D-D': north-west to south-east, respectively. High strength, "Yellow block" sandstone is interpreted to occur over the northern two-thirds of the site (i.e. north of about Chainage 25 m on Section B-B').

7.2 Ground Floor Terraces

The geotechnical model for the ground floor terraces is a layer of rubble and sand filling up to 2.3 m thick, with thick concrete beneath Units 2 and 3 (i.e. between Chainages Ch58-Ch69 m on Drawing 6, Appendix C), and mortared bricks between 1.0 m - 1.65 m thick beneath Units 1 and 3 (i.e. between Chainages Ch54-Ch75 m on Drawing 6: possible brick wall or footing). Layers of massive and bedded, medium or high strength sandstone were encountered below these materials.

North of mapping traverse 104 (Appendix D), a narrow void or cave or a weathered seam of soil strength clayey sand (at a similar elevation), was observed in both current and historical mapping traverses of the cliff face, and within multiple boreholes. Some seepage of groundwater was noted coming from these seams during the mapping. The encountered seams and voids (possibly up to

200 mm thick) are interpreted to be laterally continuous in a northerly direction beneath the terraces, over an approximate length of 40 m. It appears that the mortared bricks at Borehole BH202 have been taken down to the level of this seam, and probably found below it.

South of mapping traverse 104, weathered seams or voids were not encountered beneath the terrace within the high strength sandstone. It is noted that a thin layer of medium strength sandstone was encountered below the rubble / sand filling.

8. Proposed Development

Based upon the architectural drawings for the project prepared by GroupGSA Architects Pty Ltd (refer Drawing 1), the proposed development includes:

- the excavation of a car parking basement with two to three levels, with a final finished level of RL46.23 m (anticipated excavation depths within the range 6 m-10.6 m below the current ground surface);
- extension of the building on the south-western / seaward-side of the building, to create balconies for each of the units, founded below the existing ground level terrace; and
- construction of up to two levels of residential 'penthouse' apartments on the top of the building.

No specific column or footing loads were available at the time of preparation of this report. As requested, investigation of footings for the building and brick retaining wall below the terrace was deleted from the scope of work.

The geotechnical issues considered relevant to the proposed development include excavation and associated vibration, stress relief, excavation support, groundwater, foundations and earthquake provisions.

9. Comments

9.1 Site Preparation

9.1.1 General

Site preparation for the excavation of the basement car park will include:

- demolition of the free-standing laundry block;
- removal of trees and shrubs adjacent to the existing unit block; and
- stripping of asphalt, concrete kerbs, and roadbase / filling (to depths of between 0.15 - 2 m below current surface levels).

Site preparation for the construction of the new balconies and footings will include:

- creation of site access for machinery (probably via the southern side of the building, or through Unit 6);

- demolition of the existing terrace roofing / shade structure, dividing walls, and removal of timber decking;
- installation of fall / edge protection (i.e. beyond the proposed extent of the new balconies, which may include installation on the cliff crest below);
- installation of access / anchor points, to enable access for workers (e.g. via rope) onto the cliff crest below, if required;
- installation of suitable protections for the telecommunications facility at the northern end of the building; and
- preparation of a methodology and access routes for the removal of drilling spoil from the terrace.

9.1.2 Dilapidation Surveys

Dilapidation surveys should be carried out on surrounding buildings, structures and pavements that may be affected during the construction period. The dilapidation surveys should be undertaken before the commencement of any demolition and excavation work, in order to document any existing defects, so that any claims for damage due to construction related activities can be accurately assessed.

9.2 Excavation

9.2.1 Proposed Basement Car Park

Following completion of the site preparation, excavations for the proposed basement car park, below the base of stripping, is expected to encounter medium to high strength, medium to coarse grained massive sandstone, with widely spaced defects. It is understood that quarrying of the sandstone is being considered, with a specific excavation sequence and methodology likely to be required to maximise the volume of sandstone blocks removed as potential dimension stone from within the basement excavation envelope.

Care will be required when excavating close to the recently-diverted sewer, which appears to mostly have been laid within a trench cut into the rock (refer Photos F1 to F5 in Appendix F).

9.2.2 Ground Floor Terraces

It is understood that widespread removal of all concrete slabs and rubble filling within the area of the existing terraces is not being considered. Instead, it is understood that localised excavation will be undertaken to install new balcony footings, through concrete slabs and rubble filling down to the top of rock (temporary support is likely to be required to keep the holes open). Excavations for the new footings at the northern end of the building (i.e. Unit 1 to Unit 3) are expected to encounter a thick layer of concrete or mortared bricks, which may require specialised boring equipment to penetrate effectively.

Relatively light weight machines may be required for this area of the site, due to the proximity of the proposed footing excavations to the edge of the supporting brick retaining wall below. The load-bearing capacity of the retaining wall for working machines has not been assessed: the structural engineer should be contacted for advice in this regard.

It is noted that some seepage of water at the soil-rock interface is to be expected, particularly on the northern portion of the building, which will need to be managed during footing excavations to ensure that sediment-laden water does not migrate into the neighbouring property (i.e. below the cliff) during footing excavation work.

9.2.3 General

The filling materials and any natural soils should be readily excavated using conventional earthmoving equipment. It is noted that smaller, more specialised equipment may be required to undertake the excavation work on the ground level terraces, due to the limited working space and variable materials expected to be encountered. This machinery may require additional time to complete the work to the required depths, particularly where excavation below the seams and voids is required. At these locations, consideration could be given to pre-boring of smaller diameter 'pilot' holes at each of the footing locations, to check for voids and seams.

It is anticipated that quarrying of the medium strength and stronger sandstone for dimension stone will require the use of a combination of rock saws and rock hammers. For any areas of the site where quarrying is not being considered, deepening of the excavation through medium and high strength rock will require the use of heavy ripping equipment or rock hammers.

Rippability of the sandstone is critically dependent upon the spacing of bedding and vertical joints, as well as on strength. An excavator fitted with a medium to large-sized rock hammer is likely to be required to remove the medium or higher strength sandstone, albeit at relatively slow rates. Excavation contractors should make their own assessment of likely productivity depending on their equipment capabilities and operator skills. Detailed excavations adjacent to retaining walls or for footing excavations can be achieved by the use of rock hammers, rotary rock saws, or milling heads. Rock saws should also be used along the site boundaries to minimise over break.

Any off-site disposal of material will require assessment for re-use or classification of the soil and rock in accordance with *Environmental Guidelines: Assessment, Classification and Management of Non-Liquid Wastes* (NSW EPA, 2014: Reference 7), prior to disposal to an appropriately licensed landfill.

9.2.4 Stress Relief

It is possible that the proposed excavation could be affected by "stress relief" movement of the high strength sandstone induced by the excavation. Based upon experience of similar excavations, the movement (towards the excavation) could be up to 1 mm to 2 mm per vertical metre depth of excavation into the bedrock, particularly for excavation faces with east-west trending orientations such as adjacent to the existing multi-storey unit block.

The movements are likely to be greatest towards the centre of the long dimension of the excavation and reducing to the corners where the excavation is constrained.

Stress relief movements are likely to occur over a relatively short duration. It is therefore recommended that all concrete / structural elements of the new structure are not cast directly against the excavated rock face.

9.3 Vibration Control

Noise and vibration will be caused by excavation work on the site. The use of hydraulic rock hammers or impact breakers will cause vibration which, if not controlled, could possibly result in damage to nearby structures and underground services (e.g. closer than 20 m), and disturbance to occupants.

It is assumed that the foundation systems of nearby buildings are founded on medium or high strength sandstone. It is suggested that vibrations be provisionally limited to a peak particle velocity (PPV) of 8 mm/s at the ground level of the neighbouring buildings to protect architectural features, and for occupant comfort, though this level of vibration will be potentially disturbing to occupants. It is considered that this limit should also be applied to the existing unit block whilst occupied. If the whole building is to be vacated during the works then it may be feasible to increase the PPV to 15 mm/s at the foundation level, subject to confirmation of the foundation conditions of the existing structure and while maintaining the vibration level below the allowed limit at adjacent buildings.

The provisional level of 8 mm/s complies with AS/ISO 2631.2 – 2014 (Reference 8) and is below the normal building damage threshold level. It is suggested that the client assess whether the proposed vibration limit will have a serviceability impact on nearby sensitive structures (if present), or for human comfort. This provisional limit may need to be modified depending on the result of such assessments, or following a review of building condition surveys. A site specific vibration monitoring trial may be required to determine vibration attenuation once excavation plant and methods have been finalised.

9.4 Batter Slopes and Excavation Support

9.4.1 General

Based upon the drawings provided, sections of the excavations for the basement and within the ground floor terraces will be close to either the sewer diversion trench, property boundaries or to existing structures (which are assumed to be founded on the underlying medium to high strength sandstone).

Permanent batter slopes within the footprint of the proposed basement and for the terraces are shown on the preliminary structural drawings to be vertical, for excavations in both rock and soil. The extent of vertical excavations within soil for the proposed basement are inferred to be typically up to about 1 m, and up to about 2m high adjacent to the southern boundary (near Borehole BH101) and also for footing excavations along the terrace.

In general, low-height vertical excavations within soil around the perimeter of the basement could be temporarily supported with soil nails, mesh and shotcrete, or a concrete or shotcrete retaining wall founded on sandstone with closely spaced reinforcement bars drilled and grouted into the underlying rock. Retention of soil thicknesses greater than 1 m will require specific assessment, to ensure that adequate lateral support is provided and slope stability maintained.

Retention of filling within footing excavation holes along the terraces, prior to the placement of concrete, will require the use of temporary casing or shoring to prevent hole collapse.

Where batters are proposed in soils in other parts of the site, it is expected that batter slopes will be mostly less than 1.5 m high. Based on this, the maximum batter slopes recommended for the design of temporary cuts of up to 1.5 m height are presented in Table 11.

Material stockpiles and machinery / equipment should not be stored at the crest of unsupported excavations.

Where excavation is required close to existing structures supported on high-level footings, it may be necessary to incorporate a set-back to the top of the batters, or underpin the footings to a lower 'stable' founding stratum.

Table 11: Recommended Maximum Batter Slopes for Excavated Slopes

Excavated material	Temporary Batter	Permanent Batter
Filling	1H:1V with weather protection, or 1.5H:1V	2H:1V
Low strength sandstone	0.5H:1V	1H:1V
Medium strength sandstone (or better)	Vertical [1]	Vertical [1]

Note: (1) Should be inspected by an engineering geologist for unstable wedges, which, if present, should be removed or rock bolted.

Typically, medium and high strength rock is generally globally stable when cut vertically, provided that there are no adversely oriented joints or other defects / seams present. It is considered that the medium and high strength sandstone within the footprint of the proposed basement can be cut vertically and left unsupported as the excavation progresses, subject to a detailed assessment of jointing and rock conditions by a suitably qualified geotechnical engineer/engineering geologist, who will advise on any remedial works considered necessary to maintain stability (such as spot bolting or installation of shotcrete). Regular rock face inspections will be required during excavation (recommended at about every 1.5 m 'drop') to determine whether conditions are as anticipated.

Based upon the limited data on joint orientations for the Hawkesbury Sandstone at the site, joints are inferred to be oriented at slight angles to the proposed excavation faces. It is expected that some wedges will be formed where these near-vertical joints intersect the excavation faces.

9.4.2 Design

Excavation faces retained either temporarily or permanently will be subjected to earth pressures from the ground surface down to the top of medium strength rock.

Table 12 outlines material strength parameters that may be used for the preliminary design of excavation support structures. Retaining walls may be designed on the basis of the parameters given in Table 12 with a triangular pressure distribution, assuming the walls are cantilevered or braced.

The values of active earth pressure coefficient, Ka, to be used for estimating soil pressures are for a level ground surface and a wall that allows some minor (outward) lateral movement. To minimise movement of adjacent footings, the retained soil and weathered rock below the foundations should be designed with an "at rest" lateral earth pressure coefficient (Ko) – refer Table 12.

Lateral pressures due to surcharge loads from adjacent buildings, sloping ground surface, nearby roads, and construction machinery should be included where relevant. Hydrostatic pressures acting on the back of the retaining wall(s) should also be included in the design, where adequate drainage is not provided behind its full height.

Table 12: Typical Material and Strength Parameters for Excavation Support Structures

Material	Bulk Density (kN/m^3)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth Pressure at Rest (K_o)	Ultimate Passive Earth Pressure (kPa)
Filling	18	0.4	0.6	-
Low strength sandstone	22	0	0.1	2000
Medium strength sandstone	22	0	0	6000

9.5 Groundwater

Standing water was measured at similar levels (i.e. between RL47.5 m and 47.9 m) in two open boreholes, measured the day following drilling. The water was inferred to be entering the boreholes from defects within the rock. It is noted that the base of the cliff, on the south-eastern side of the building (about 40 m south-east of these boreholes) has an elevation of approximately RL46.5 m to RL47 m. Groundwater was noted seeping from seams within the cliff face at elevations of between RL52 m and RL53 m, and was also previously observed within a footing exposure at the northern end of the building (i.e. Test Pit TP1) at the soil-rock interface.

The above observations indicate that groundwater is present within the site as both a shallow, perched water table, and a deeper water table which is likely to decrease in elevation towards the cliff line and Tamarama Gully. It is noted that groundwater levels have been known to vary by over 1 m, relatively quickly, as they are affected by the prevailing climatic and downslope drainage conditions.

Based on published information and previous experience, the permeability of the Hawkesbury Sandstone rock mass is inferred to be relatively low. It is anticipated that groundwater ingress into the excavation will occur as seepage through and along the soil / rock interface on the site, and also from rock defects (e.g. joints). Seepage flows are likely to increase following periods of extended wet weather.

At this stage it is not possible to accurately estimate the likely extent and rate of seepage, though it is anticipated that seepage rates will be relatively low given the expected low permeability of the rock mass. Inflow rates such as these are usually readily handled by sump and pump measures, with the pumps required to periodically remove stored water from any sub-floor drainage system(s). During construction, testing of water quality may be necessary prior to disposal, and permission is likely to be required to dispose to the Council stormwater system.

It is suggested that monitoring of flows during the early phases of excavation be undertaken to assess long term pumping requirements (if any). Grouting of open joints and partings may be necessary if excessive water ingress is an issue during excavation.

Previous experience also indicates that the groundwater within the Hawkesbury Sandstone can have moderate concentrations of dissolved solids, particularly iron. Once groundwater comes into contact with the atmosphere, precipitation of iron oxides is likely to occur and provision should be made for the filtering and/or cleaning of this precipitate from subsoil drains, sumps, pumps and other fittings over the medium to longer term.

Based upon the groundwater observations and ground conditions encountered during the investigation, the groundwater drawdown effects on adjacent properties are likely to be negligible, however, it is possible that a reduction in perched seepage flows down the cliff (i.e. from RL52 m) may be experienced.

9.6 Foundations

9.6.1 Proposed Basement Car Park

High strength, bedded sandstone (Class II or I) is expected to be encountered at bulk excavation level over the footprint of the proposed basement excavation. The interpreted geological profile for the site is depicted on the interpreted cross-sections A-A' to D-D' (Drawings 2 to 5, Appendix C). It is noted that thin bands (20-70 mm thick) of very low strength sandstone and clay were encountered about 2 m below the final finished level in some locations (refer boreholes BH101 and BH102 on Drawing 3).

This 'class' of rock is considered to be a suitable founding material for the car parking structure. On the basis of the materials anticipated at these levels, spread footings (i.e. pad or strip footings) should be suitable for supporting the footings of the proposed structure. If soil and weaker rock layers are encountered in the footings (e.g. fractured material), then consideration should be made for the footings/excavation to be taken deeper to below the fractured rock.

9.6.2 Ground Floor Terraces

Foundations for the new balcony footings, north of (and including) mapping traverse 104 / Unit 6, will need to be taken to below the weathered seams and voids encountered in the boreholes, to uniformly found on the underlying high strength sandstone (Class II or I). This 'class' of rock is considered to be a suitable founding material for the proposed new balcony footings. With reference to Drawing 6, the depth of additional excavation through medium and high strength rock is indicated to be up to 1.9 m. Due to access and safety considerations, bored piles (temporarily cased) would likely be required.

Due to the inferred connection of the seams / voids within the sandstone (beneath the terrace) to the cliff face, consideration should be given to the use of a thick concrete mixture for the footings, to limit the amount of concrete lost from the base of the footing into the seam and out towards the cliff edge. Alternatively, hand grout packing of the seams (e.g. via rope access) could be attempted with the permission of the neighbour.

South of mapping traverse 104 / Unit 6, foundations for the new balcony footings will need to be taken through the rubble filling, to uniformly found on the underlying medium and high strength sandstone

(Class II or I). On the basis of the materials anticipated at these levels, spread footings (i.e. pad or strip footings) should be suitable for supporting the footings of the proposed structure at these locations.

9.6.3 Design

Recommended maximum allowable (and ultimate) bearing pressures, shaft adhesions and modulus values for the various rock strata encountered in boreholes at the site are presented in Table 13. These parameters apply to the design of spread foundations, such as pads or strip footings, or for socketed bored piles, for the support of axial compression loadings. They can only be adopted if the excavations are clean and free of loose debris, with pile sockets free of smear and adequately roughened immediately prior to concrete placement. An experienced geotechnical professional should inspect all pile excavations and spread footings (e.g. pads) prior to the placement of concrete and steel.

Footings taken down into consistent Class II sandstone (or better) may be designed for 6,000 kPa and possibly up to 10,000 kPa, subject to spoon testing during construction. However, if higher bearing pressures are used in design then significant additional testing will be required in the form of 'proof' core boreholes and spoon testing of footings, to ensure there are no defects beneath footings. Alternatively, if a lower allowable bearing pressure of 3,500 kPa is adopted then testing during construction could be limited to the geotechnical inspection of foundations.

Table 13: Recommended Design Parameters and Moduli for Foundation Design

Foundation Stratum[1]	Allowable End Bearing (MPa)	Ultimate End Bearing (MPa)	Allowable Shaft Adhesion (kPa)[2]	Ultimate Shaft Adhesion (kPa)[2]	Field Elastic Modulus (MPa)
Low strength Sandstone (Class IV)	1.0	4	150	250	100
Medium strength Sandstone (Class III)	3.5	20	350	800	350
High strength Sandstone (Class II or better)	6.0	60	600	1500	900

Notes: 1 Rock Classification based on Pells et. al (1998) and Bertuzzi and Pells (2002).
2 Shaft adhesion applicable to the design of bored piles, uncased over the rock socket length, where adequate sidewall cleanliness and roughness are achieved.

To use a bearing pressure value for design of 6 MPa, 33% of the footings should be spoon tested to a depth equivalent to 1.5 times the footing width. In spoon testing, a 50 mm diameter hole is drilled below the base of the footing to a depth of 1.5 times the footing width, followed by testing to check for the presence of weak layers or clay bands.

For design using the ultimate values provided in Table 13, a geotechnical strength reduction factor ($Ø_g$) should be determined by the designer, in accordance with AS 2159-2009. Serviceability criteria will also need to be met when using ultimate design parameters.

Where footings are located within the zone of influence of adjacent excavations, drawn upward at 45 degrees from the toe of the excavation (such as lift shafts or tanks), the allowable bearing pressure should be reduced by 25% and the excavation carefully inspected for adversely oriented joints. Alternatively, the footings may be taken deeper to below the zone of influence.

The settlement of a spread footing is dependent on the loads applied to the footing and the foundation conditions below the footing. The total settlement of a spread footing designed using the allowable parameters provided in Table 13 is expected to be less than 1% of the footing width upon application of the design load. Differential settlement between adjacent columns is expected to be less than half of this value.

All spread footings should be inspected by an experienced geotechnical professional to check the adequacy of the foundation material and proof drilled or spoon tested as appropriate.

If anchors / tie/down support is required for the lift core structures, it is considered that preliminary design could be based upon a working bond stress of 600 kPa, for rock of at least medium strength. It will be necessary to inspect the drilling of selected anchor holes to confirm that conditions are as encountered and inferred from the boreholes.

9.6.4 Existing Footings of Unit Block

Based on the previous footing exposures completed for the northern, southern and western sides of the existing unit block (Reference 3), the existing footings have been taken to at least low to medium strength sandstone, for which the parameters given in Table 13 for a Class III material are considered appropriate.

It was noted in the report (Reference 3) that a sample of fibre cement from Test Pit TP5 was confirmed as containing asbestos minerals. The full report should be referred to for further details on the findings of the footing exposures.

9.7 Floor Slab and Pavement Design

The floor of the proposed basement at bulk excavation level (BEL) can be designed as a slab on ground. The final rock surface (at BEL) should be trimmed and scraped clean of debris. As the floor will be excavated within rock it is suggested that slab design be based on a design CBR for the subgrade material not exceeding 8%.

It will be necessary to provide under-floor drainage to safeguard against uplift pressures if the slab is designed for drained conditions, and to direct seepage to the stormwater drainage system. This could comprise a minimum 100 mm thick, durable open graded crushed rock with subsurface drains and sumps connected to the stormwater system (where permitted).

If imported material is used to level the site and to form subgrade levels, the design CBR value will depend on the type of imported material. The design CBR value is based on the provision of adequate surface and subsoil drainage to maintain the subgrade as close to the optimum moisture content as possible.

9.8 Seismic Design

In accordance with the Earthquake Loading Standard, AS 1170.4 – 2007 (Reference 9), the site has a hazard factor (z) of 0.08. A site sub-soil class of Rock (B_e) is considered to be appropriate for this site.

10. References

1. Herbert C., 1983, Sydney 1:100 000 Geological Sheet 9130, 1st edition. Geological Survey of New South Wales, Sydney.
2. Douglas Partners Pty Ltd: "Geotechnical Investigation, Proposed Car Park, Alterations and Additions, 20 Illawong Avenue, Tamarama", report reference 72261, dated 8 April 2011;
3. Supplementary Geotechnical Investigation of Existing Footings, Proposed Car Park, Alterations and Additions, 20 Illawong Avenue, Tamarama", report reference 72261.03, dated 8 December 2014;
4. Supplementary Geotechnical Assessment of Southern Cliff Line, Proposed Car Park, Alterations and Additions, 20 Illawong Avenue, Tamarama", report reference 72261.04, dated 3 March 2017;
5. Public Works Advisory, NSW Government: "Dimension Sandstone Investigation, 20 Illawong Avenue, Tamarama", report reference 17-GT37A, dated 7 July 2017;
6. Australian Standard AS2159-2009, "Piling – Design and Installation", Third edition, 2009, Standards Australia.
7. NSW Environment Protection Authority (EPA), 2014. "Environmental Guidelines: Assessment, Classification and Management of Non-Liquid Wastes".
8. Australian / International Standard AS/ISO 2631.2 – 2014, "Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Vibration in buildings (1 Hz to 80 Hz)".
9. Australian Standard AS 1170.4 – 2007 (Amendment 2, 2018), "Structural design actions, Part 4: Earthquake actions in Australia", Standards Australia Limited.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at 20 Illawong Avenue, Tamarama, in accordance with DP's proposal SYD18094a (Rev 1) dated 24 September 2018. Acceptance was received from Nathan Dutch of GK Strata Management Pty Ltd on 25 September 2018, on behalf of Strata Plan SP1731. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Strata Plan SP1731 or their agents for this project only and for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological

processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached pages and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires a risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

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

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole 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. They may not be the same at the time of construction as are indicated in the report; and
- 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 first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or 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 a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP 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 and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

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, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report 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. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Site Photographs

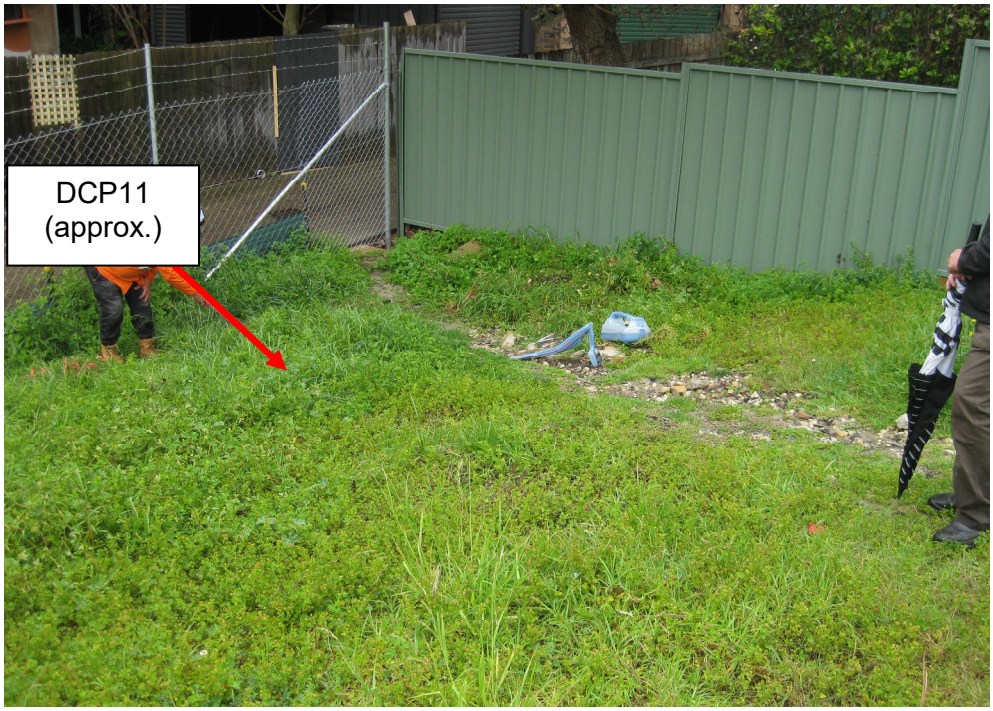


Photo 1 – View south-west towards laneway and southern property boundary. Historical test location indicated as shown.

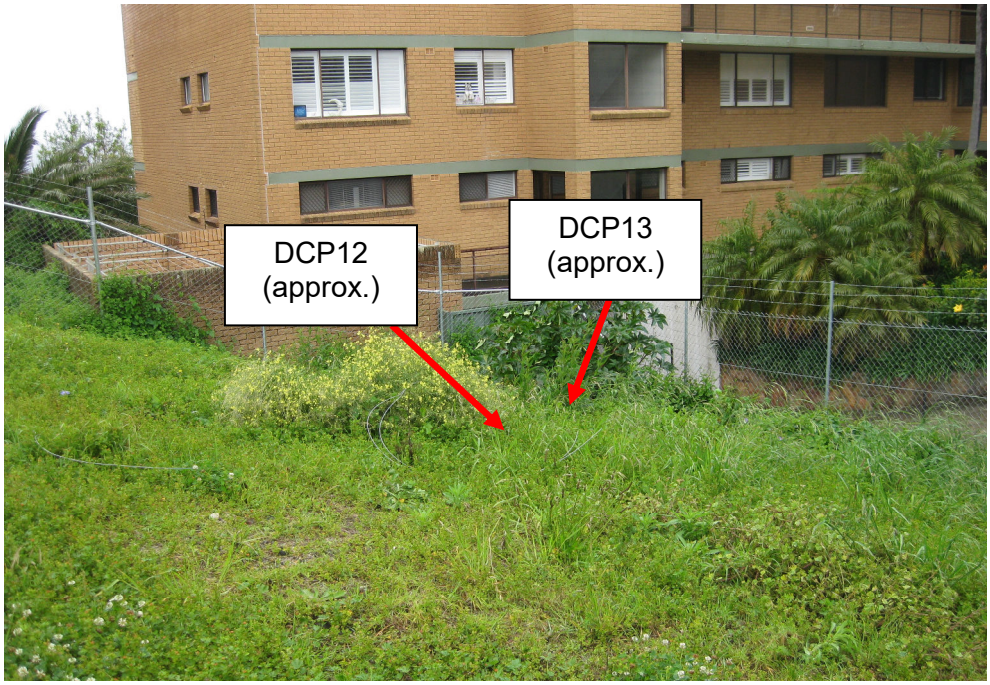


Photo 2 – View south-east towards neighbouring property and laneway along southern property boundary. Historical test locations indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 1 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

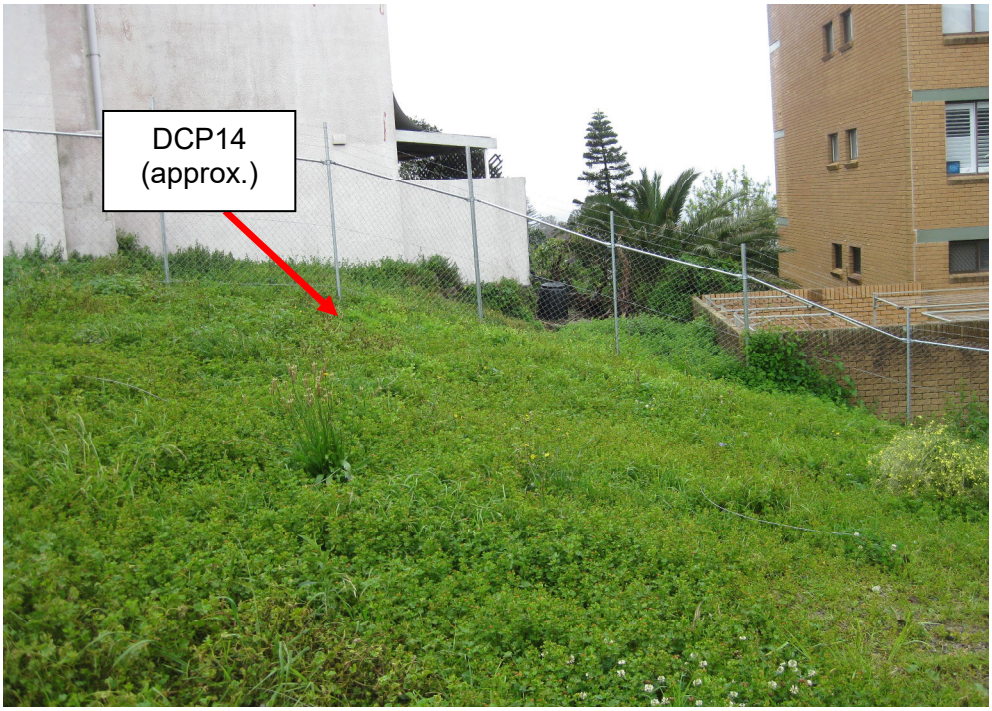


Photo 3 – View south-east towards cliffline and 20 Illawong Avenue building. Historical test location indicated as shown.

Photo 4 – View north-west towards existing car park. Test locations indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 2 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

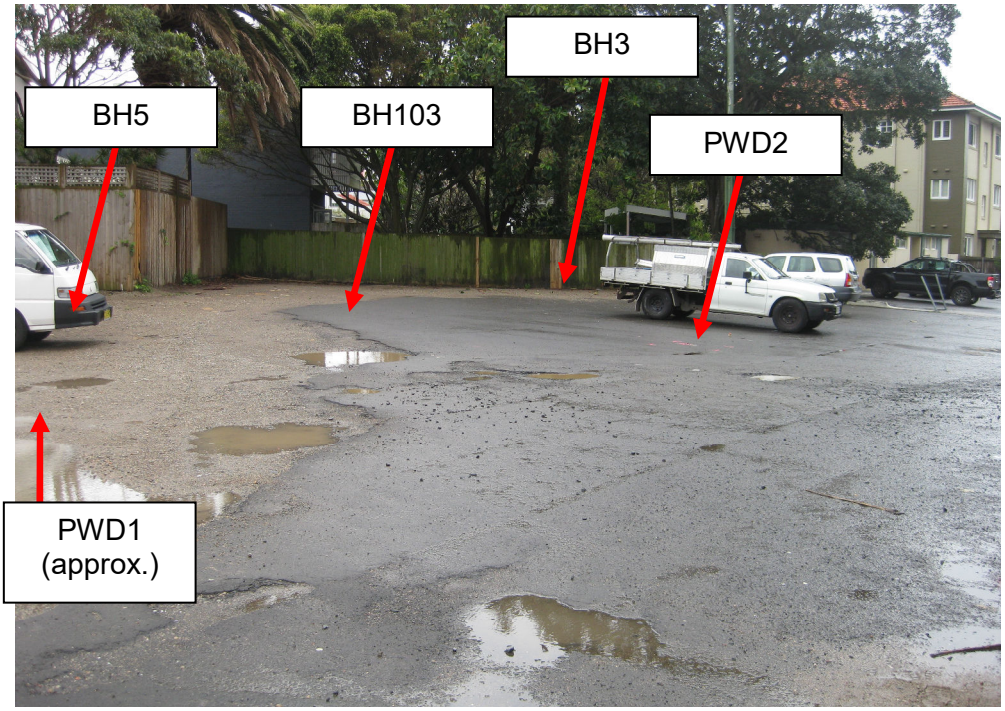


Photo 5 – View north within existing car park. Historical and current test locations indicated as shown.

Photo 6 – View south-east towards neighbouring property and laneway along southern property boundary. Historical test locations indicated as shown

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 3 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

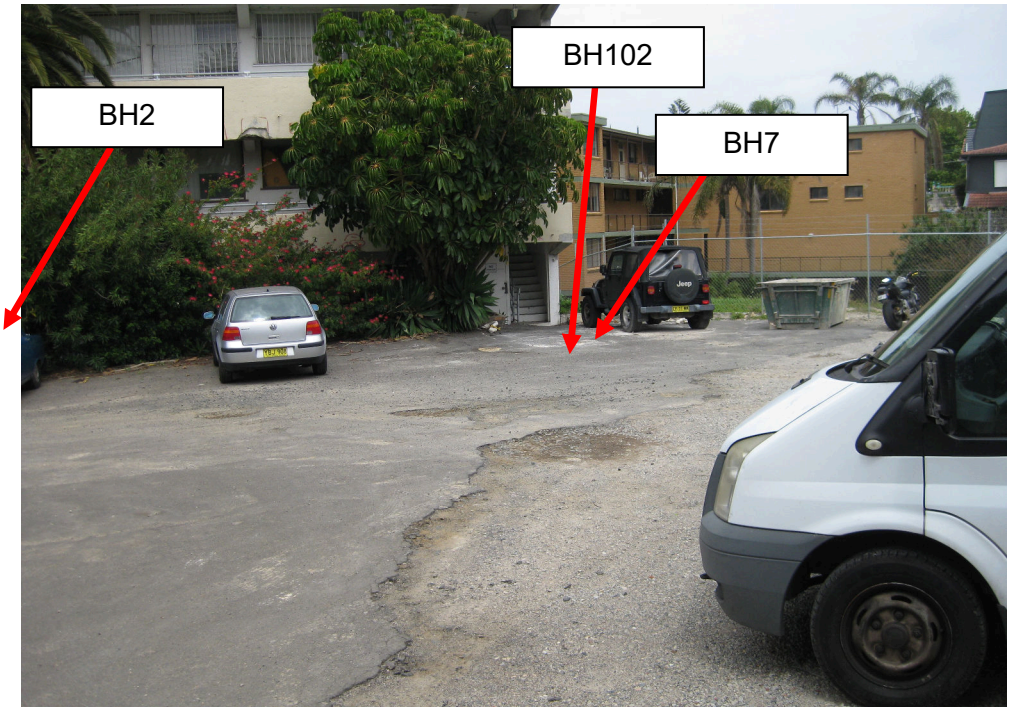


Photo 7 – View south within existing car park. Historical and current test locations indicated as shown.

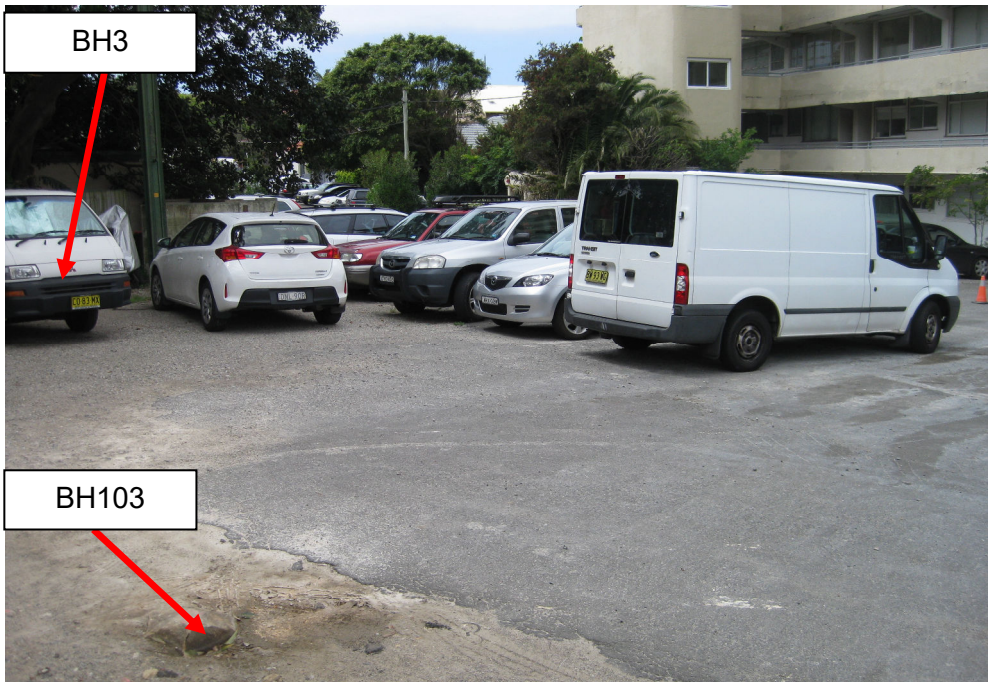


Photo 8 – View east within existing car park. Historical and current test locations indicated as shown

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 4 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

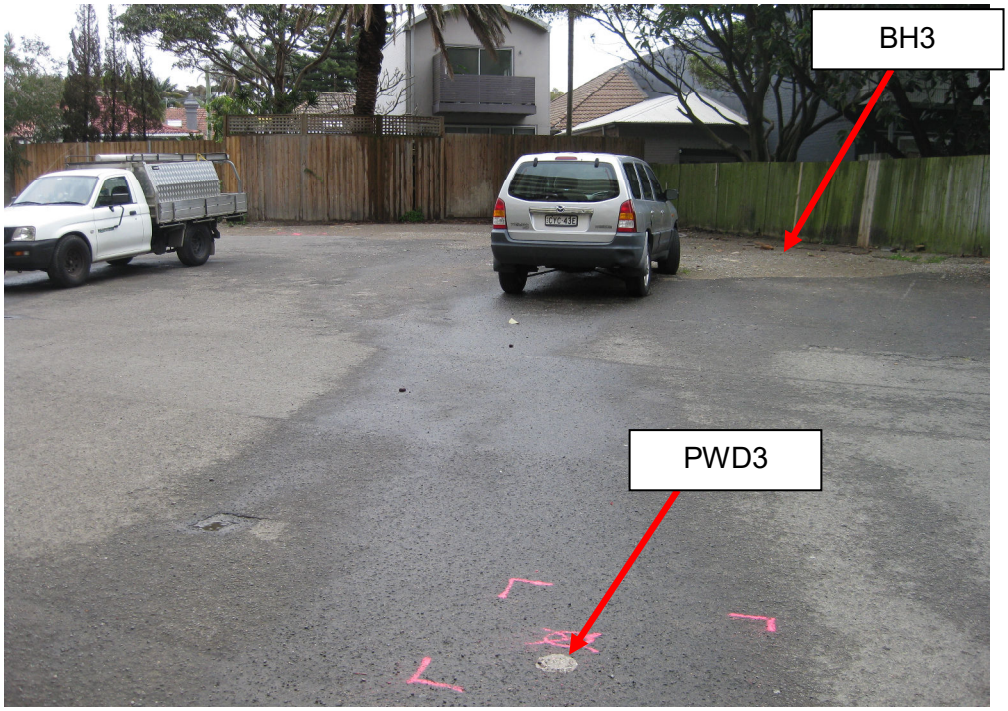


Photo 9 – View west within existing car park. Historical and current test locations indicated as shown.

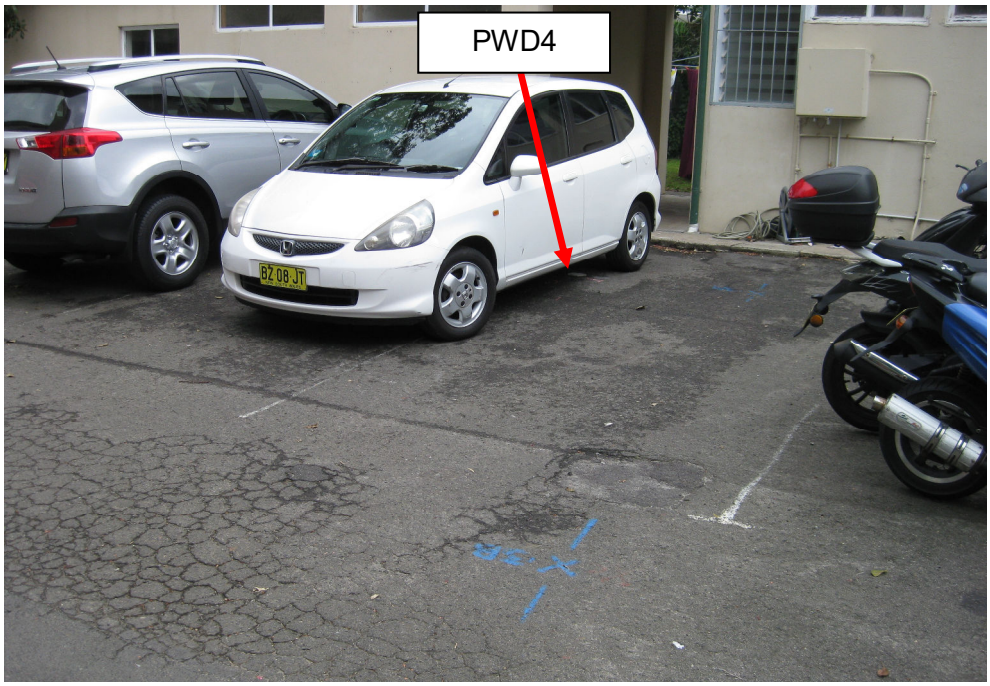


Photo 10 – View north-west within existing car park towards laundry. Historical test location indicated as shown

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 5 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Photo 11 – View west within existing car park. Historical and current test locations indicated as shown.

Photo 12 – View north-west towards existing car park. Rock exposure indicated as shown

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 6 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

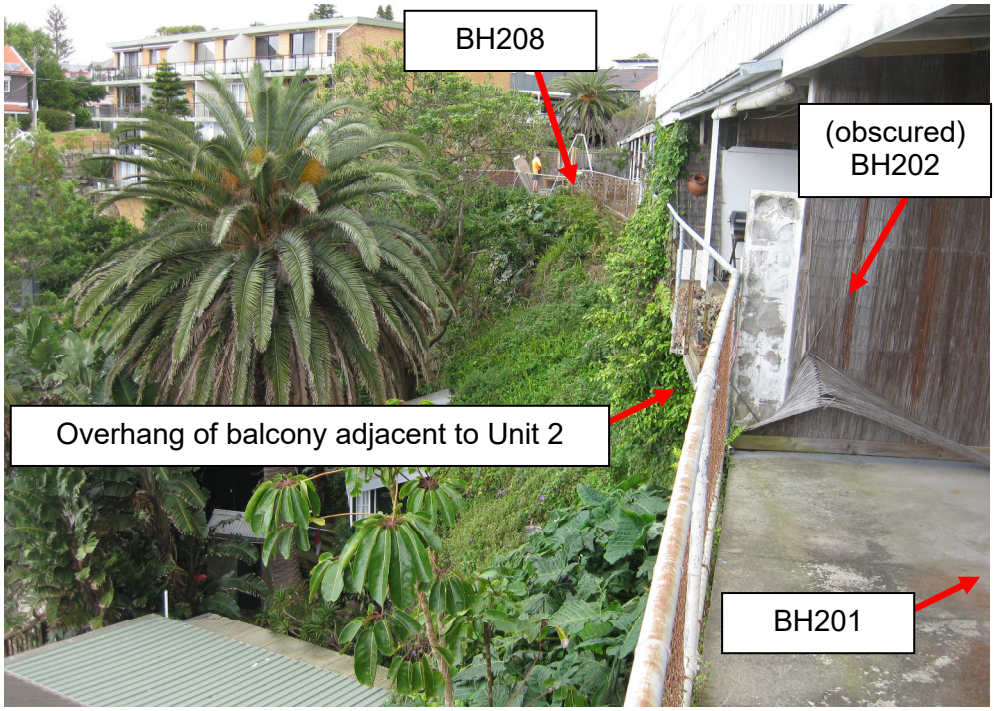


Photo 13 – View south-west along balcony edge from Unit 1. Current test locations indicated as shown.

Photo 14 – View south-west along balcony of Unit 2. The position of BH202 is indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 7 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Photo 15 – View south-west along balcony edge from Unit 4.

Photo 16 – View south-west along balcony of Unit 5. The position of BH206 is indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 8 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Photo 17 – View north-east along balcony of Units 5 and 6. Borehole positions are indicated as shown.

Photo 18 – View south-west along balcony of Unit 7. The position of BH208 is indicated as shown, below a timber deck.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 9 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Photo 19 – View east at southern end of balcony / terrace of Unit 8.

Photo 20 – View south-west at southern end of balcony / terrace of Unit 10.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 10 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

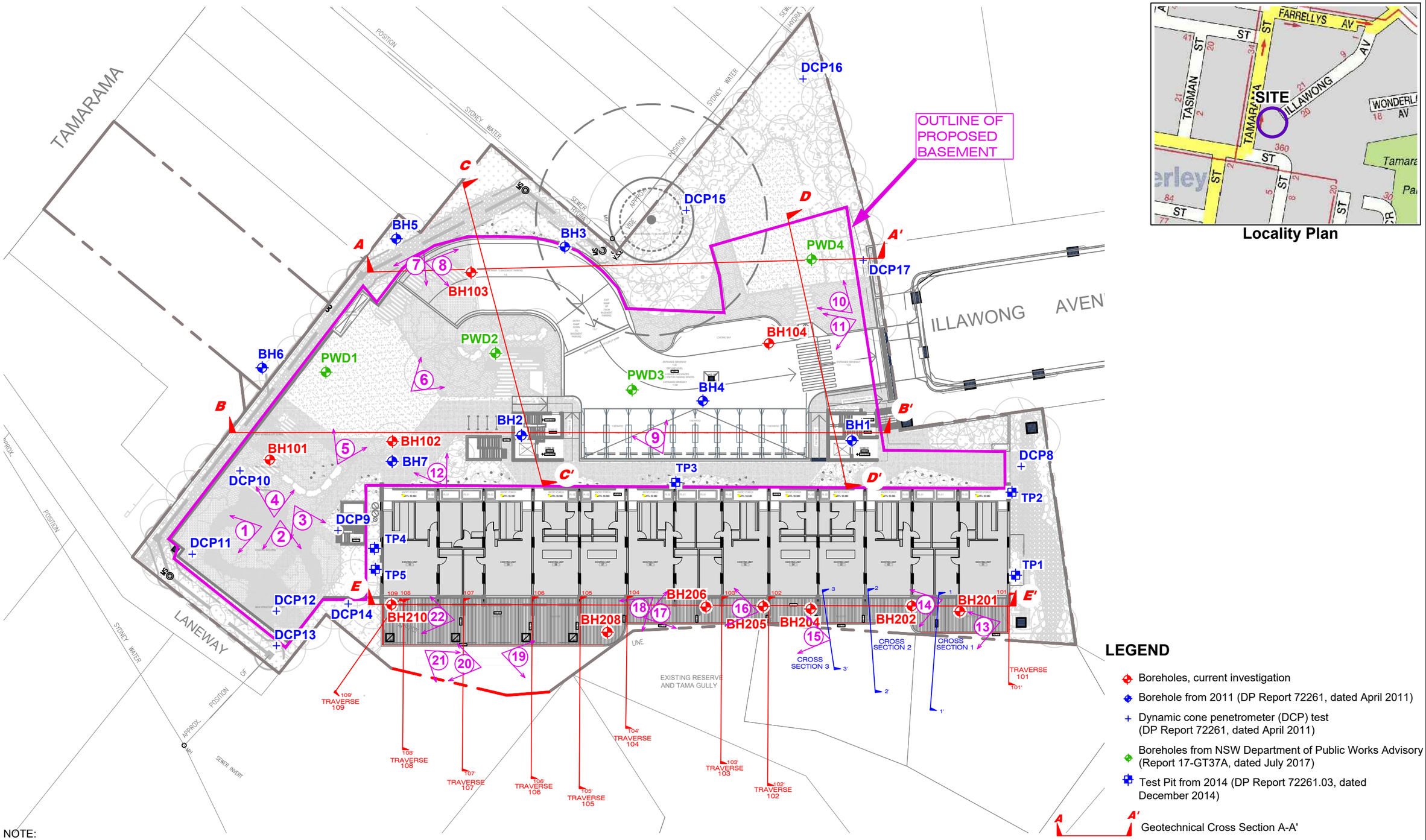
Photo 21 – View east at southern end of balcony / terrace of Unit 10, adjacent to cliff edge.

Photo 22 – View south-west at southern end of balcony / terrace of Unit 10. The position of Borehole BH210 is indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: 11 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Appendix C

Drawings



Locality Plan

LEGEND

- Boreholes, current investigation
- Borehole from 2011 (DP Report 72261, dated April 2011)
- Dynamic cone penetrometer (DCP) test (DP Report 72261, dated April 2011)
- Boreholes from NSW Department of Public Works Advisory (Report 17-GT37A, dated July 2017)
- Test Pit from 2014 (DP Report 72261.03, dated December 2014)
- A — A' Geotechnical Cross Section A-A'
- 101 — 101' Cliff Mapping Traverse, current investigation
- 1 — 1' Cliff Mapping Traverse (DP Report 72261.04.R.002, dated March 2017)
- 2 Site Photo number with direction of view

NOTE:
1: Base drawing from Group GSA (Proj 160455, Dwg A2002, dated 21.4.2017)
2: Test locations are approximate only and are shown with reference to existing features.

0 2 4 6 8 10 15 20 30 40m
1:400 @ A3

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Strata Plan SP1731		TITLE: **Site and Test Location Plan**	PROJECT No: 72261.06
OFFICE: Sydney	DRAWN BY: PSCH	**Alterations and Additions**	DRAWING No: 1
SCALE: 1:400 @ A3	DATE: 14.11.2018	**20 Illawong Avenue, TAMARAMA**	REVISION: 0

A

A'

INTERSECTION
SECTION C-C'

INTERSECTION
SECTION D-D'

PROPERTY
BOUNDARY

BH5
Offset 2.1m
Bottom Depth
0.65 m

BH103
Offset - 0.2m
Rock Strength
EL VL L M H VH EH
refusal
Bottom Depth
14.25 m

BH3
Offset 2.9m
Rock Strength
EL VL L M H VH EH
Bottom Depth
9.98 m

PWD4
Offset 0.2m
Rock Strength
EL VL L M H VH EH
Bottom Depth
11.97 m

DCP17
Offset 0.2m
0.98m

FILLING

HIGH STRENGTH MASSIVE
SANDSTONE

HIGH STRENGTH MASSIVE
SANDSTONE

VERY LOW TO MEDIUM
STRENGTH MASSIVE SANDSTONE

HIGH STRENGTH MASSIVE
YELLOW BLOCK SANDSTONE

HIGH STRENGTH MASSIVE
YELLOW BLOCK SANDSTONE

HIGH STRENGTH BEDDED
SANDSTONE

HIGH STRENGTH BEDDED
SANDSTONE

HIGH STRENGTH BEDDED
SANDSTONE

RL46.23 m

PROPOSED
BASEMENT
OUTLINE

RL46.23 m

PROPOSED
BASEMENT
OUTLINE

ELEVATION (AHD)

65 60 55 50 45 40 35

0 5 10 15 20 25 30 35 40 45 50

DISTANCE ALONG PROFILE (m)

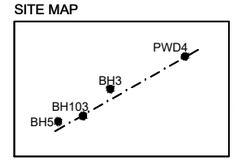
NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level indicative only.

LEGEND

- Core Loss
- Asphaltic Concrete
- Not recorded- assumed soil strength
- Filling
- Sand
- Sandstone
- Sandstone coarse grained
- Sandstone fine grained
- Interpreted Geological Boundary
- Interpreted Top of Weathered Rock

TESTS / OTHER
N - Standard penetration test value
▽ - Water level
EL - Extremely low strength rock
VL - Very low strength rock
L - Low strength rock
M - Medium strength rock
H - High strength rock

SITE MAP



0 3
Horizontal Scale (metres)
Natural Scale

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Strata Plan 1731		TITLE: **Interpreted Geotechnical Cross-Section A-A'** **Proposed Car Park, Alterations and Additions** **20 Illawong Avenue, TAMARAMA**
OFFICE: Sydney	DRAWN BY: HDS	
SCALE: 1:150 (H) 1:150 (V) @ A3	DATE: 06.11.2018	

PROJECT No:	72261.06
DRAWING No:	2
REVISION:	0

B

B'

INTERSECTION SECTION C-C'

INTERSECTION SECTION D-D'

PROPERTY BOUNDARY

Sewer trench

FILLING

BH101
Offset - 3.1m
Rock Strength
EL VL L M H VH EH
N = 10
Bottom Depth 14.5 m

BH102
Offset - 1.1m
Rock Strength
EL VL L M H VH EH
Bottom Depth 14.68 m

BH2
Offset - 0.2m
Rock Strength
EL VL L M H VH EH
Bottom Depth 15m

PWD3
Offset 4.0m
Rock Strength
EL VL L M H VH EH
Bottom Depth 11.45 m

BH4
Offset 4.5m
Bottom Depth 0.55 m

VERY LOW TO MEDIUM STRENGTH MASSIVE SANDSTONE

FILLING

BH1
Offset - 0.6m;
Rock Strength
EL VL L M H VH EH
refusal
Bottom Depth 15.6 m

HIGH STRENGTH MASSIVE SANDSTONE

HIGH STRENGTH BEDDED SANDSTONE

HIGH STRENGTH MASSIVE SANDSTONE

HIGH STRENGTH BEDDED SANDSTONE

HIGH STRENGTH MASSIVE YELLOW BLOCK SANDSTONE

HIGH STRENGTH MASSIVE YELLOW BLOCK SANDSTONE

HIGH STRENGTH BEDDED SANDSTONE

RL46.23 m

PROPOSED BASEMENT OUTLINE

ELEVATION (AHD)

65 60 55 50 45 40 35 30 25

0 10 20 30 40 50 60 70

DISTANCE ALONG PROFILE (m)

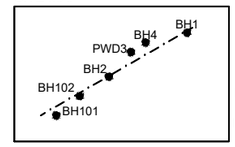
NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level indicative only.
5. Different scale used compared with other cross-sections.

LEGEND

- Core Loss
- Asphaltic Concrete
- Not recorded- assumed soil strength
- Filling
- Roadbase
- Sandstone
- Sandstone coarse grained
- Sandstone fine grained
- Topsoil
- Interpreted Geological Boundary
- Interpreted Top of Weathered Rock

TESTS / OTHER
- N - Standard penetration test value
- ▽ - Water level
- EL - Extremely low strength rock
- VL - Very low strength rock
- L - Low strength rock
- M - Medium strength rock
- H - High strength rock

SITE MAP



0 4
Horizontal Scale (metres)
Natural Scale

NOTE: Different scale used compared to other sections

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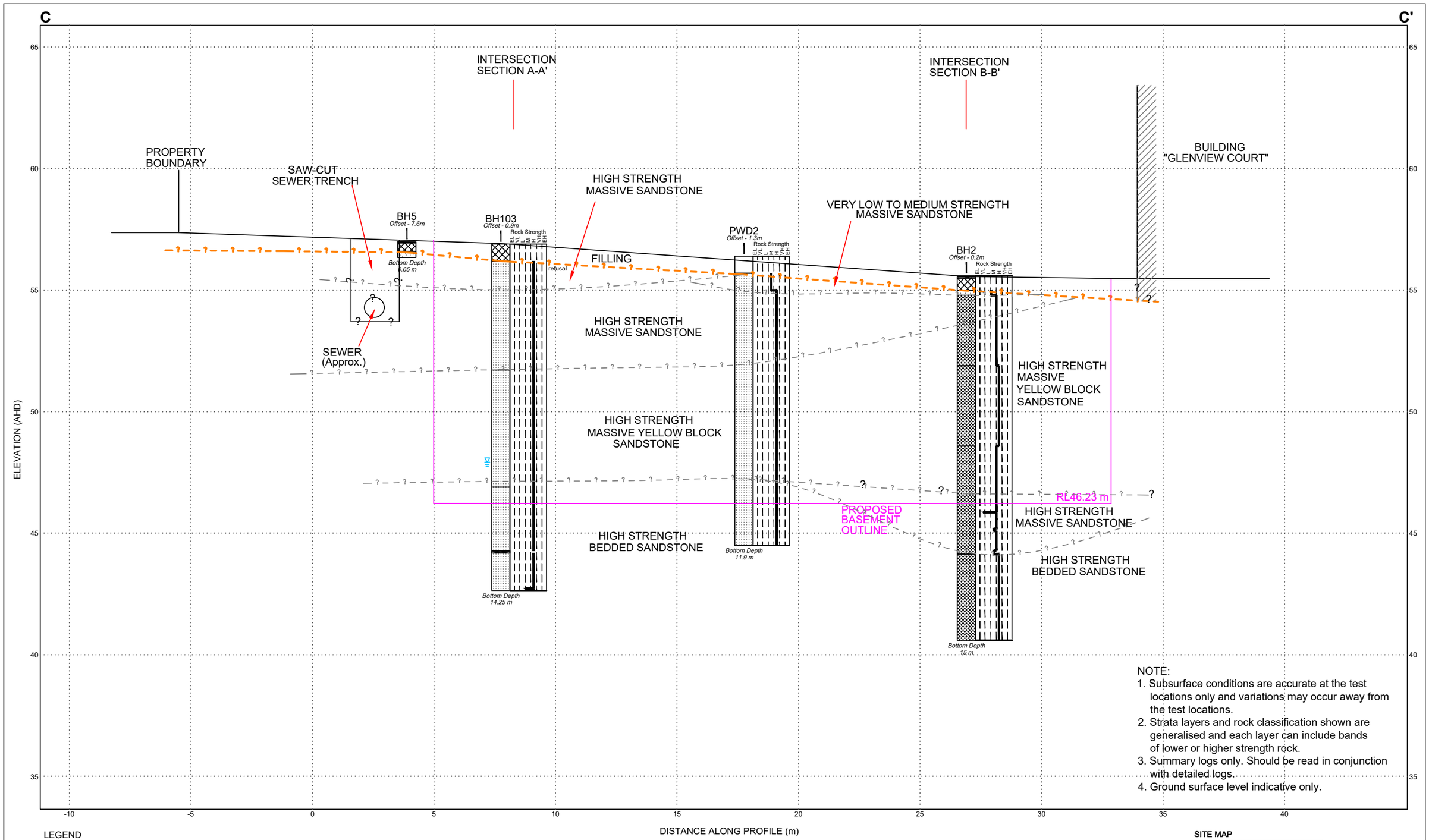
CLIENT: Strata Plan 1731		TITLE: **Interpreted Geotechnical Cross-Section B-B'**	PROJECT No: 72261.06
OFFICE: Sydney	DRAWN BY: HDS	**Proposed Car Park, Alterations and Additions**	DRAWING No: 3
SCALE: 1:200 (H) 1:200 (V) @ A3	DATE: 06.11.2018	**20 Illawong Avenue, TAMARAMA**	REVISION: 0



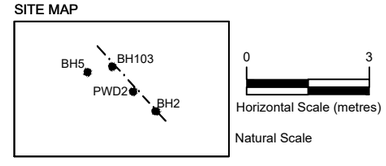
NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level indicative only.

LEGEND

- Core Loss
- Asphaltic Concrete
- Not recorded- assumed soil strength
- Filling
- Roadbase
- Sand
- Sandstone
- Sandstone coarse grained
- Sandstone fine grained
- Interpreted Geological Boundary
- Interpreted Top of Weathered Rock

TESTS / OTHER
N - Standard penetration test value
▽ - Water level
EL - Extremely low strength rock
VL - Very low strength rock
L - Low strength rock
M - Medium strength rock
H - High strength rock

SITE MAP



Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Strata Plan 1731		TITLE: **Interpreted Geotechnical Cross-Section C-C'**	PROJECT No: 72261.06
OFFICE: Sydney	DRAWN BY: HDS	**Proposed Car Park, Alterations and Additions**	DRAWING No: 4
SCALE: 1:150 (H) 1:150 (V) @ A3	DATE: 06.11.2018	**20 Illawong Avenue, TAMARAMA**	REVISION: 0

D

D'

INTERSECTION SECTION A-A'

INTERSECTION SECTION B-B'

LAUNDRY

BUILDING "GLENVIEW COURT"

PWD4
Offset 1.5m
Rock Strength
EL VL L M H VH EH
Bottom Depth 11.97 m

BH104
Offset - 4.2m
Rock Strength
EL VL L M H VH EH
Bottom Depth 14.6 m

BH1
Offset 2.1m
Rock Strength
EL VL L M H VH EH
refusal
Bottom Depth 15.6 m

FILLING

VERY LOW TO MEDIUM STR. MASSIVE SANDSTONE

HIGH STRENGTH MASSIVE SANDSTONE

HIGH STRENGTH MASSIVE YELLOW BLOCK SANDSTONE

HIGH STRENGTH MASSIVE YELLOW BLOCK SANDSTONE

HIGH STRENGTH BEDDED SANDSTONE

RL46.23 m

PROPOSED BASEMENT OUTLINE

ELEVATION (AHD)

65 60 55 50 45 40 35

-10 -5 0 5 10 15 20 25 30 35 40

DISTANCE ALONG PROFILE (m)

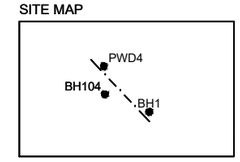
NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level indicative only.

LEGEND

- Core Loss
- Asphaltic Concrete
- Not recorded- assumed soil strength
- Filling
- Sandstone
- Sandstone coarse grained
- Sandstone fine grained
- Topsoil
- Interpreted Geological Boundary
- Interpreted Top of Weathered Rock

TESTS / OTHER
- N - Standard penetration test value
- ▽ - Water level
- EL - Extremely low strength rock
- VL - Very low strength rock
- L - Low strength rock
- M - Medium strength rock
- H - High strength rock

SITE MAP



0 3
Horizontal Scale (metres)
Natural Scale

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Strata Plan 1731		TITLE: **Interpreted Geotechnical Cross-Section D-D'**	PROJECT No: 72261.06
OFFICE: Sydney	DRAWN BY: HDS	**Proposed Car Park, Alterations and Additions**	DRAWING No: 5
SCALE: 1:150 (H) 1:150 (V) @ A3	DATE: 06.11.2018	**20 Illawong Avenue, TAMARAMA**	REVISION: 0

E

E'

BUILDING "GLENVIEW COURT"

INTERSECTION TRAVERSE 109 (OBLIQUE)

INTERSECTION TRAVERSE 108

INTERSECTION TRAVERSE 107

INTERSECTION TRAVERSE 106

INTERSECTION TRAVERSE 105

INTERSECTION TRAVERSE 104

INTERSECTION TRAVERSE 103

INTERSECTION TRAVERSE 102

INTERSECTION TRAVERSE 3

INTERSECTION TRAVERSE 2

INTERSECTION TRAVERSE 1

INTERSECTION TRAVERSE 101

BH210 Offset 0.4m Rock Strength EL VL L M H

BH208 Offset - 2.0m Rock Strength EL VL L M H

BH206 Offset 0.1m Rock Strength EL VL L M H

BH205 Offset 0.2m Rock Strength EL VL L M H

BH204 Offset 0.2m Rock Strength EL VL L M H

BH202 Offset -0.1m Rock Strength EL VL L M H

BH201 Offset 0.5m Rock Strength EL VL L M H

RUBBLE FILLING

MEDIUM STRENGTH MASSIVE SANDSTONE

MASSIVE HIGH STRENGTH SANDSTONE

BEDDED HIGH STRENGTH SANDSTONE

Bottom Depth 5.06 m

Bottom Depth 5.75 m

RUBBLE FILLING

SAND FILLING

MASSIVE HIGH STRENGTH SANDSTONE

SEAM

JOINT 77°/031°

MASSIVE HIGH STRENGTH SANDSTONE

Bottom Depth 6 m

Bottom Depth 5.21 m

SAND FILLING

VOID

SEAM

Bottom Depth 5.48 m

CONCRETE (Pipe washout repair)

SAND FILLING

BRICKS (Possible footing)

SEAM

BEDDED HIGH STRENGTH SANDSTONE

Bottom Depth 6.25 m

Reinforced Concrete FILLING- Cemented

CONCRETE

BRICKS (Possible footing)

BEDDED HIGH STRENGTH SANDSTONE

SEAM

Bottom Depth 5.88 m

RL 46.23
PROPOSED BASEMENT LEVEL ON FOR SIDE OF BUILDING

RL 46.23
PROPOSED BASEMENT LEVEL ON FOR SIDE OF BUILDING

ELEVATION (AHD)

60 58 56 54 52 50 48 46 44 42 40

10 20 30 40 50 60 70

DISTANCE ALONG PROFILE (m)

NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level indicative only.

Note: Horizontal and vertical scales not equal

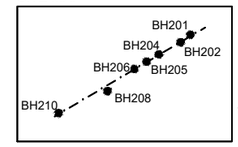
LEGEND

- Core Loss
- Bricks
- Concrete
- Filling
- Sandstone
- Interpreted Geological Boundary

TESTS / OTHER

- EL Extremely low strength rock
- VL - Very low strength rock
- L - Low strength rock
- M - Medium strength rock
- H - High strength rock
- 77°/031° - Measured Dip and Dip Direction of defect, relative to Magnetic North

SITE MAP



0 4

Horizontal Scale (metres)
Vertical Exaggeration = 2.0

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Geotechnics / Environment / Groundwater

CLIENT: Strata Plan 1731		TITLE: **Interpreted Geotechnical Cross-Section E-E'** **Ground Floor Balconies - Alterations and Additions** **20 Illawong Avenue, TAMARAMA**
OFFICE: Sydney	DRAWN BY: HDS	
SCALE: 1:200 (H) 1:100 (V) @ A3	DATE: 13.11.2018	

PROJECT No:	72261.06
DRAWING No:	6
REVISION:	0

Appendix D

Field Work Results

Sampling

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

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil 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.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud 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 the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils 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 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm 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 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

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

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This 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.

Soil Descriptions

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Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

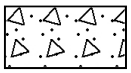
Symbols & Abbreviations

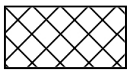
Graphic Symbols for Soil and Rock

General

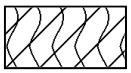

Asphalt

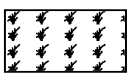

Road base

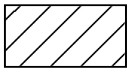

Concrete

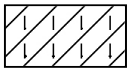

Filling

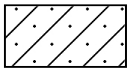
Soils


Topsoil

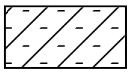

Peat

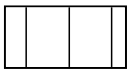

Clay

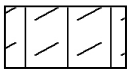

Silty clay

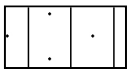

Sandy clay

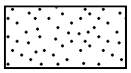

Gravelly clay

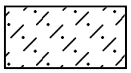

Shaly clay

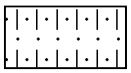

Silt


Clayey silt


Sandy silt

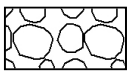

Sand

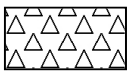

Clayey sand


Silty sand


Gravel

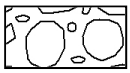

Sandy gravel


Cobbles, boulders

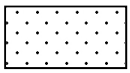

Talus

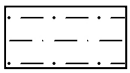
Sedimentary Rocks

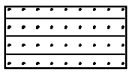

Boulder conglomerate

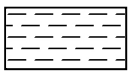

Conglomerate


Conglomeratic sandstone

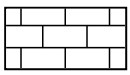

Sandstone


Siltstone

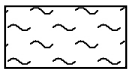

Laminite

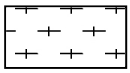

Mudstone, claystone, shale

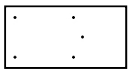

Coal


Limestone

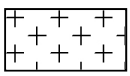
Metamorphic Rocks

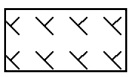

Slate, phyllite, schist

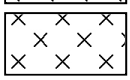

Gneiss

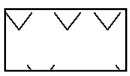

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Proposed Car Park, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 56.2 AHD
EASTING: 339719.4
NORTHING: 6247825.1
DIP/AZIMUTH: 90°/--

BORE No: BH101
PROJECT No: 72261.06
DATE: 19/10/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
56	0	FILLING: brown, slightly gravelly medium sand filling, with some sandstone cobbles, trace steel fragments, gravel comprises fine to coarse sandstone and brick, damp							A			
55	1								A			
									S			9,6,4 N = 10
54	2											
	2.0	SANDSTONE: high strength, slightly weathered, unbroken, light grey and light orange-brown, medium to coarse grained sandstone, massive, with trace carbonaceous flakes (possibly leached)										PL(A) = 1.1
53	3	Below 3m: iron-staining (liesegang rings?)							C	100	100	PL(A) = 1.5
52	4							>>				PL(A) = 1.5
51	5								C	100	100	PL(A) = 1.9
	5.75	SANDSTONE: high strength, slightly weathered then fresh, slightly fractured, orange-brown then light grey, medium to coarse grained sandstone, thinly bedded at 0-10° 6.0m-6.15m: iron cementation and with siltstone clasts						6.08m: B, 0-10°, un, ro, fe stn				PL(A) = 1.3
50	6											
49	7											PL(A) = 1.4
48	8								C	100	100	PL(A) = 1.6
47	9							>>				PL(A) = 1.6

RIG: Bobcat **DRILLER:** SS **LOGGED:** RMM **CASING:** HW to 2.1m

TYPE OF BORING: Solid flight auger (TC Bit) to 2.1m; NMLC diamond core to 14.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Proposed Car Park, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 56.2 AHD
EASTING: 339719.4
NORTHING: 6247825.1
DIP/AZIMUTH: 90°/--

BORE No: BH101
PROJECT No: 72261.06
DATE: 19/10/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
46		SANDSTONE: high strength, slightly weathered then fresh, slightly fractured, orange-brown then light grey, medium to coarse grained sandstone, thinly bedded at 0-10° *(continued)*										PL(A) = 1.8
45	11											PL(A) = 2.2
		11.49m-13.0m: with some very low to low strength bands						11.49m: B, 5°, un, cly 5mm 11.73m: B, 5°, un, cly 5mm 11.81m: Ds, 70mm 12.31m: Ds, 20mm	C	100	92	
44	12											PL(A) = 1.3
43	13							13m: Cs,10mm				PL(A) = 0.36
									C	100	96	
42	14							14.11m: B, 0-5°, un, cly 5mm 14.16m: B, 0-5°, un, cly 5mm				PL(A) = 1.5
	14.5	Bore discontinued at 14.5m - Target Depth Reached										
41	15											
40	16											
39	17											
38	18											
37	19											

RIG: Bobcat **DRILLER:** SS **LOGGED:** RMM **CASING:** HW to 2.1m

TYPE OF BORING: Solid flight auger (TC Bit) to 2.1m; NMLC diamond core to 14.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH101 PROJECT NO. 72261.06 OCTOBER 2018

2.1m-6m

DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH101 PROJECT NO. 72261.06 OCTOBER 2018

6m-11m

DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH101 PROJECT NO. 72261.06 OCTOBER 2018

11m-14.5m

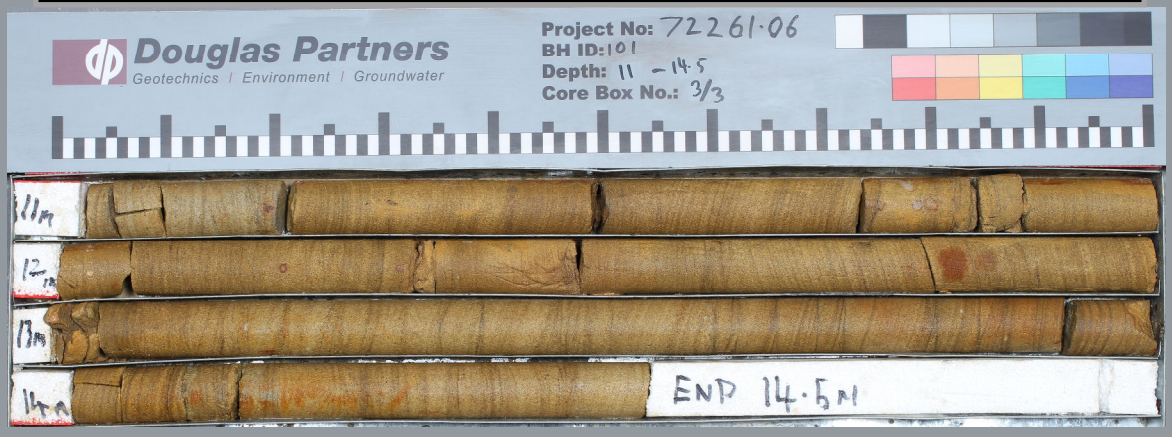
BORE: 101 PROJECT: TAMARAMA NOVEMBER 2018
(21 days post-drilling)

2.1m – 6m

BORE: 101 PROJECT: TAMARAMA NOVEMBER 2018
(21 days post-drilling)

6m – 11m

BORE: 101 **PROJECT: TAMARAMA** **NOVEMBER 2018**
(21 days post-drilling)



11m – 14.5m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Proposed Car Park, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 56.5 AHD
EASTING: 339729
NORTHING: 6247833
DIP/AZIMUTH: 90°/--

BORE No: BH102
PROJECT No: 72261.06
DATE: 19/10/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
56	0.05	ASPHALTIC CONCRETE							A			
	0.15	FILLING: brown, medium sand filling, with some fine to coarse sandstone gravels, damp							A			
55	1	SANDSTONE: medium to high strength, slightly weathered, slightly fractured to unbroken, light grey and light orange-brown, medium to coarse grained sandstone, massive, trace carbonaceous flakes (possibly leached)							C	100	99	PL(A) = 0.47 PL(A) = 0.74
54	2							2.09m: Cs, 10mm				
53	3	2.75m-3.8m: iron staining (liesegang rings?)							C	100	100	PL(A) = 1.1 PL(A) = 1.4
52	4							>>				
51	5											PL(A) = 1.4
50	6								C	100	99	PL(A) = 1.3 PL(A) = 0.96
49	6.96	SANDSTONE: medium to high strength, slightly to moderately weathered then fresh, slightly fractured, light grey, medium to coarse grained sandstone, with siltstone and carbonaceous bedding laminations at 0-10°						6.96m: B, 0-5°, ir, ro, fe stn 7.6m: B, 0-10°, un, ro, cly 0-5mm 8.18m: B, 5°, pl, healed, fe stn 8.54m: B, 5°, pl, ro, cly stn				PL(A) = 0.65
48	8											
47	9	9.2m-9.7m: handling breaks on bedding planes							C	100	100	PL(A) = 1.8 PL(A) = 1.3

RIG: Bobcat **DRILLER:** SS **LOGGED:** RMM **CASING:** Uncased

TYPE OF BORING: Solid flight auger (TC Bit) to 0.36m; washbore to 0.55m; NMLC diamond core to 14.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Proposed Car Park, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 56.5 AHD
EASTING: 339729
NORTHING: 6247833
DIP/AZIMUTH: 90°/--

BORE No: BH102
PROJECT No: 72261.06
DATE: 19/10/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
46	11	SANDSTONE: medium to high strength, slightly to moderately weathered then fresh, slightly fractured, light grey, medium to coarse grained sandstone, with siltstone and carbonaceous bedding laminations at 0-10° *(continued)*						>>	C	100	100	PL(A) = 1.5
45	12	11.94m-13.55m: with some very low and low strength bands						11.94m: Ds, 20mm 12.15m: B, 0-5°, un, ro, cly 0-5mm 12.25m: B, 5-10°, un, ro, cln 12.39m: J, 40°, un, ro, cln 12.76m: B, 0-5°, ir, ro, cln 13.4m: B, 5°, ro, pl, cbs vn 13.55m: B, 5°, un, ro, cly vn				PL(A) = 1.7 PL(A) = 0.78 PL(A) = 1.5
44	13								C	100	98	
43	14											
42	14.68	Bore discontinued at 14.68m - Target Depth Reached						14.55m: B, 5°, un, ro, cbs vn 14.67m: Ds, 10mm				
41	15											
40	16											
39	17											
38	18											
37	19											

RIG: Bobcat **DRILLER:** SS **LOGGED:** RMM **CASING:** Uncased

TYPE OF BORING: Solid flight auger (TC Bit) to 0.36m; washbore to 0.55m; NMLC diamond core to 14.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH102 PROJECT NO. 72261.06 OCTOBER 2018

0.55m-5m

DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH102 PROJECT NO. 72261.06 OCTOBER 2018

5m-10m

DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH102 PROJECT NO. 72261.06 OCTOBER 2018

10m-14.68m

BORE: 102 PROJECT: TAMARAMA NOVEMBER 2018
(21 days post-drilling)

0.55m – 5m

BORE: 102 PROJECT: TAMARAMA NOVEMBER 2018
(21 days post-drilling)

5m – 10m

BORE: 102 **PROJECT: TAMARAMA** **NOVEMBER 2018**
(21 days post-drilling)

10m – 14.68m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Proposed Car Park, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 56.9 AHD
EASTING: 339727.6
NORTHING: 6247854.7
DIP/AZIMUTH: 90°/--

BORE No: BH103
PROJECT No: 72261.06
DATE: 18/10/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
			EW HW MW SW FS FR		Ex Low / Very Low / Low / Medium / High / Very High / Ex High		0.01 / 0.05 / 0.10 / 0.50 / 1.00	B - Bedding J - Joint S - Shear F - Fault				
		FILLING: brown, medium to coarse sand filling, with some fine to coarse sandstone gravel and cobbles up to approximately 400mm diameter, trace steel fragments, damp							A			
	0.7								A			10/0 refusal
56	1	SANDSTONE: high strength, slightly weathered, slightly fractured to unbroken, light grey and light orange-brown, medium to coarse grained sandstone, massive, trace carbonaceous flakes (possibly leached)							A / S			(no sample)
		Below 1.75m: partial iron staining (liesegang rings)							C	100	100	PL(A) = 1.6
55	2											
												PL(A) = 1.1
54	3											
												PL(A) = 1.3
53	4							3.98m: B, 0-5°, un, ro, fe stn				
									C	100	100	
52	5											PL(A) = 1.6
	5.18	SANDSTONE: high strength, fresh, unbroken, light grey, medium to coarse grained sandstone with some carbonaceous flakes, massive (Yellow block)										
51	6											PL(A) = 1.5
												PL(A) = 1.5
50	7	Below 7.08m: with quartz clasts and ironstained blotches						>>	C	100	100	
49	8											PL(A) = 2
48	9					19-10-18						PL(A) = 2
									C	100	100	
	9.7	SANDSTONE: description on next page										
47	10.0											PL(A) = 3.6

RIG: Scout 2 **DRILLER:** SS **LOGGED:** RMM **CASING:** HW to 1.0m, HQ to 3.0m

TYPE OF BORING: Solid flight auger (TC Bit) to 1.0m; NMLC diamond core to 14.25m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Open borehole purged of water on 18.10.2018 after completion of drilling. Groundwater measured at 9.0m on 19.10.2018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Proposed Car Park, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 56.9 AHD
EASTING: 339727.6
NORTHING: 6247854.7
DIP/AZIMUTH: 90°/--

BORE No: BH103
PROJECT No: 72261.06
DATE: 18/10/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
46	11	SANDSTONE: high strength, fresh, unbroken, light grey, medium to coarse grained sandstone with some carbonaceous flecks, thinly bedded and with occasional cross-beds and carbonaceous laminations at 0-10°						10.91m: B, 0-5°, pl, ro, cln	C	100	100	PL(A) = 1.7
45	12											PL(A) = 1.7
	12.71							12.62m: CORE LOSS: 90mm				
44	13								C	96	93	PL(A) = 1.1
43	14											PL(A) = 1.2
	14.25	Bore discontinued at 14.25m - Target Depth Reached						14.16m: Ds, 20mm 14.18m: B, 5°, un, ro, cly vn				
42	15											
41	16											
40	17											
39	18											
38	19											
37												

RIG: Scout 2 **DRILLER:** SS **LOGGED:** RMM **CASING:** HW to 1.0m, HQ to 3.0m

TYPE OF BORING: Solid flight auger (TC Bit) to 1.0m; NMLC diamond core to 14.25m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Open borehole purged of water on 18.10.2018 after completion of drilling. Groundwater measured at 9.0m on 19.10.2018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH103 PROJECT NO. 72261.06 OCTOBER 2018

1m-5m

DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

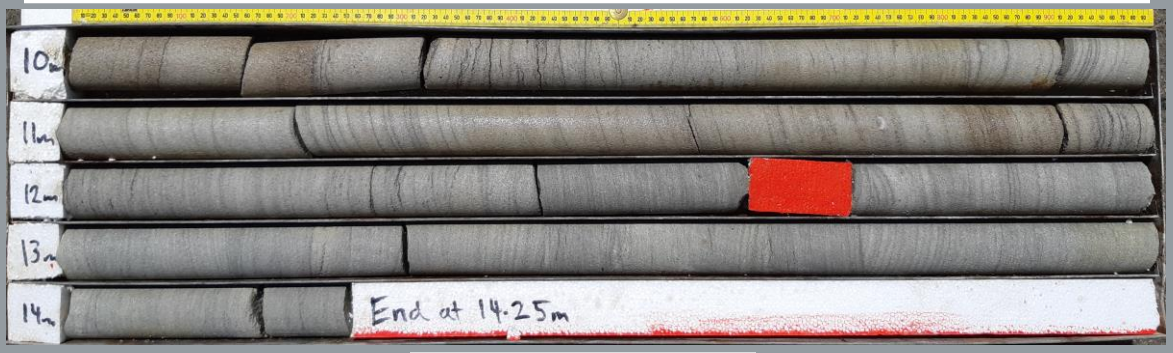
BH103 PROJECT NO. 72261.06 OCTOBER 2018

5m-10m

DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH103 **PROJECT NO. 72261.06** **OCTOBER 2018**



10m-14.25m

BORE: 103 PROJECT: TAMARAMA NOVEMBER 2018
(21 days post-drilling)

1m – 5m

BORE: 103 PROJECT: TAMARAMA NOVEMBER 2018
(21 days post-drilling)

5m – 10m

BORE: 103 PROJECT: TAMARAMA NOVEMBER 2018
(21 days post-drilling)

10m – 14.25m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Proposed Car Park, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 55.8 AHD
EASTING: 339759.3
NORTHING: 6247864.4
DIP/AZIMUTH: 90°/--

BORE No: BH104
PROJECT No: 72261.06
DATE: 18/10/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.05	ASPHALTIC CONCRETE							A			
		FILLING: dark grey, medium sand filling, with some fine to coarse sandstone and brick gravels and cobbles, damp to moist							A			
	0.8	SANDSTONE: high strength, moderately weathered, unbroken, light grey and light orange-brown, medium to coarse grained sandstone, massive, with iron staining (liesegang rings?)							A			PL(A) = 1.5
54	1								C	100	100	PL(A) = 1.1
	2											
	2.3	SANDSTONE: high strength, fresh, slightly fractured, light grey, medium to coarse grained sandstone, massive, with occasional carbonaceous flakes (Yellow block)										PL(A) = 1.9
53	3											
	3.57							3.53m: CORE LOSS: 40mm				
52	4											PL(A) = 1.5
									C	99	99	
51	5											PL(A) = 1.8
50	6											PL(A) = 1.7
	6.15	SANDSTONE: high strength, slightly fractured, light grey, medium to coarse grained sandstone with some carbonaceous flecks, thinly bedded and with occasional cross-beds and carbonaceous laminations at 0-10°						6.14m: B, 5°, un, ro, cly 2mm 6.34m: B, 5°, un, ro, cbs vn 6.39m: B, 5°, pl, ro, cly vn 6.7m: B, 0-5°, un, ro, cbs vn				
49	7											PL(A) = 2.8
									C	100	99	
48	8					19-10-18						PL(A) = 1.7
47	9							8.54m: B, 5°, pl, ro, cly vn 8.54m: J, 60°, un, ro, cln 8.54m: J, 60°, un, ti 8.7m: J, 60°, un, ro, cln				PL(A) = 1.5
46									C	100	95	

RIG: Scout 2 **DRILLER:** SS **LOGGED:** RMM **CASING:** HW to 1.0m

TYPE OF BORING: Solid flight auger (TC Bit) to 0.9m; NMLC diamond core to 14.6m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Open borehole purged of water on 18.10.2018 after completion of drilling. Groundwater measured at 8.3m on 19.10.2018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Proposed Car Park, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 55.8 AHD
EASTING: 339759.3
NORTHING: 6247864.4
DIP/AZIMUTH: 90°/--

BORE No: BH104
PROJECT No: 72261.06
DATE: 18/10/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
45	11	SANDSTONE: high strength, slightly fractured, light grey, medium to coarse grained sandstone with some carbonaceous flecks, thinly bedded and with occasional cross-beds and carbonaceous laminations at 0-10° *(continued)*							C	100	95	PL(A) = 1.5 PL(A) = 1.9
44	12	11.7m-13.97m: with some low to medium strength bands						11.7m-11.85m: B(x4), 0-5°, un, cly 2-5mm				PL(A) = 1.7
43	13							12.7m: B, 0°, un, cly 10mm 13.04m: B, 0°, un, cly 3mm 13.14m: B, 0°, un, cly 2mm	C	100	100	PL(A) = 0.38
42	14							13.92m: B, 0°, un, cly 5mm 14.04m: B, 5°, un, ro, cbs vn				PL(A) = 1.4
41	14.6	Bore discontinued at 14.6m - Target Depth Reached										
40	15											
39	16											
38	17											
37	18											
36	19											

RIG: Scout 2 **DRILLER:** SS **LOGGED:** RMM **CASING:** HW to 1.0m

TYPE OF BORING: Solid flight auger (TC Bit) to 0.9m; NMLC diamond core to 14.6m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Open borehole purged of water on 18.10.2018 after completion of drilling. Groundwater measured at 8.3m on 19.10.2018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH104 PROJECT NO. 72261.06 OCTOBER 2018

0.9m-5m

DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH104 PROJECT NO. 72261.06 OCTOBER 2018

5m-10m

DOUGLAS PARTNERS PTY LTD

20 ILLAWONG ST, TAMARAMA

BH104 **PROJECT NO. 72261.06** **OCTOBER 2018**

10m-14.6m

BORE: 104 PROJECT: TAMARAMA NOVEMBER 2018
(21 days post-drilling)

0.9m – 5m

BORE: 104 PROJECT: TAMARAMA NOVEMBER 2018
(21 days post-drilling)

5m – 10m

BORE: 104 PROJECT: TAMARAMA NOVEMBER 2018
(21 days post-drilling)

10m – 14.6m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Ground Floor Terraces, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 55.5 AHD
EASTING: 339794
NORTHING: 6247849
DIP/AZIMUTH: 90°/--

BORE No: 201
PROJECT No: 72261.06
DATE: 31/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.0	CONCRETE, grey. Below 0.38m: 22mm steel reinforcement. Below 0.56m: 2x 24mm steel reinforcement										
	0.6	FILLING: brown sand and cement filling, over medium sand filling. At 1m, sandstone boulder, high strength, slightly weathered, grey, brown and red-brown boulder										
54	1.43	CONCRETE										
	1.7	FILLING/VOID: silty and filling or void, inferred to be in a loose condition										
	2.0	MORTARED BRICKS (possible brick wall or footing)										
53	3.0	SANDSTONE: high strength, highly weathered, slightly fractured, brown, red-brown and pale grey, medium grained sandstone with some quartz clasts, thinly bedded, with occasional cross-beds						3.16m: B10-15°, fe 3.84m: B10°, fe	C	100	100	PL(A) = 1.5
52	4.26	Inferred Clayey SAND weathered seam						4.26m: B0°, Cly vn CORE LOSS: 250mm	C	14	0	
51	4.51	SANDSTONE: high strength, highly weathered, slightly fractured, brown and red-brown, medium grained sandstone, thinly bedded at 0-20°, with iron induration						4.62m: B5°, fe	C	100	100	PL(A) = 1.7
	5.2	SANDSTONE: high strength, fresh, slightly fractured, pale grey, medium grained sandstone with grey siltstone laminations dipping 0-10°						5.12m: B5°, fe	C	100	100	PL(A) = 2.2
50	5.88	Bore discontinued at 5.88m										
49												
48												

RIG: Proline **DRILLER:** Tightsite **LOGGED:** JS **CASING:** HQ to 2.5m

TYPE OF BORING: Concrete coring to 1.34m, HQ Casing advancing to 2.5m, NMLC-coring to 5.88m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Borehole grouted upon completion to 3.00m, then backfilled to surface. Note that core photography was completed 14 days following completion of drilling.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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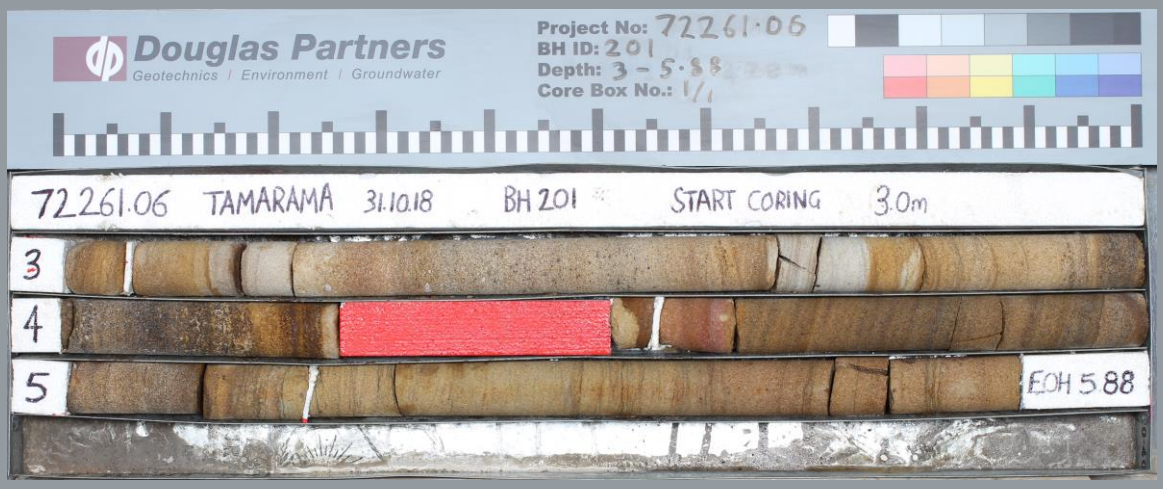
BORE: BH201 PROJECT: TAMARAMA OCTOBER 2018



3m – 5.88m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Ground Floor Terraces, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 55.5 AHD
EASTING: 339790
NORTHING: 6247846
DIP/AZIMUTH: 90°/--

BORE No: 202
PROJECT No: 72261.06
DATE: 30 - 31/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.11	TIMBER FLOORBOARD AND JOISTS CONCRETE: (no reinforcement observed)										
54	1.55	FILLING: brown, coarse gravel filling (building rubble: bricks and concrete) with medium sand										
53	2.1	MORTARED BRICKS (possible brick wall or footing)										
52	3.75								C	100	100	
51	3.95	SANDSTONE: medium then high strength, highly weathered, fractured to slightly fractured, pale grey, brown and red-brown, medium grained sandstone, beds of massive and cross-bedded sandstone dipping 0-10°, occasional carbonaceous flakes						3.75m: CORE LOSS: 200mm 3.95m: J40°, fe 4.15m: J60°, fe 4.27m: B10-15°, fe 4.51m: B20°, fe	C	79	79	PL(A) = 0.52
50	5.24	SANDSTONE: high strength, fresh, slightly fractured, pale grey, medium grained sandstone with some siltstone laminations, with occasional cross-beds dipping 0-15°						5.18m: B0°, fe 5.19m: B5°, fe	C	100	99	PL(A) = 1.7 PL(A) = 1.8 PL(A) = 2.8
49	6.25	Bore discontinued at 6.25m										

RIG: Proline **DRILLER:** Tightsite **LOGGED:** JS **CASING:** HQ to 2.3m

TYPE OF BORING: Concrete coring to 1.55m, HQ Casing advancing to 2.3m, NMLC-coring 3.37m to 6.25m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Borehole grouted upon completion to 3.95m, then backfilled to surface. Note that core photography was completed 14 days following completion of drilling.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

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Photo D1 – View of concrete cored from beneath the balcony of Unit 2 (Borehole BH202). The start / top of the core is indicated as shown.

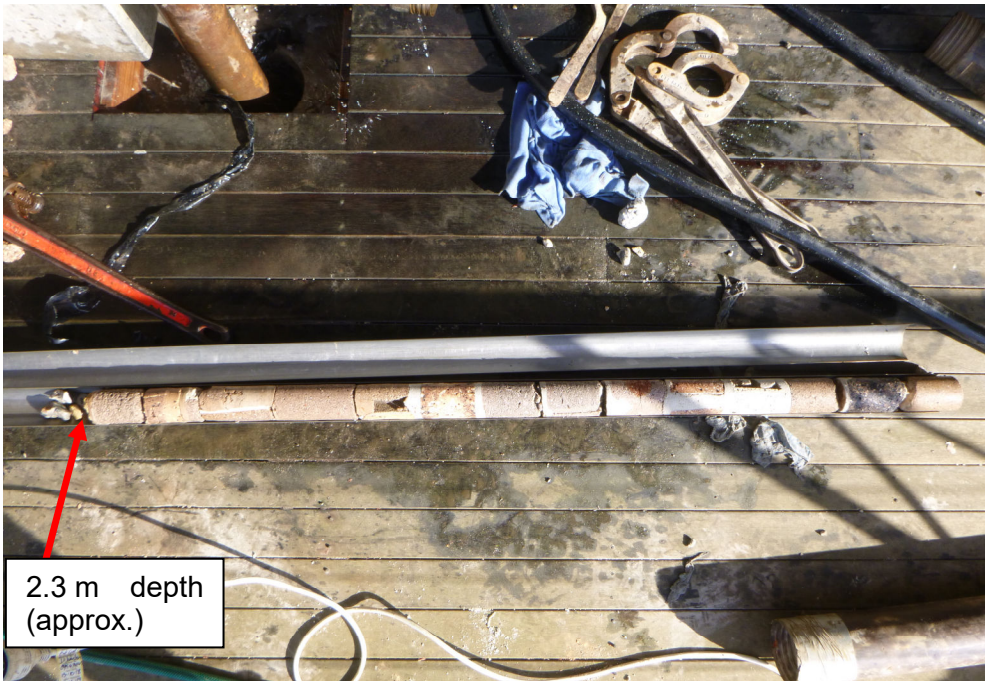

Photo D2 – View of mortared bricks within Borehole BH202. The start / top of the bricks is indicated as shown (approximate start / top depth of 2.3 m).

Douglas Partners Geotechnics / Environment / Groundwater	**Detailed Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D1 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Photo D3 – View of rubble filling removed from Borehole BH206, drilled within the balcony of Unit 6.

Douglas Partners Geotechnics / Environment / Groundwater	**Detailed Photographs** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D2 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

BORE: BH202 PROJECT: TAMARAMA OCTOBER 2018

3.37m – 6.25m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Ground Floor Terraces, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 55.5 AHD
EASTING: 339781
NORTHING: 6247841
DIP/AZIMUTH: 90°/--

BORE No: 204
PROJECT No: 72261.06
DATE: 1/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.06	TIMBER FLOORBOARDS AND JOISTS										
	0.3	CONCRETE										
	1	FILLING: brown, sand and cement filling, over brick, mortar and concrete rubble filling										
	1.2	FILLING: silty sand filling, inferred to be in a loose condition										
54	2											
	2.33	SANDSTONE: high strength, moderately weathered, slightly fractured, pale grey and brown, medium grained sandstone, massive, trace carbonaceous flakes						2.36m: B5°, fe	C	89	87	PL(A) = 1.5
53	3											
	3.3	Probable Void within CORE LOSS zone						3.3m: B0°, fe CORE LOSS: 180mm				
52	3.48	SANDSTONE: high strength, highly weathered, unbroken, pale grey and brown, medium grained sandstone, massive with iron staining (liesegang rings?)						3.48m: B0°, fe				PL(A) = 1.3
	4											
	4.15	SANDSTONE: high strength, highly weathered, unbroken, grey becoming brown, medium grained sandstone, massive, trace of quartz clasts							C	100	100	PL(A) = 1.4
51	4.74	SANDSTONE: high strength, slightly weathered, unbroken, orange brown to brown, medium grained sandstone, thinly bedded with some quartz clasts										PL(A) = 1.4
	5											PL(A) = 1.3
50	5.48	Bore discontinued at 5.48m										
	6											
49	7											
48												

RIG: Proline **DRILLER:** Tightsite **LOGGED:** JS **CASING:** HQ to 2.35m

TYPE OF BORING: Concrete coring to 0.5m, HQ Casing advancing to 2.33m, NMLC-coring to 5.48m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Borehole grouted upon completion to 2.33m, then backfilled to surface. Note that core photography was completed 14 days following completion of drilling.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: BH204 PROJECT: TAMARAMA OCTOBER 2018

2.33m – 5.48m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Ground Floor Terraces, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 55.5 AHD
EASTING: 339776
NORTHING: 6247838
DIP/AZIMUTH: 90°/--

BORE No: 205
PROJECT No: 72261.06
DATE: 29/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.02	TILES										
	0.16	CONCRETE										
	1	FILLING: brown, brick, mortar and concrete rubble filling										
54	1.3	FILLING: silty sand filling, inferred to be in a loose condition										
	2	SANDSTONE: high strength, moderately weathered, slightly fractured then unbroken, brown and pale grey, medium grained sandstone, massive							C	100	100	
53								2.79m: B5-10°, fe	C	100	95	PL(A) = 1.3
	3											
52		Below 3.64m, orange-brown and grey, highly weathered, with bands of iron induration, thinly to medium bedded, becoming thinly bedded below 4.5m						3.61m: B5°, fe 3.62m: B5-10°, cly 15mm 3.64-3.69m: Ds, 50mm 3.69m: B5°, fe, cly vn				PL(A) = 1.2
	4											
51									C	100	100	PL(A) = 2
	5	Below 5.05m: with some quartz clasts										PL(A) = 1.1
	5.21	Bore discontinued at 5.21m										
50	6											
49	7											
48												

RIG: Proline **DRILLER:** Tightsite **LOGGED:** JS **CASING:** HQ to 2.0m

TYPE OF BORING: Concrete coring to 0.25m, HQ Casing advancing to 2.0m, NMLC-coring to 5.21m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Borehole grouted upon completion to 2.00m, then backfilled to surface. Note that core photography was completed 14 days following completion of drilling.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: BH205 PROJECT: TAMARAMA OCTOBER 2018

2.00m – 5.21m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Ground Floor Terraces, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 55.5 AHD
EASTING: 339771
NORTHING: 6247835
DIP/AZIMUTH: 90°/--

BORE No: 206
PROJECT No: 72261.06
DATE: 30/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.02	TILES										
	0.06	CONCRETE										
		FILLING: brown, brick, mortar and concrete rubble filling, with some fine to medium sand										
	1											
54	1.3	FILLING: silty sand filling, inferred to be in a loose condition										
	1.62	SANDSTONE: high strength, slightly weathered then fresh, unbroken, pale grey, medium grained sandstone, massive, with occasional carbonaceous flakes							C	100	100	PL(A) = 0.75
	2											
53												PL(A) = 0.56
	3											
52	3.56							3.56m: B0°, fe CORE LOSS: 70mm				
	3.63	Probable Void within CORE LOSS zone						3.63m: B5°, fe	C	95	92	PL(A) = 1
		SANDSTONE: high strength, moderately and highly weathered then slightly weathered, slightly fractured to unbroken, brown and pale grey, medium grained sandstone, massive, with some heavily iron stained bands between 4.7m-5.9m										PL(A) = 2.4
	4											
51												
	5								C	100	96	PL(A) = 1.3
50												
	6							5.8m: B5°, fe 5.85m: B20°, fe				
	6.0	Bore discontinued at 6.0m										
49												
	7											
48												

RIG: Proline **DRILLER:** Tightsite **LOGGED:** JS **CASING:** HQ to 1.62m

TYPE OF BORING: Hand auger to 0.7m, DCP 0.15-0.6m, HQ Casing advancing to 1.62m, NMLC-coring to 6.00m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Borehole grouted upon completion, then backfilled to surface. Note that core photography was completed 14 days following completion of drilling.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: BH206 PROJECT: TAMARAMA OCTOBER 2018

1.62m – 6.00m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Ground Floor Terraces, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 55.3 AHD
EASTING: 339760
NORTHING: 6247826
DIP/AZIMUTH: 90°/--

BORE No: 208
PROJECT No: 72261.06
DATE: 29/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.06	TIMBER FLOORBOARDS AND JOISTS							A			
	0.2	CONCRETE										
		FILLING: brown and grey, fine to medium sand filling with concrete rubble, sandstone cobbles and gravel, humid										
54	1.3	FILLING: dark brown, silty medium sand filling, moist, generally in a medium dense condition										
	1.57	SANDSTONE: low then medium strength, slightly weathered then fresh, unbroken, brown then pale grey, medium grained sandstone, massive							A			PL(A) = 0.22
53		2.3m: trace carbonaceous flakes							C	100	100	PL(A) = 0.52
52								>>	C	100	100	PL(A) = 0.77
51		At 4.0m: becoming high strength										
50								5.15m: B10°, cly co 2mm	C	100	100	PL(A) = 1.6
	5.75	Bore discontinued at 5.75m										PL(A) = 0.79
49												
48												

RIG: Proline **DRILLER:** Tightsite **LOGGED:** JS **CASING:** HQ to 1.57m

TYPE OF BORING: DCP 0.15-0.4m, Hand auger to 1.57m, NMLC-coring to 5.75m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Borehole grouted upon completion to 1.50m, then backfilled to surface. Note that core photography was completed 14 days following completion of drilling.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

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BORE: BH208 PROJECT: TAMARAMA OCTOBER 2018

1.57m – 5.76m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Alterations and Additions
LOCATION: Ground Floor Terraces, 20 Illawong Avenue, TAMARAMA

SURFACE LEVEL: 55.5 AHD
EASTING: 339740
NORTHING: 6247817
DIP/AZIMUTH: 90°/--

BORE No: 210
PROJECT No: 72261.06
DATE: 2/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.07	PAVERS										
	0.13	FILLING: yellow-brown, medium sand filling, damp							A			Fibre cement
	0.24	CONCRETE										
		FILLING: grey and brown, medium sand filling with some concrete and brick rubble and a trace of glass and fibre cement sheeting (possible ACM)										
54	1											
	2											
	2.1	SANDSTONE: medium then high strength, slightly weathered then fresh, slightly fractured, pale grey, medium grained sandstone, massive						2.18m: B5°, cly vn 2.41-4.20m: J80-90°, fe, un, roots in joint	C	100	94	PL(A) = 0.37
53	3											
52	4											
		Below 4.15m: with a trace of siltstone flakes and quartz clasts						4.3m: B10-15°, cly co 10mm	C	100	100	PL(A) = 1.2
51	5											
	5.06	Bore discontinued at 5.06m										
50	6											
49	7											
48												

RIG: Proline **DRILLER:** Tightsite **LOGGED:** JS **CASING:** HQ to 2.1m

TYPE OF BORING: DCP 0.6-1.2m, Hand auger to 1.3m, HQ Casing advancing to 2.1m, NMLC-coring to 5.06m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Borehole grouted upon completion to 2.10m, then backfilled to surface. Note that core photography was completed 14 days following completion of drilling.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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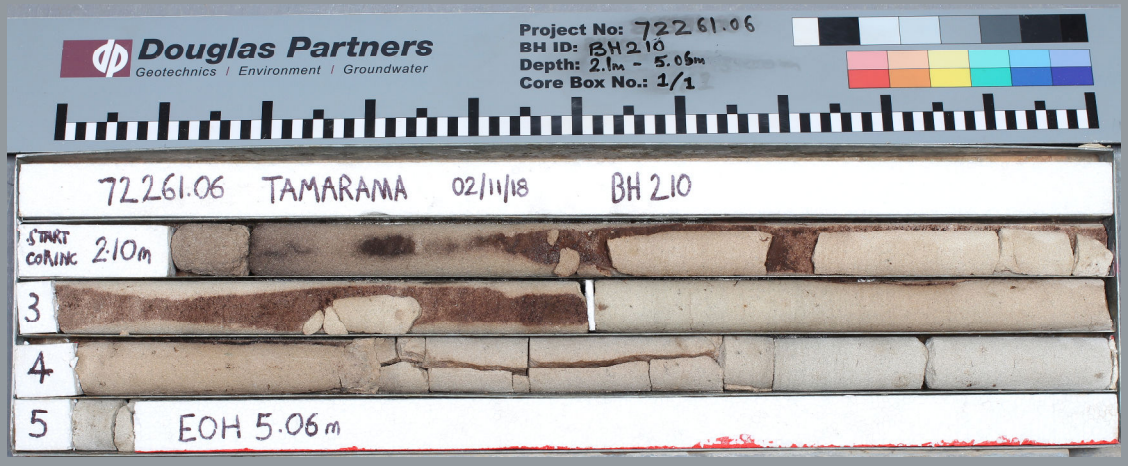
BORE: BH210 PROJECT: TAMARAMA NOVEMBER 2018



2.10m – 5.06m

Douglas Partners
Geotechnics / Environment / Groundwater

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Results of Dynamic Penetrometer Tests

Client Strata Plan SP1731 | Project No. 72261.06

Project Alterations and Additions | Date 21/11/2018

Location 20 Illawong Avenue, Tamarama | Page No. 1 of 1

TEST LOCATION	BH206	BH208	BH210								
RL (m)	55.5	55.3	55.5								
Depth (m)	**Penetration Resistance** Blows/150 mm										
0 - 0.15	E	E	E								
0.15 - 0.30	5	8	E								
0.30 - 0.45	8	30/100	E								
0.45 - 0.60	15	End	E								
0.60 - 0.75	B		1								
0.75 - 0.90			2								
0.90 - 1.05			1								
1.05 - 1.20			1								
1.20 - 1.35			End								
1.35 - 1.50											
1.50 - 1.65											
1.65 - 1.80											
1.80 - 1.95											
1.95 - 2.10											
2.10 - 2.25											
2.25 - 2.40											
2.40 - 2.55											
2.55 - 2.70											
2.70 - 2.85											
2.85 - 3.00											
3.00 - 3.15											
3.15 - 3.30											
3.30 - 3.45											
3.45 - 3.60											

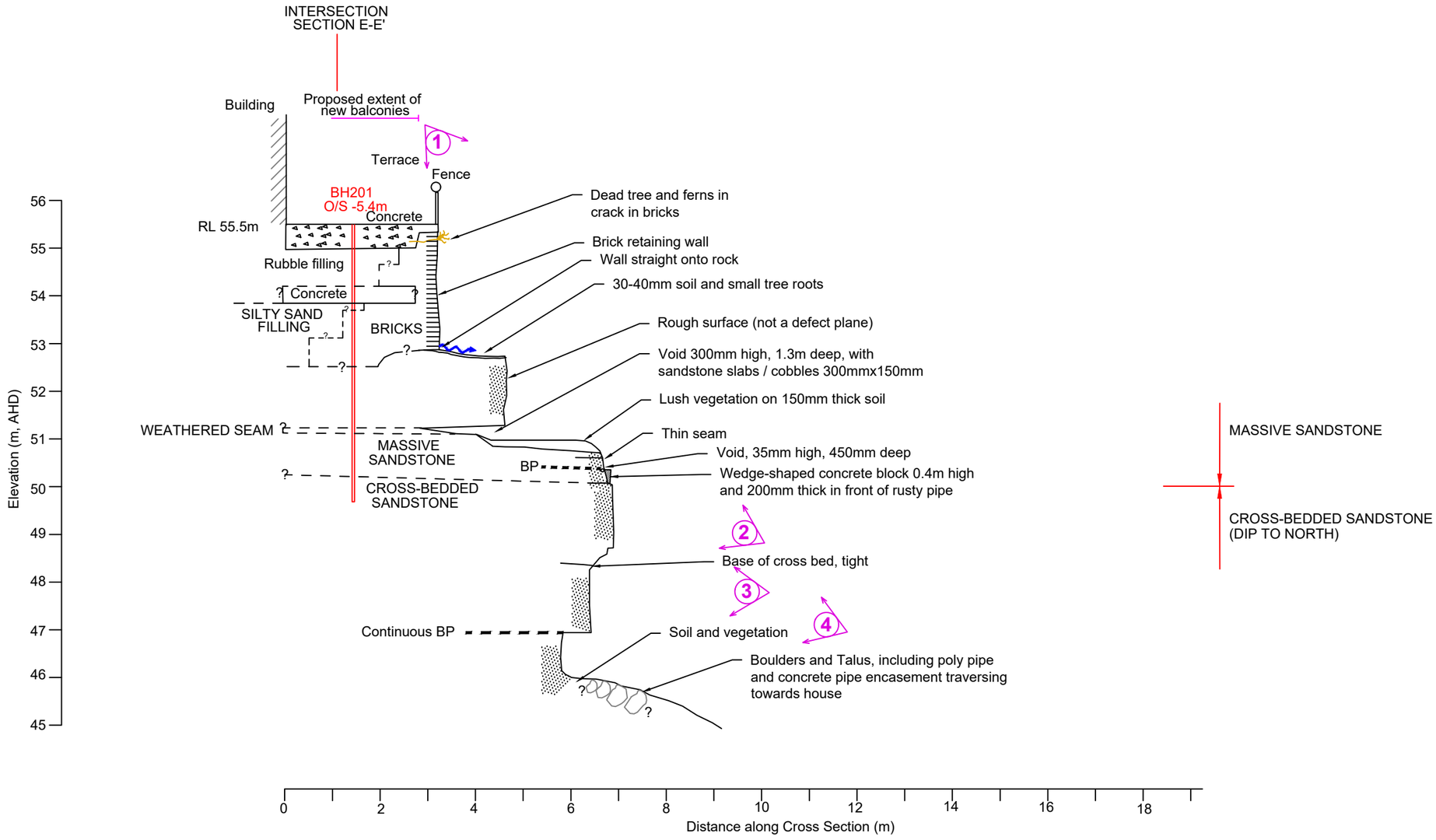
Test Method AS 1289.6.3.2, Cone Penetrometer ☑ | **Tested By** JS

AS 1289.6.3.3, Flat End Penetrometer | **Checked By** HDS

Remarks E denotes this layer was Excavated

B denotes the DCP was bouncing, and the test terminated

30 / 100 denotes 30 blows for 100 mm of penetration



LEGEND

- Seepage
- BP Bedding parting defect
- 1 Photo number with direction of view
- Sandstone outcrop
- B Boulder
- —?—?— Interpreted geotechnical boundary

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Strata Plan SP1731	TITLE: **Cliff Geological Mapping Traverse 101** **Alterations and Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.06
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: Trav 101
	SCALE: 1:100 @ A3 / DATE: 1.11.2018		REVISION: 0

Mapping Traverse 101, Photo 1 – View south-east from Unit 1 (ground floor), down towards No. 14 Illawong Avenue below. The upper part of the mapping traverse is in the foreground.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 101** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D3 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 101, Photo 2 – View of mid-portion of slope along mapping traverse 101. A wedge-shaped concrete block and rusty pipe noted on the mapping section are indicated as shown.

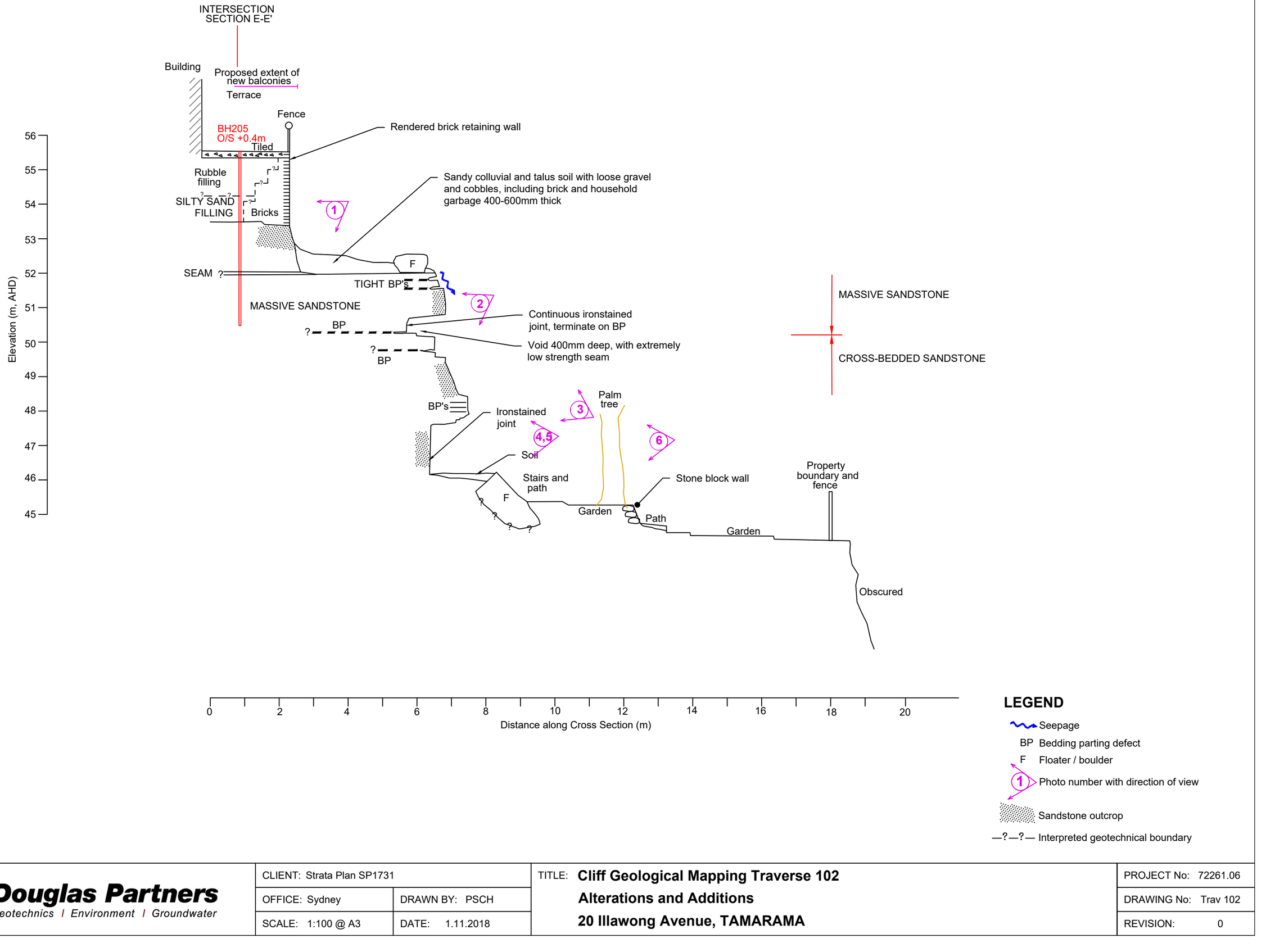
Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 101** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D4 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 101, Photo 3 – View of lower portion of slope along mapping traverse 101. High strength cross-bedded sandstone exposed, and with an overhang formed above a bedding parting defect which extends more than 10 m to either side of the section line.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 101** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D5 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 101, Photo 4 – View north-west towards Unit 1 from the base of the cliff, at cliff mapping traverse 101.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 101** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D6 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018



LEGEND

- Seepage
- BP Bedding parting defect
- F Floater / boulder
- Photo number with direction of view
- Sandstone outcrop
- Interpreted geotechnical boundary

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Strata Plan SP1731	TITLE: **Cliff Geological Mapping Traverse 102 Alterations and Additions 20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.06
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: Trav 102
	SCALE: 1:100 @ A3 / DATE: 1.11.2018		REVISION: 0

Mapping Traverse 102, Photo 1 – View of interface between rendered brick retaining wall and the underlying sandstone at mapping traverse 102, showing a thin layer of “levelling” concrete on top of the sandstone.

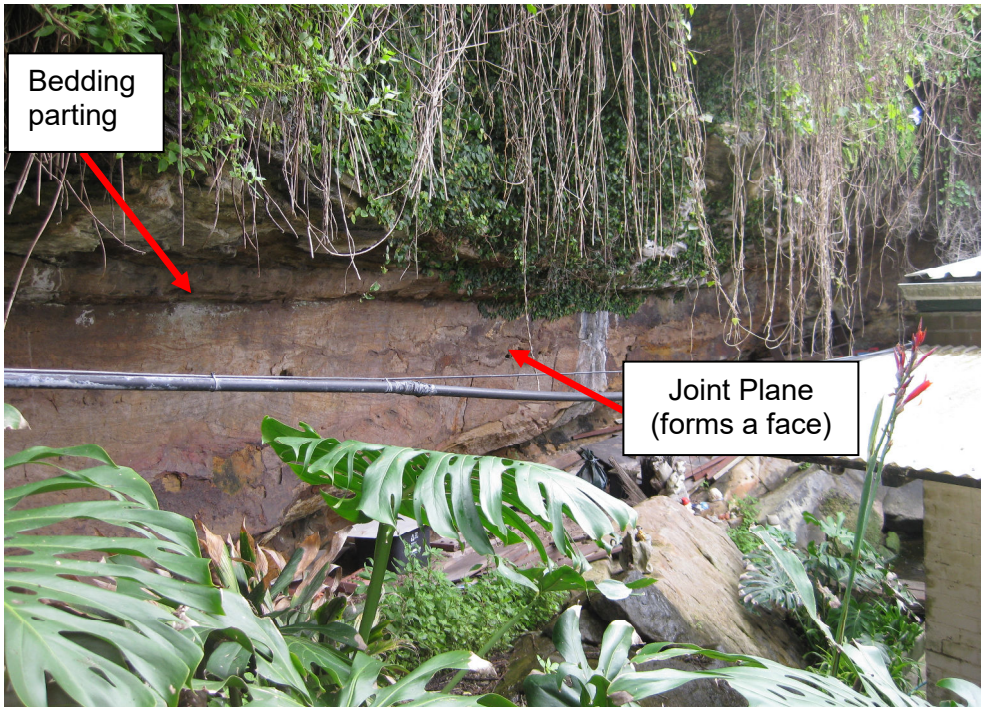
Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 102** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D7 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 102, Photo 2 – View of a continuous bedding parting defect and overhang (cave) at mapping traverse 102, with a sub-vertical, iron-stained joint plane forming the rear of the 'cave'.

Mapping Traverse 102, Photo 3 – View of overhang at RL51 m on mapping traverse 102, with a bed of massive sandstone above and cross-bedded sandstone below. Cave location is indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 102** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D8 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 102, Photo 4 – View of overhang in cross-bedded sandstone (RL47.5 m) at mapping traverse 102, with a sub-vertical, iron-stained joint plane forming the rear of the overhang.

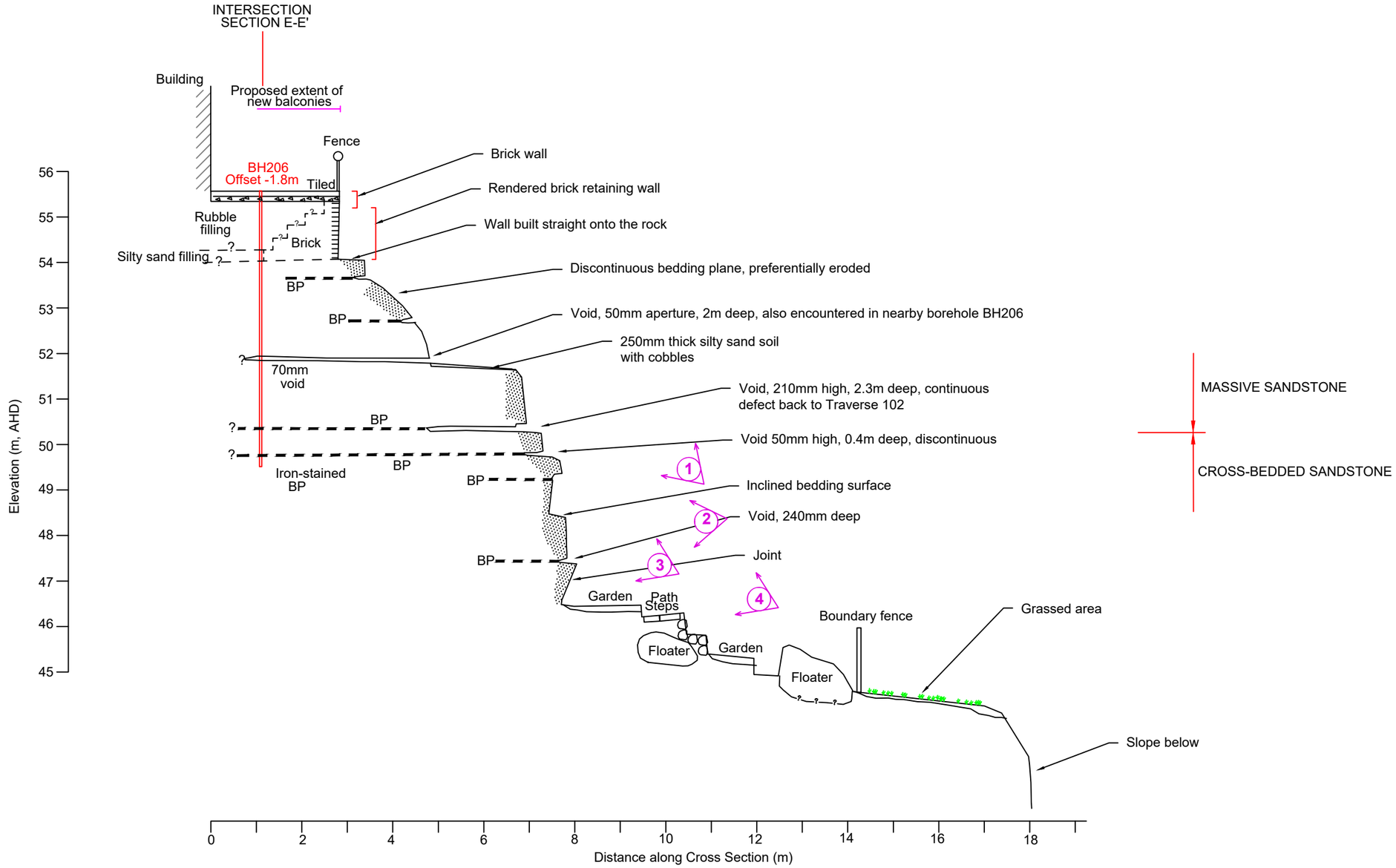


Mapping Traverse 102, Photo 5 – View of overhang in cross-bedded sandstone to the north of traverse 102. Continuous bedding plane and undulating joint plane indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 102** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D9 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 102, Photo 6 – View of lower part of slope along mapping traverse 102. High strength cross-bedded sandstone exposed, and with an overhang formed above a bedding parting defect which extends more than 10 m to either side of the section line.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 102** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D10 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018



LEGEND

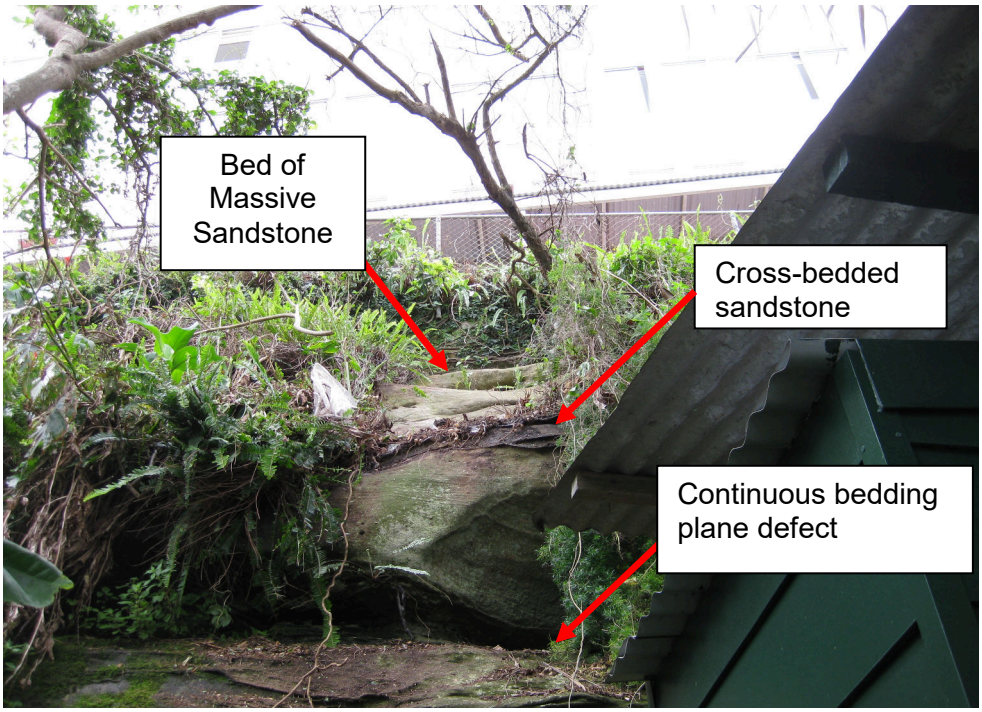
BP Bedding parting defect

1 Photo number with direction of view

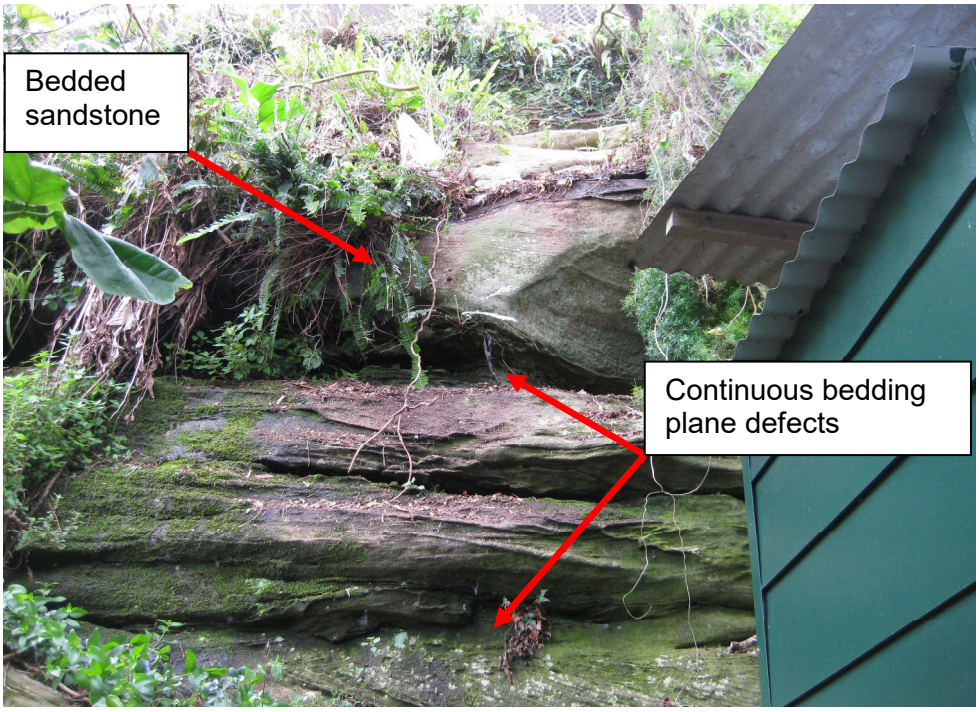
Sandstone outcrop

—?—?— Interpreted geotechnical boundary

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Strata Plan SP1731	TITLE: **Cliff Geological Mapping Traverse 103** **Alterations and Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.06
	OFFICE: Sydney DRAWN BY: PSCH		DRAWING No: Trav 103
	SCALE: 1:100 @ A3 DATE: 1.11.2018		REVISION: 0



Mapping Traverse 103, Photo 1 – View of upper part of mapping traverse 103 from below, with a bed of massive sandstone forming the upper part of the cliff, over cross-bedded sandstone, as shown.



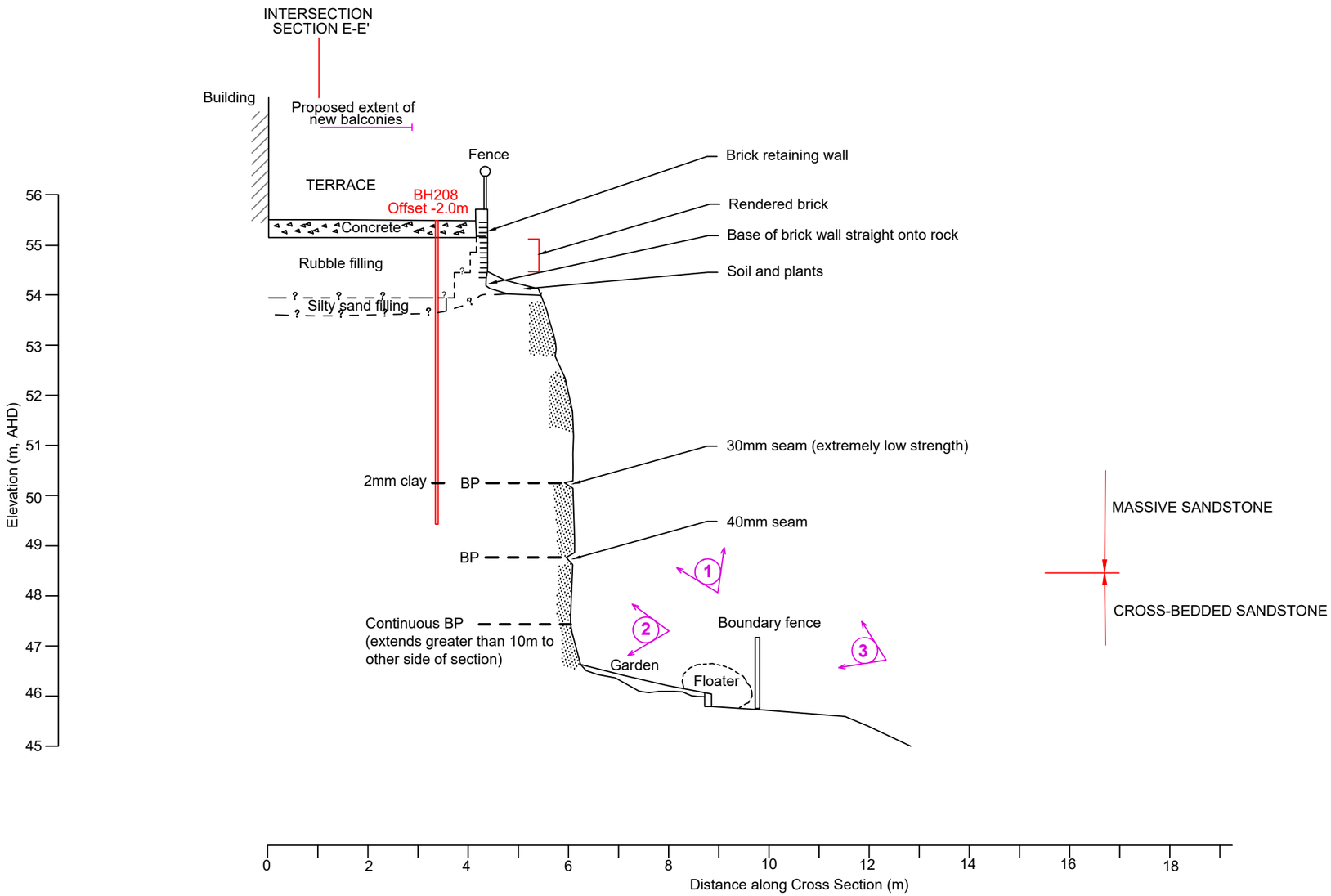
Mapping Traverse 103, Photo 2 – View of cross-bedded sandstone at mapping traverse 103..

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 103** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D11 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 103, Photo 3 – Oblique view of mapping traverse 103 from below, with cross--bedded sandstone exposed, as shown.

Mapping Traverse 103, Photo 4 – View of lower part of cliff at traverse 103.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 103** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D12 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018



LEGEND

- Seepage
- BP Bedding parting defect
- Photo number with direction of view
- Sandstone outcrop
- Interpreted geotechnical boundary

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Strata Plan SP1731	TITLE: **Cliff Geological Mapping Traverse 104** **Alterations and Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.06
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: Trav 104
	SCALE: 1:100 @ A3 / DATE: 1.11.2018		REVISION: 0

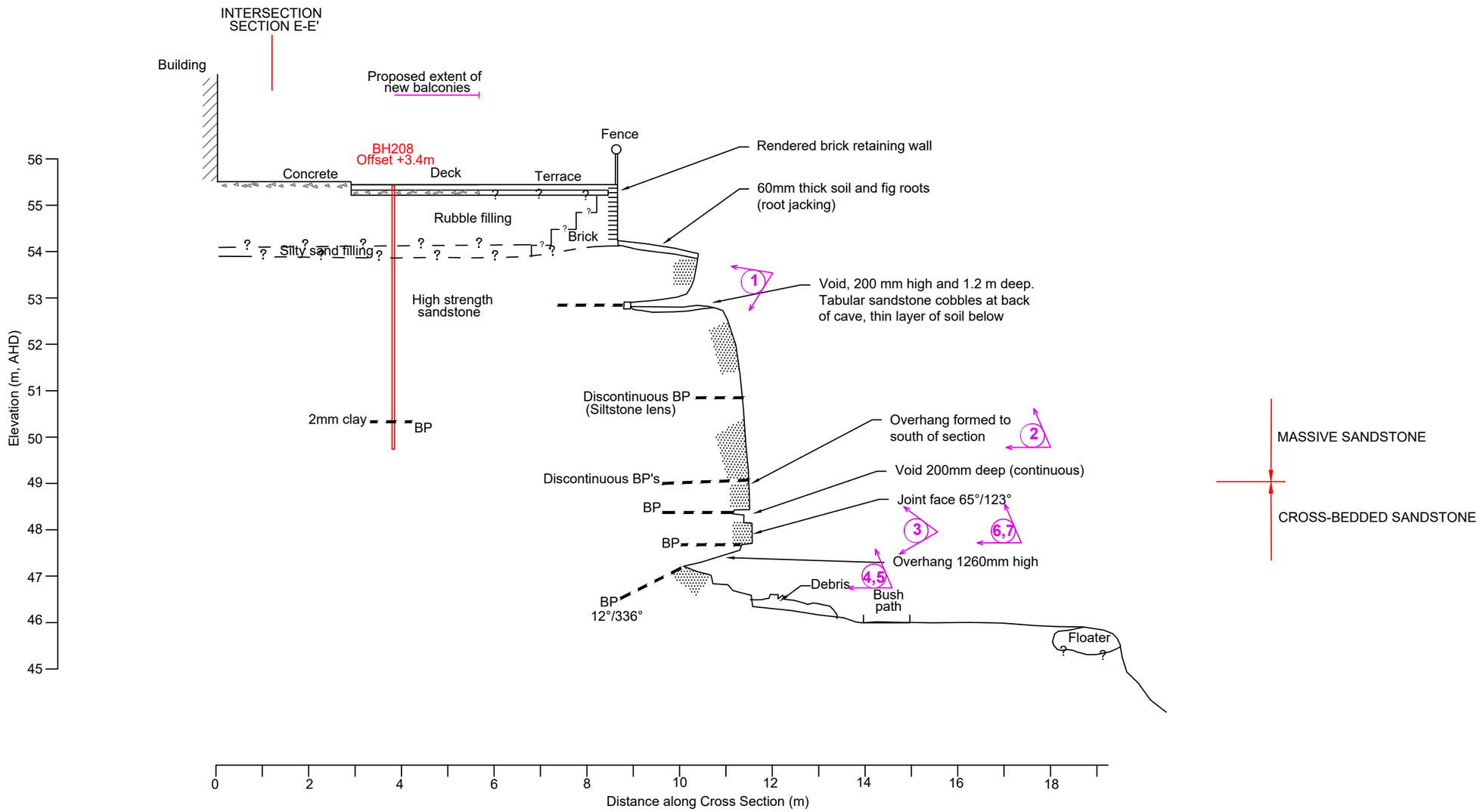
Mapping Traverse 104, Photo 1 – View towards the existing unit building at mapping traverse 104. Solid sandstone exposed for most of the lower part of the slope.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 104** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D13 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 104, Photo 2 – View of the lower part of the traverse, exposing thin, continuous seams / bedding partings, which are indicated as shown.

Mapping Traverse 104, Photo 3 – View north of mapping traverse 104. Continuous bedding planes within cross-bedded sandstone are indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 104** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D14 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018



LEGEND

- Seepage
- BP Bedding parting defect
- 12°/336° Dip/ Dip direction relative to magnetic north
- 1 Photo number with direction of view
- Sandstone outcrop
- —?—?— Interpreted geotechnical boundary

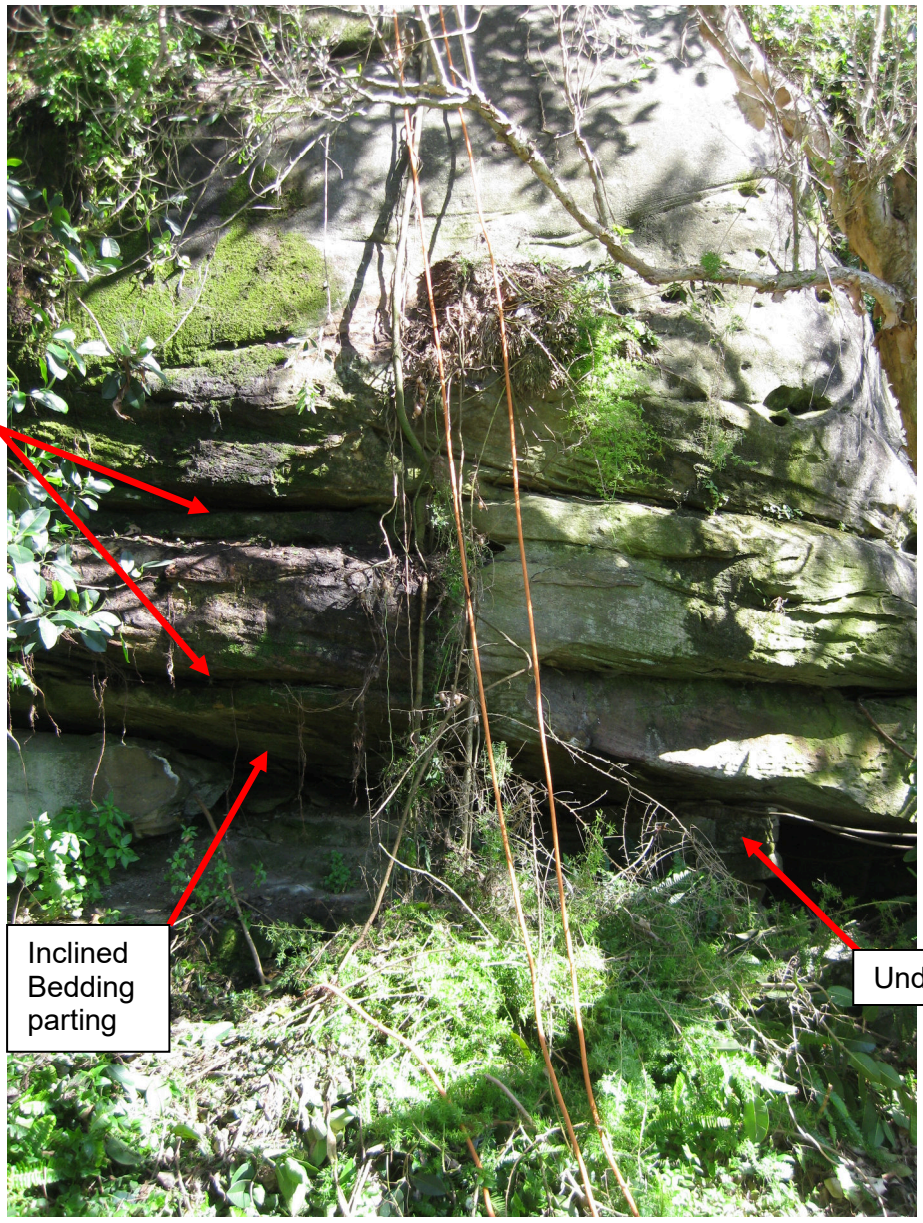
Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Strata Plan SP1731	TITLE: **Cliff Geological Mapping Traverse 105** **Alterations and Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.06
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: Trav 105
	SCALE: 1:100 @ A3 / DATE: 1.11.2018		REVISION: 0

Mapping Traverse 105, Photo 1 – View within a cave formed below a bed of massive sandstone, along a bedding parting defect. Depth of cave from front face is 1.2 m, with sandy colluvium on floor of cave.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 105** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D15 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 105, Photo 2 – View towards the existing unit building at mapping traverse 105. Interbedded massive and laminated sandstone exposed for most of the lower part of the slope, with some discontinuous siltstone lenses and discontinuous bedding parting defects.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 105** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D16 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018



Mapping Traverse 105, Photo 3 – View towards the existing unit building at mapping traverse 105. Overhang and cave formed within cross-bedded sandstone at toe of slope. Sub-horizontal and inclined bedding partings, and a mortared brick underpinning column observed within cave, indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 105** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D17 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 105, Photo 4 – View towards traverse 104 from traverse 105. Overhang and cave formed within cross-bedded sandstone at toe of slope. Mortared brick underpinning observed within cave, indicated as shown.

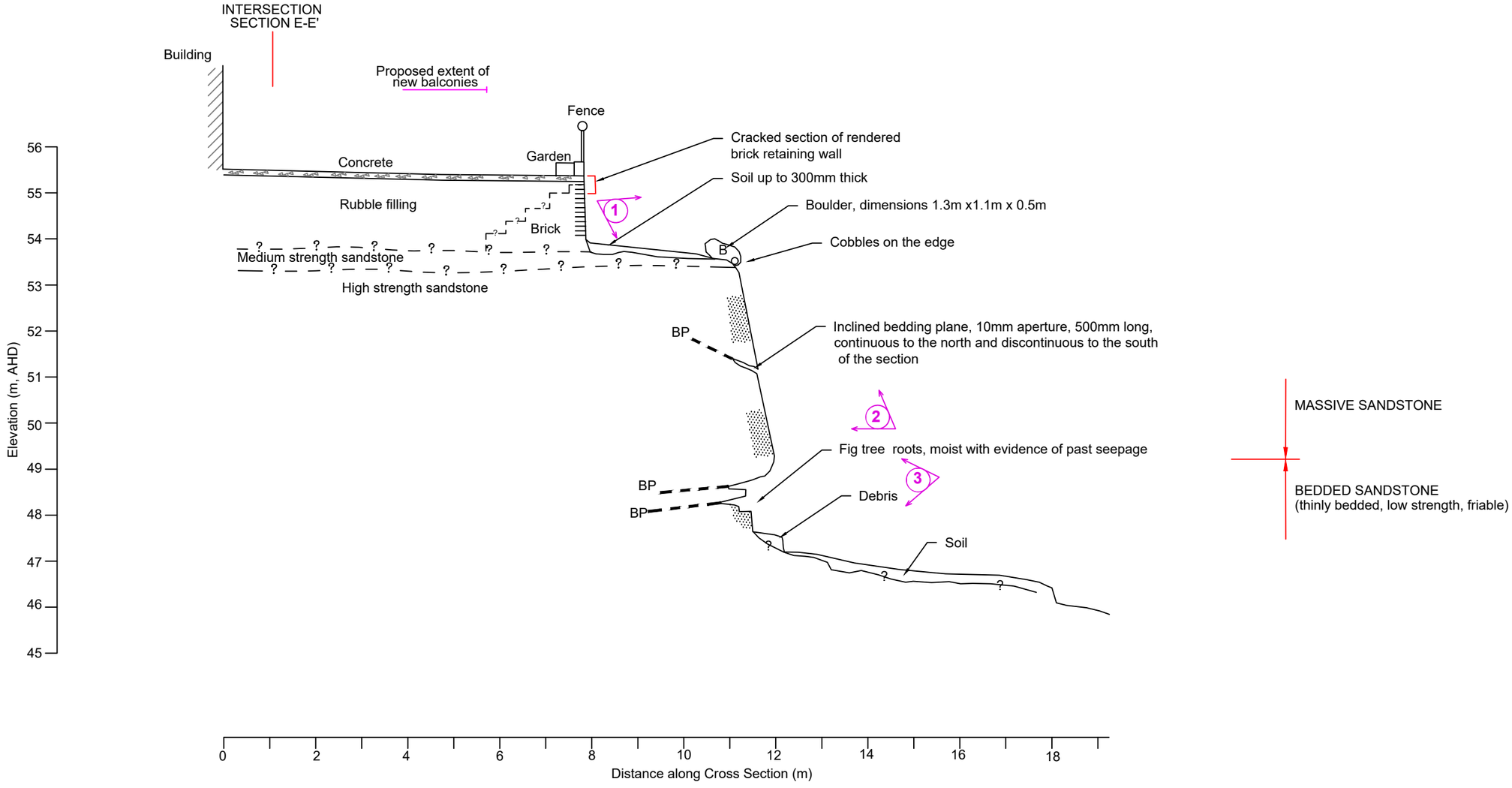
Mapping Traverse 105, Photo 5 – View towards mapping traverse 106 from traverse 105. Tabular boulder on sub-horizontal bedding plane within cave, with debris and colluvium forming a bush path indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 105** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D18 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 105, Photo 6 – Side view of mapping traverse 105 (indicated). Persistent sub-vertical joint, forming a face, is indicated as shown.

Mapping Traverse 105, Photo 7 – View towards mapping traverse 105. Continuous bedding partings within cross-bedded sandstone are indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 105** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D19 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018



LEGEND

- B Detached boulder
- BP Bedding parting defect
- 1 Photo number with direction of view
- Sandstone outcrop
- —?—?— Interpreted geotechnical boundary

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Strata Plan SP1731	TITLE: **Cliff Geological Mapping Traverse 106** **Alterations and Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.06
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: Trav 106
	SCALE: 1:100 @ A3 / DATE: 1.11.2018		REVISION: 0

Mapping Traverse 106, Photo 1 – View downslope from the crest of mapping traverse 106, showing some boulders at the slope crest, indicated as shown.

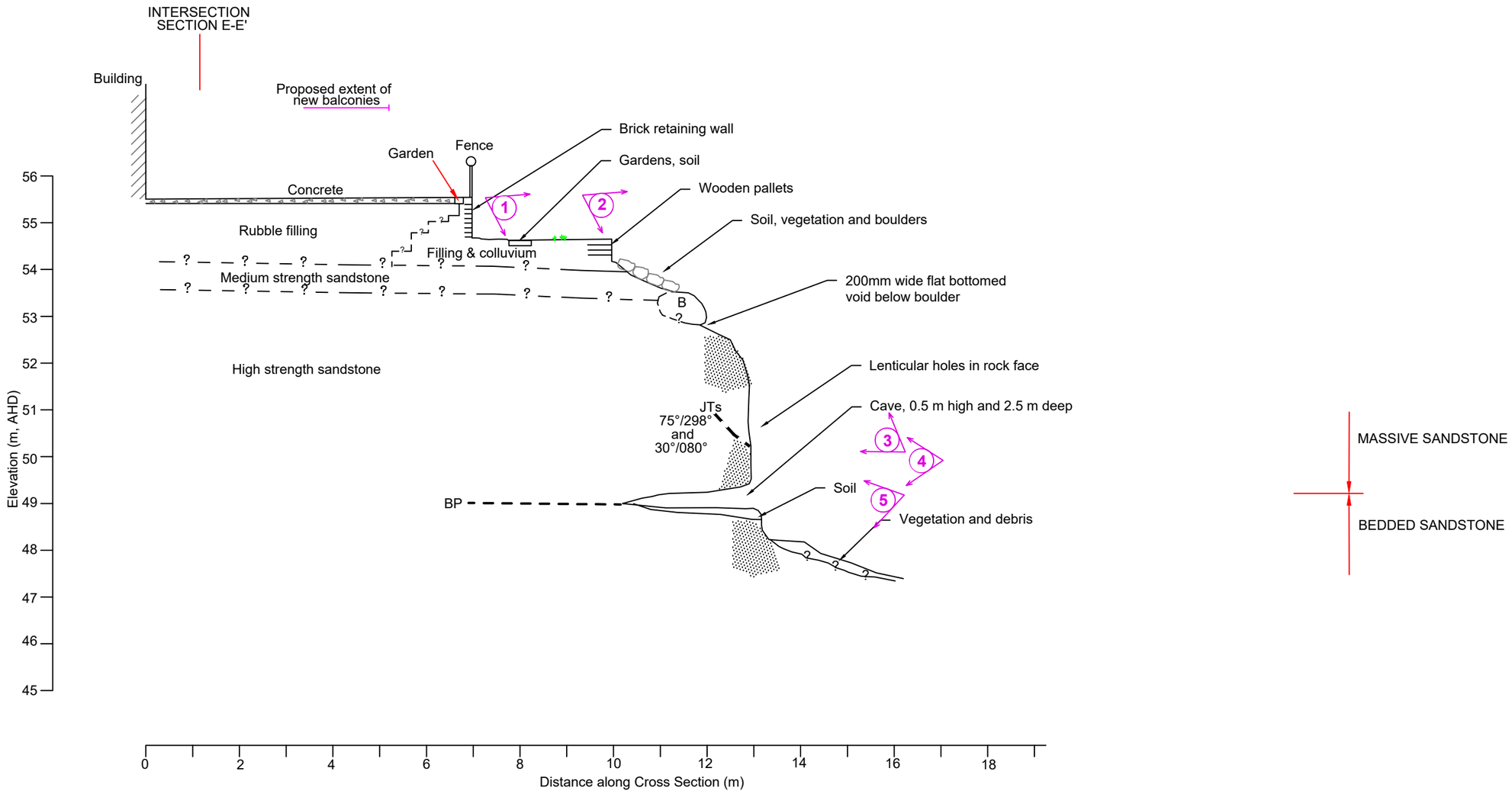
Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 106** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D20 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 106, Photo 2 – View upslope at mapping traverse 106, with a weathered, inclined and discontinuous bedding parting defect indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 106** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D21 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 106, Photo 3 – View of base of cliff at mapping traverse 106. Fig tree roots and evidence of past seepage were observed within small caves and overhangs formed in cross-bedded sandstone.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 106** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D22 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018



MASSIVE SANDSTONE

BEDDED SANDSTONE

LEGEND

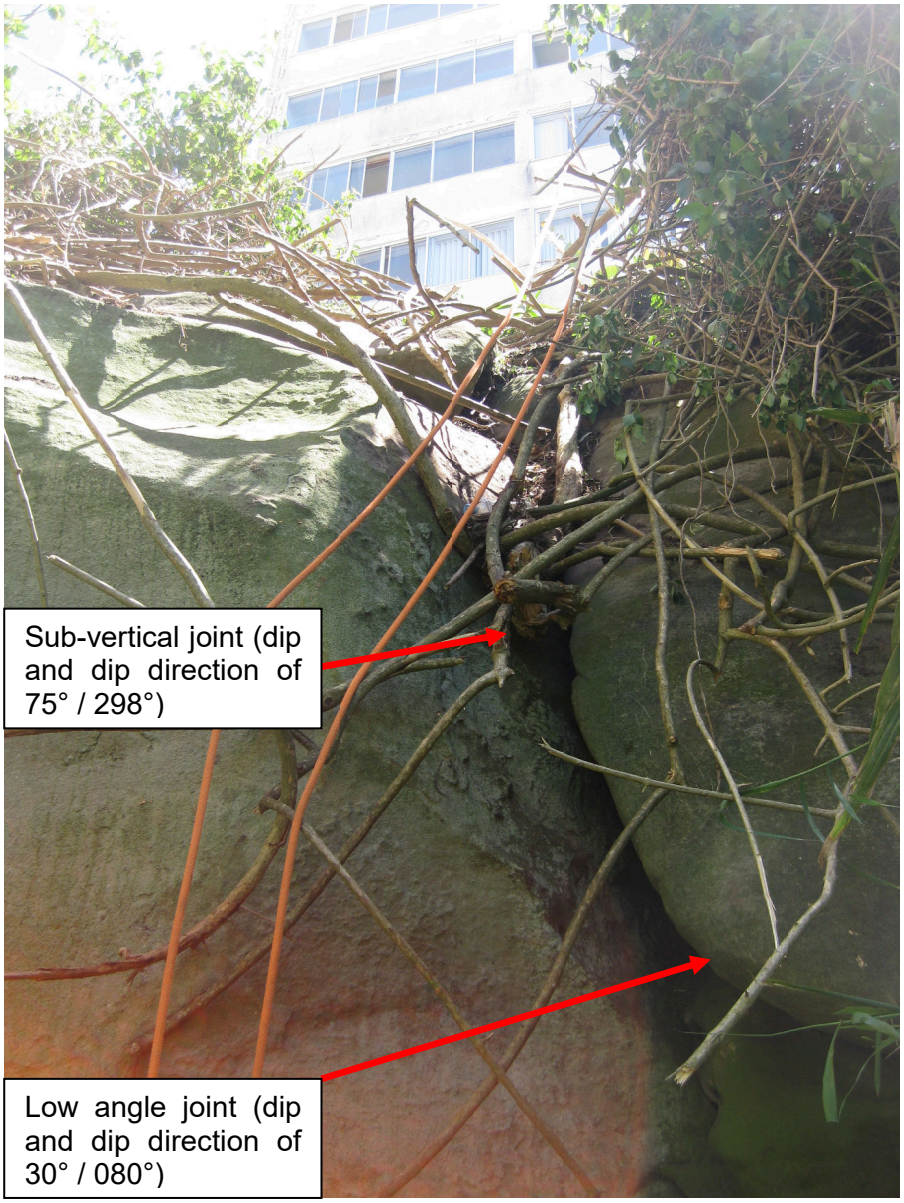
B	Detached boulder
JT	Joint defect
75°/298°	Measured Dip and Dip direction relative to magnetic north
	Sandstone outcrop
1	Photo number with direction of view
—?—?—	Interpreted geotechnical boundary

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Strata Plan SP1731	TITLE: **Cliff Geological Mapping Traverse 107** **Alterations and Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.06
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: Trav 107
	SCALE: 1:100 @ A3 / DATE: 1.11.2018		REVISION: 0

Mapping Traverse 107, Photo 1 – View south-west along crest of slope near the start of mapping traverse 107, showing an informal garden area.

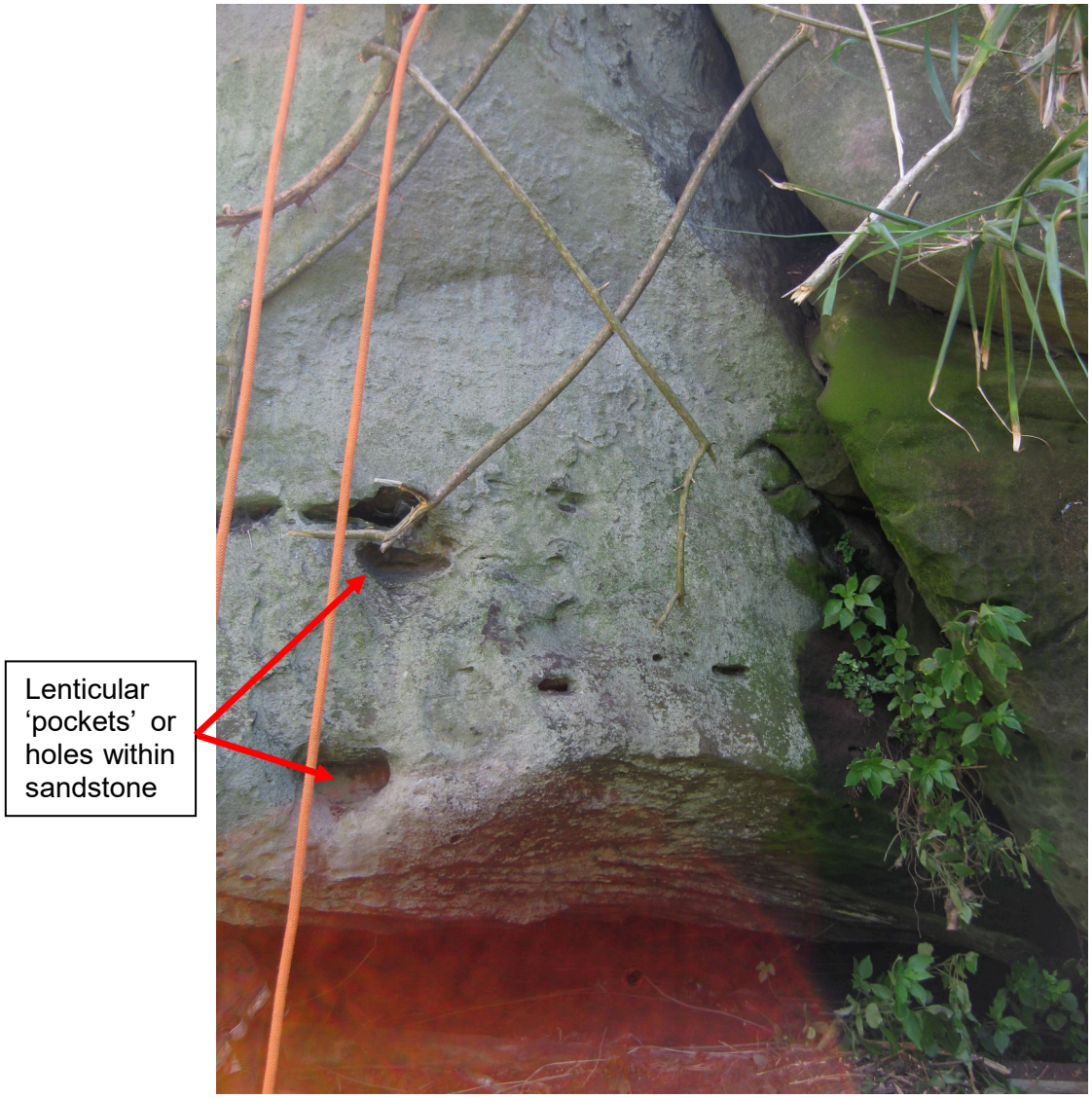
Mapping Traverse 107, Photo 2 – View down slope at the crest of traverse 107, with boulders and other debris on the slope surface.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 107** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D23 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018



Mapping Traverse 107, Photo 3 – View upslope from base of traverse 107, of sub-vertical and inclined joints within a bed of massive sandstone. The joints and their orientations are indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 107** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D24 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

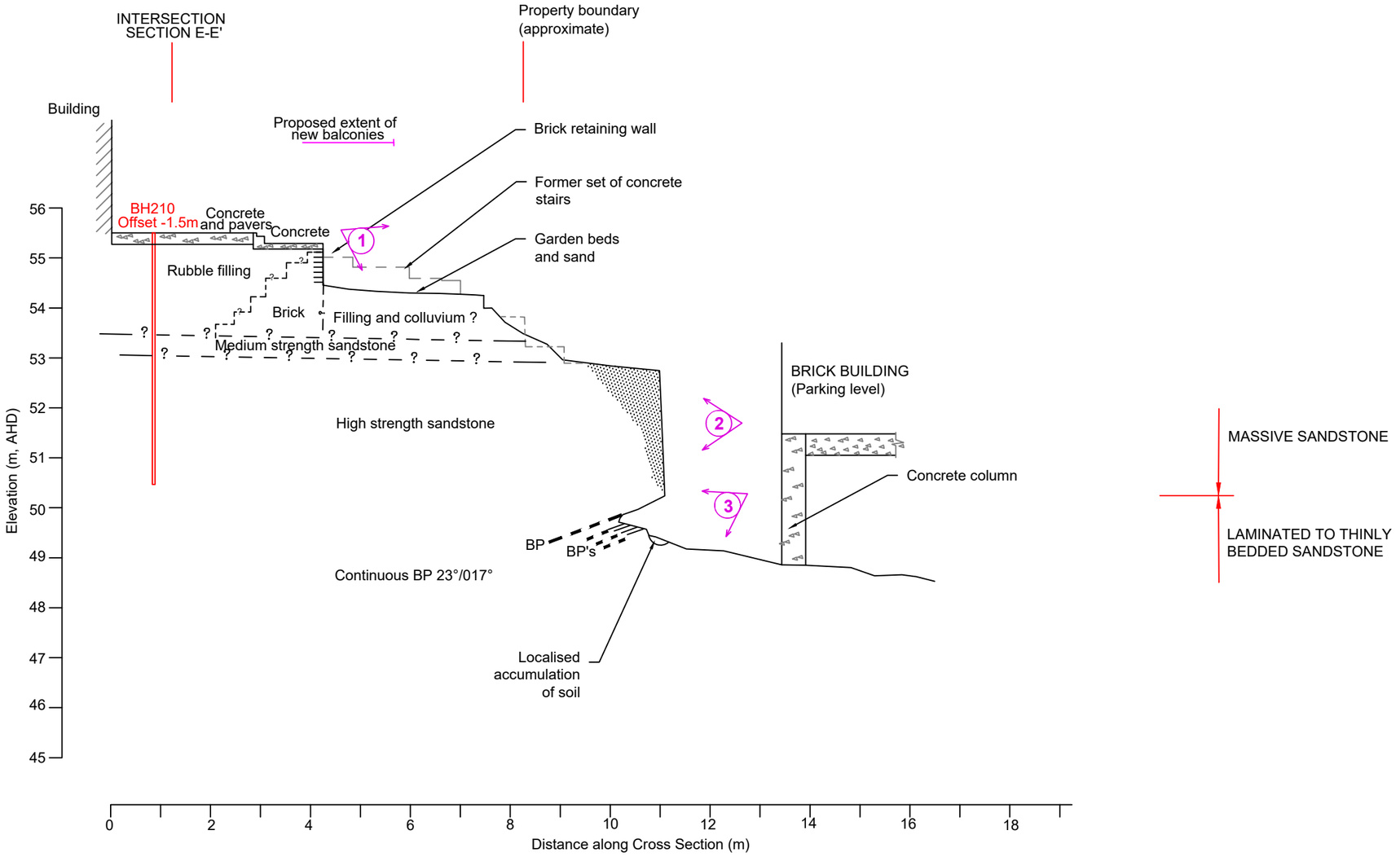


Mapping Traverse 107, Photo 4 – View of lower part of slope along mapping traverse 107, below Photo 3. Lenticular 'pockets' or holes are present in the sandstone, indicated as shown..

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 107** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D25 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 107, Photo 5 – View of overhang and cave within cross-bedded sandstone, 0.5 m high and 2.5 m deep, developed on continuous bedding parting.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 107** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D26 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018



MASSIVE SANDSTONE

LAMINATED TO THINLY
BEDDED SANDSTONE

LEGEND

BP	Bedding parting defect
23°/017°	Measured Dip and Dip direction relative to magnetic north
	Sandstone outcrop
1	Photo number with direction of view
—?—?—	Interpreted geotechnical boundary

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Strata Plan SP1731		TITLE: **Cliff Geological Mapping Traverse 108**	PROJECT No: 72261.06
OFFICE: Sydney	DRAWN BY: PSCH	**Alterations and Additions**	DRAWING No: Trav 108
SCALE: 1:100 @ A3	DATE: 1.11.2018	**20 Illawong Avenue, TAMARAMA**	REVISION: 0

Mapping Traverse 108, Photo 1 – View south-west along crest of slope near the start of mapping traverse 108, showing a former set of concrete stairs leading towards the crest of the slope.

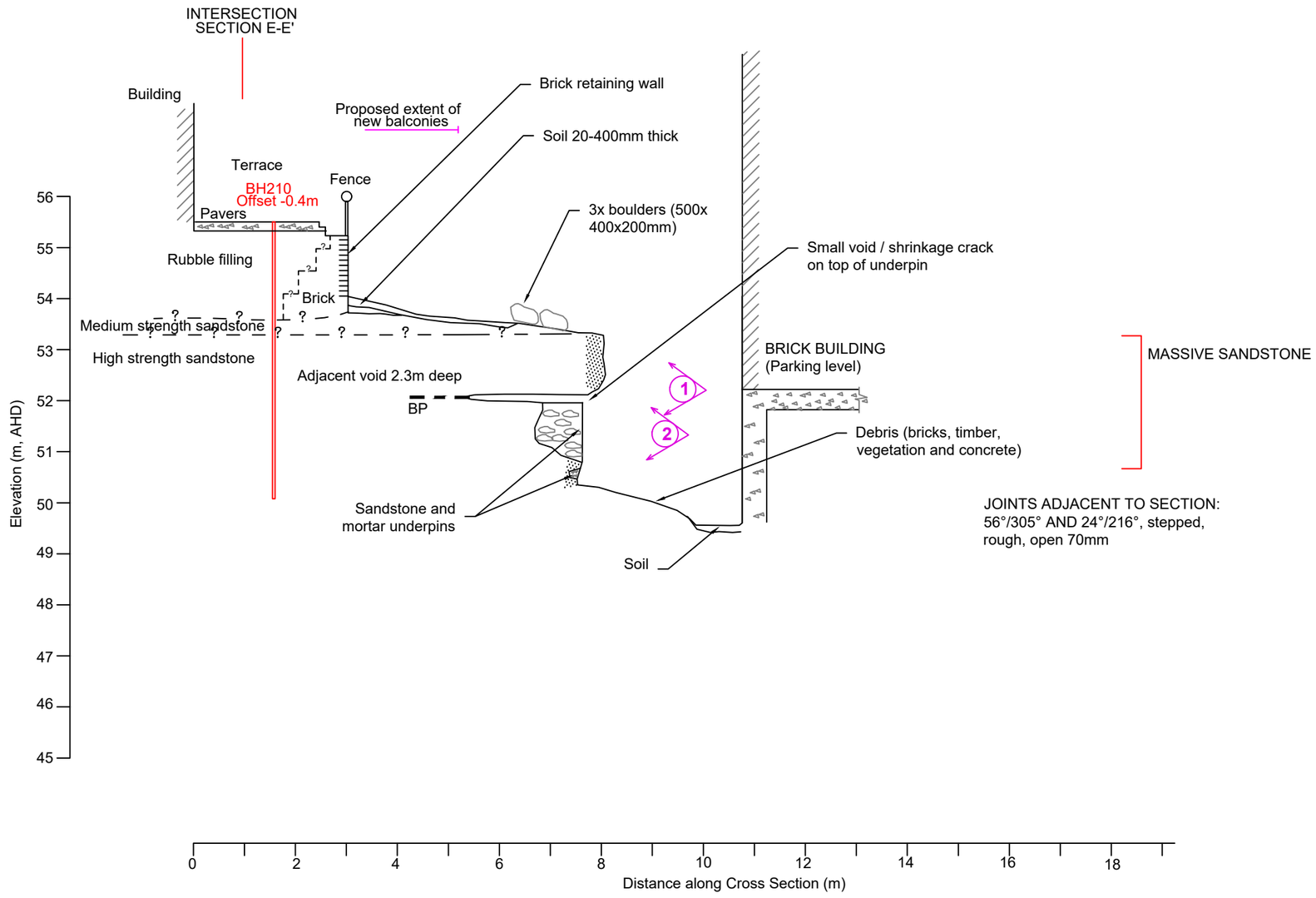
Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 108** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D27 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 108, Photo 2 – View upslope from base of traverse 108, of high strength sandstone.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 108** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D28 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 108, Photo 3 – View of lower part of slope along mapping traverse 108, below Photo 2. Overhang formed on continuous bedding parting defect, indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 108** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D29 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018



LEGEND

BP Bedding parting defect

1 Photo number with direction of view

Sandstone outcrop

—?—?— Interpreted geotechnical boundary

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Strata Plan SP1731	TITLE: **Cliff Geological Mapping Traverse 109** **Alterations and Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.06
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: Trav 109
	SCALE: 1;100 @ A3 / DATE: 1.11.2018		REVISION: 0

Mapping Traverse 109, Photo 1 – View of southern end of cliff line at mapping traverse 109. Mortared sandstone underpinning is present as indicated. Low angle and moderately dipping joints were present as indicated, adjacent to a 2.3 m deep void.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 109** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D30 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Mapping Traverse 109, Photo 2 – View north towards mapping traverse 109, showing sub-horizontal and dipping bedding plane defects.

Douglas Partners Geotechnics / Environment / Groundwater	**Cliff Mapping – Traverse 109** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: D31 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 14/11/2018

Appendix E

Laboratory Test Results

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 203765

Client Details

Client	Douglas Partners Pty Ltd
Attention	Huw Smith
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**72261.06, 20 Illawong Ave**
Number of Samples	2 Soil
Date samples received	23/10/2018
Date completed instructions received	23/10/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	30/10/2018
Date of Issue	30/10/2018

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Jacinta Hurst, Laboratory Manager

Soil Aggressivity			
Our Reference		203765-1	203765-2
Your Reference	UNITS	BH102	BH104
Depth		0.3	0.5
Date Sampled		19/10/2018	18/10/2018
Type of sample		Soil	Soil
pH 1:5 soil:water	pH Units	9.1	8.2
Electrical Conductivity 1:5 soil:water	µS/cm	87	95
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	27	110

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Soil Aggressivity					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	106	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	92	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	97	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No: 72261.06	**Suburb:** Tamarama	**To:** ~~Lab name~~ Envirolab Services P/L, 12 Ashley St, Chatswood
Project Name: 20 Illawong Ave	**Order Number**	
Project Manager: Huw Smith	**Sampler:** RMN.	**Attn:**
Emails: huw.smith@douglaspartners.com.au		**Phone:**
Date Required: Same day ☐ 24 hours ☐ 48 hours ☐ 72 hours ☐ Standard ☑		**Email:**
Prior Storage: ☐ Esky ☐ Fridge ☑ Shelved	Do samples contain 'potential' HBM? Yes ☐ No ☑	(If YES, then handle, transport and store in accordance with FPM HAZID)

Sample ID	Lab ID	Date Sampled	Sample Type (S - soil, W - water)	Container Type (G - glass, P - plastic)	Heavy Metals	~~OCP/OPP PCB~~	~~TRH and BTEX~~	~~PAH~~	~~Total Phenols~~	~~Asbestos 500 ml~~	Aggressivity (pH, EC, sulphate, chloride)			Notes/preservation
1 BH102-0.3m		19.10	S	P							•			
2 BH104-0.5m		18.10	S	P							•			
PQL (S) mg/kg												ANZECC PQLs req'd for all water analytes ☐		

Envirolab Services, 12 Ashley St, Chatswood NSW, Ph: (02) 9910 6200
Job No: 203765
Date Received: 23/10/18
Time Received: 1620
Received By: S.J
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

PQL = practical quantitation limit. If none given, default to Laboratory Method Detection Limit

Metals to Analyse: 8HM unless specified here:

Lab Report/Reference No:

Total number of samples in container: | **Relinquished by:** | **Transported to laboratory by:**

Send Results to: Douglas Partners Pty Ltd | **Address:** 96 Hermitage Rd, West Ryde | **Phone:** 98090666 | **Fax:**

Signed: [signature] | **Received by:** Soumya | **Date & Time:** 23/10/18 1620

Appendix F

Historical Field Work Results

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Proposed Car Park, Alterations & Additions
LOCATION: 20 Illawong Avenue, Tamarama

SURFACE LEVEL: 55.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 72261
DATE: 8/2/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.05	TOPSOIL - dark grey, silty sand topsoil with some grass rootlets (possible filling)							A			
		FILLING - grey to grey brown, fine to medium grained, sand filling with crushed sandstone and brick fragments						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	A			
1									A			
									S			2,25/130mm refusal
54	1.4	SANDSTONE - very low strength, light grey brown, fine to medium grained sandstone										
	1.8	SANDSTONE - high strength, slightly weathered and fresh, slightly fractured and unbroken, light grey and brown, medium to coarse grained, massive sandstone						1.96m: J25°, he, ti				PL(A) = 1.1
2									C	100	100	PL(A) = 1.7
53												
3												PL(A) = 2
52												
4												
51												PL(A) = 2.8
5									C	100	100	
50	5.6	SANDSTONE - medium to high then high strength, slightly weathered and fresh, slightly fractured and unbroken, light grey brown, medium to coarse grained sandstone. Some siltstone laminations						5.27m: J10°, cly, co 5.57m: J25°, pl, ro, fe, cly, co 5.72-6.0m: J, sv, un, ro, cln				PL(A) = 1
6												
49												PL(A) = 2.7
7								6.73 & 6.90m: B (x2) 5°, cly, vn, ti				
48								7.47m: B10°, cly, co				PL(A) = 2.1
8									C	100	99	
47								8.45 & 8.67m: B5°- 10°, cly, vn, ti				PL(A) = 1.9
9												
46	10.0							9.76 & 9.80m: B (x2) 0°-	C	100	99	PL(A) = 2.1

RIG: Bobcat **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 1.5m

TYPE OF BORING: Solid flight auger to 1.5m; Rotary to 1.8m; NMLC-Coring to 15.6m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: 20% water loss from 14.3m

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Proposed Car Park, Alterations & Additions
LOCATION: 20 Illawong Avenue, Tamarama

SURFACE LEVEL: 55.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 72261
DATE: 8/2/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
45	11	SANDSTONE - high strength, fresh, slightly fractured and unbroken, light grey brown, medium to coarse grained sandstone - some siltstone laminations						5°, carbonaceous laminations	C	100	99	PL(A) = 2 PL(A) = 1
44	12											
43	13							12.9-13.71m: B (x2) 5°, cly, vn				PL(A) = 2 PL(A) = 1.4
42	14								C	100	95	PL(A) = 2
41	14.4	SANDSTONE - medium to high strength, fresh, fractured to slightly fractured, light yellow grey to grey, medium grained sandstone. Some medium strength siltstone bands and clasts						14.63m: J45°, cu, sm, sl, cln 14.77m: J30°, cu, ro, cln 14.8m: J45°, 25°, st, sm, cln 14.85m: J25°, pl, ro, cln 14.93m: J25°, Cz (10mm), cly				PL(A) = 1
40	15											
	15.6	Bore discontinued at 15.6m										
39	16											
38	17											
37	18											
36	19											

RIG: Bobcat **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 1.5m

TYPE OF BORING: Solid flight auger to 1.5m; Rotary to 1.8m; NMLC-Coring to 15.6m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: 20% water loss from 14.3m

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY

PROPOSED CAR PARK, ALTERATIONS & ADDITIONS - TAMARAMA

BORE 1 PROJECT 72261 FEB 2011

1.8 -6.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED CAR PARK, ALTERATIONS & ADDITIONS - TAMARAMA

BORE 1 PROJECT 72261 FEB 2011

6.0 – 11.0m

DOUGLAS PARTNERS PTY

PROPOSED CAR PARK, ALTERATIONS & ADDITIONS - TAMARAMA

BORE 1 PROJECT 72261 FEB 2011

11.0 – 15.6m

DOUGLAS PARTNERS PTY LTD

PROPOSED CAR PARK, ALTERATIONS & ADDITIONS - TAMARAMA

BORE PROJECT 72261 FEB 2011

m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Proposed Car Park, Alterations & Additions
LOCATION: 20 Illawong Avenue, Tamarama

SURFACE LEVEL: 55.6 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 72261
DATE: 8/2/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
55	0.05	BITUMINOUS CONCRETE						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10°	A			
	0.1	ROADBASE GRAVEL										
	0.6	FILLING - dark grey, fine to medium grained sand filling							A			
	0.8	SANDSTONE - low to medium strength, light grey brown, fine grained sandstone							A			PL(A) = 0.8
54	1	SANDSTONE - medium to high strength, slightly weathered, unbroken, light grey brown, medium to coarse grained sandstone										PL(A) = 1.2
53	2								C	100	100	PL(A) = 1
	3											
52	3.7	SANDSTONE - high strength, fresh, unbroken, light grey, medium to coarse grained, massive sandstone						3.9m: J5°, cly, co				PL(A) = 1.2
51	4											PL(A) = 1.1
	5								C	100	100	
50	6							6.06m: J5°- 10°, he				PL(A) = 1.3
49	7											PL(A) = 1.2
	7.0	SANDSTONE - medium to high strength, fresh, slightly fractured and unbroken, light grey, medium to coarse grained, massive sandstone. Some medium strength bands and siltstone inclusions										PL(A) = 0.9
48	8								C	100	99	PL(A) = 1.4
47	9							9.2m: J35°, pl, ro, cly, vn 9.36m: J20°, pl, ro, cln 9.37m: J30°, pl, ro, cln 9.55m: J30°, pl, ro, cly, co				PL(A) = 1
46												

RIG: Bobcat **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 0.8m

TYPE OF BORING: Solid flight auger to 0.8m; NMLC-Coring to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Proposed Car Park, Alterations & Additions
LOCATION: 20 Illawong Avenue, Tamarama

SURFACE LEVEL: 55.6 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 72261
DATE: 8/2/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
45	11	SANDSTONE - medium to high strength, fresh, slightly fractured and unbroken, light grey, medium to coarse grained, massive sandstone. Some medium strength bands and siltstone inclusions *(continued)*						9.75m: J40°, pl, ro, Ds (10-15mm) 10.45m: J10° & 50°, st, sm, cln 10.81 & 10.84m: J (x2) 20°, pl, ro, cln	C	100	96	PL(A) = 0.4
44	11.45	SANDSTONE - high strength, fresh, slightly fractured and unbroken, light grey, medium grained sandstone. Some siltstone laminations						11.35m: B5°, Ds (5mm) 11.4m: B0°, cly, cbs 11.9m: Micro fault, 60°, ti, he 12.43m: B5°, cly, vn	C	100	96	PL(A) = 0.7 PL(A) = 1.6
43	12											
42	13											PL(A) = 1.1
41	14								C	100	100	
40	15 15.0	Bore discontinued at 15.0m						14.43m: B0°, cly, co 14.65m: B10°, cly, vn				PL(A) = 2.9
39	16											
38	17											
37	18											
36	19											

RIG: Bobcat **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 0.8m

TYPE OF BORING: Solid flight auger to 0.8m; NMLC-Coring to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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DOUGLAS PARTNERS PTY

PROPOSED CAR PARK, ALTERATIONS & ADDITIONS - TAMARAMA

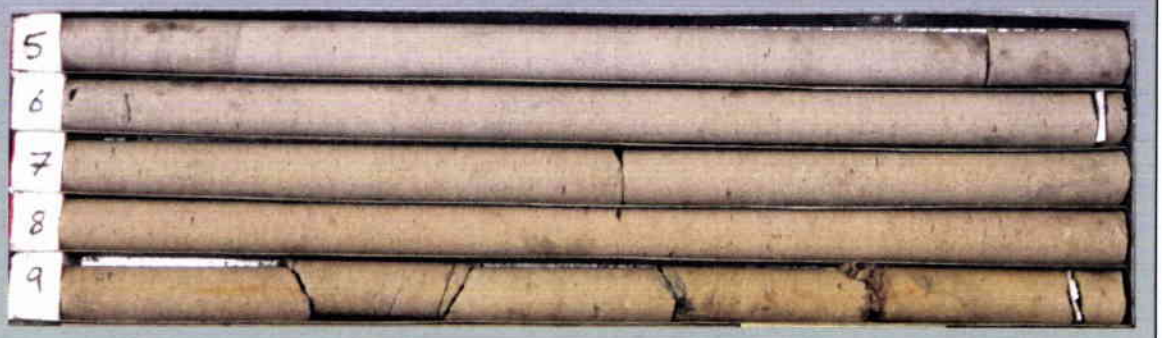
BORE 2 PROJECT 72261 FEB 2011

0.8 – 5.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED CAR PARK, ALTERATIONS & ADDITIONS - TAMARAMA

BORE 2 PROJECT 72261 FEB 2011



5.0- 10.0m

DOUGLAS PARTNERS PTY

PROPOSED CAR PARK, ALTERATIONS & ADDITIONS - TAMARAMA

BORE 2 PROJECT 72261 FEB 2011

10.0 – 15.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED CAR PARK, ALTERATIONS & ADDITIONS - TAMARAMA

BORE PROJECT 72261 FEB 2011

m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Proposed Car Park, Alterations & Additions
LOCATION: 20 Illawong Avenue, Tamarama

SURFACE LEVEL: 56.7 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 72261
DATE: 8/2/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.05	BITUMINOUS CONCRETE						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	A			
		FILLING - light grey and dark grey, fine to medium grained, sand filling with some crushed sandstone gravel							A			
56	0.8											
	0.9	SANDSTONE - very low strength, light grey brown, fine to medium grained sandstone										PL(A) = 0.8
	1	SANDSTONE - medium then high strength, moderately and slightly weathered, slightly fractured and unbroken, light grey brown, medium to coarse grained sandstone							C	100	100	PL(A) = 1.5
55	2											
54	3											PL(A) = 1.6
53	4							>>				
												PL(A) = 2.5
52	5								C	100	100	PL(A) = 1.3
51	6											PL(A) = 2.1
50	7							7.07m: B5°, cly, vn				
												PL(A) = 1.4
49								7.8m: J10°, pl, ro, fe				
48	8							7.95-8.15m: D? (x7) 8.05m: J25°, pl, ro, cln	C	100	100	PL(A) = 2.3
47	9							9.4m: D 9.65m: B5°, cly, vn, ti				PL(A) = 2.1
	9.98	Bore discontinued at 9.98m										

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 0.9m

TYPE OF BORING: Solid flight auger to 0.9m; NMLC-Coring to 9.98m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: 30% water loss from 8.0m

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

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DOUGLAS PARTNERS PTY

PROPOSED CAR PARK, ALTERATIONS & ADDITIONS - TAMARAMA

BORE 3 PROJECT 72261 FEB 2011

0.9 – 5.0m

DOUGLAS PARTNERS PTY LTD

PROPOSED CAR PARK, ALTERATIONS & ADDITIONS - TAMARAMA

BORE 3 PROJECT 72261 FEB 2011

5.0 – 9.98m

BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Proposed Car Park, Alterations & Additions
LOCATION: 20 Illawong Avenue, Tamarama

SURFACE LEVEL: 55.6 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 72261
DATE: 9/2/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		ASPHALT							
	0.05	FILLING - light brown sand filling		A	0.1				
	0.4	SANDSTONE - low to medium strength, light yellow brown, medium to coarse grained sandstone		A	0.5				
55	0.55	Bore discontinued at 0.55m - auger refusal							

RIG: Bobcat **DRILLER:** SS **LOGGED:** RKL **CASING:** Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 0.55m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Proposed Car Park, Alterations & Additions
LOCATION: 20 Illawong Avenue, Tamarama

SURFACE LEVEL: 57.0 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 72261
DATE: 8/2/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
57		ASPHALT							
	0.05	FILLING - sand and crushed sandstone filling		A	0.1				
	0.4	SAND - dark brown sand		A	0.5				
				A	0.6				
	0.65	Bore discontinued at 0.65m - auger refusal on medium strength sandstone							

RIG: Bobcat **DRILLER:** SS **LOGGED:** RKL **CASING:** Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 0.65m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Proposed Car Park, Alterations & Additions
LOCATION: 20 Illawong Avenue, Tamarama

SURFACE LEVEL: 56.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 72261
DATE: 9/2/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - brown sand filling (grass at surface)		A	0.1				
56				A	0.5				
	0.55	Bore discontinued at 0.55m - auger refusal on medium strength sandstone							

RIG: Bobcat **DRILLER:** SS **LOGGED:** RKL **CASING:** Uncased
TYPE OF BORING: Solid flight auger (TC-bit) to 0.55m
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Strata Plan 1731
PROJECT: Proposed Car Park, Alterations & Additions
LOCATION: 20 Illawong Avenue, Tamarama

SURFACE LEVEL: 56.1 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 72261
DATE: 9/2/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
56		ASPHALT							
	0.05	FILLING - brown sand filling		A	0.1				
	0.35	Bore discontinued at 0.35m - auger refusal on concrete							

RIG: Bobcat **DRILLER:** SS **LOGGED:** RKL **CASING:** Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 0.35m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SURVEY DATUM:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Results of Dynamic Penetrometer Tests

Client Strata Plan 1731
Project Proposed Car Park, Alterations and Additions
Location 20 Illawong Avenue, Tamarama

Project No. 72261
Date 8/2/2011
Page No. 1 of 1

Test Locations	8	9	10	11	12	13	14	15	16	17
RL of Test (AHD)	55.7	55.8	55.5	53.7	53.0	52.0	53.5	56.5	56.7	56.4
Depth (m)	**Penetration Resistance** Blows/150 mm									
0.00 – 0.15	3	3	5	2	3	5	4	2	1	1
0.15 – 0.30	6	8	12	4	4	5	4	1	2	2
0.30 – 0.45	10	3/50	9	30	3	8	6/75	2	1	1
0.45 – 0.60	17	B	6	B	15/100	4	B	6/20	2/100	2
0.60 – 0.75	10		8		B	4		B	B	1
0.75 – 0.90	6		8			3				3
0.90 – 1.05	9		22			13				8/75
1.05 – 1.20	7		6			20/100				B
1.20 – 1.35	3		6			B				
1.35 – 1.50	3		9							
1.50 – 1.65	6/50		4							
1.65 – 1.80	B		4							
1.80 – 1.95			4							
1.95 – 2.10			6/20							
2.10 – 2.25			B							
2.25 – 2.40										
2.40 – 2.55										
2.55 – 2.70										
2.70 – 2.85										
2.85 – 3.00										
3.00 – 3.15										
3.15 – 3.30										
3.30 – 3.45										
3.45 – 3.60										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑
AS 1289.6.3.3, Sand Penetrometer ☐

Tested By JS
Checked By RKL

Remarks 6/50 indicates 6 blows for 50mm penetration ; B = bouncing

CHARACTERISATION OF GEOTECHNICAL DATA

Geotechnical data generally fall into the categories of fact, interpretation and opinion, as defined by the Institution of Engineers, Australia, 1987 - Guidelines for the Provision of Geotechnical Information in Construction Contracts.

Facts are defined as the materials, statistics and properties which may be seen, measured or identified by means of accepted and preferably standardised criteria, classifications and tests. Examples of facts include: exploration locations, outcrop locations, samples and drill core, lithological names/descriptions of soils and rocks, measured water levels, laboratory test results and seismic time/distance plots.

Interpretative data is defined as information derived from competently made interpretation of facts using accepted and proven techniques, or reasonable judgement exercised in the knowledge of geological conditions or processes evident at the site. Examples of interpretative data are: borehole and test pit logs, inferred stratigraphy and correlations between boreholes or test pits, material and rock mass properties used in analysis (e.g. permeability), and seismic interpretation (yielding velocity and layer depths).

Opinion is derived from consideration of relevant available facts, interpretations and analysis and/or the exercise of judgement. Examples of opinions based on geotechnical/geological interpretations include bearing capacity and foundation suitability, need for foundation treatment, settlements, potential for grouting, excavation stability, ease of excavation, and suitability of construction materials.

SOIL DESCRIPTION

The methods of description and classification of soils are based on Australian Standard 1726, the SAA Site Investigation Code. The description of a soil is based on particle size distribution and plasticity as shown in the "GUIDE TO THE DESCRIPTION, IDENTIFICATION AND CLASSIFICATION OF SOILS".

SOIL CLASSIFICATION

The basic soil types and their subdivisions are defined by their particle sizes:

MAJOR SOIL CATEGORIES

Soil Classification	Particle Size
Boulders	Greater than 200mm
Cobbles	63 - 200mm
Gravel	2.36 - 63mm
Sand	0.075 - 2.36mm
Silt	0.002 - 0.075mm
Clay	Less than 0.002mm

MINOR SOIL CONSTITUENTS

As most natural soils are combinations of various constituents, the primary soil is further described and modified by its minor components:

Coarse grained soils			**Fine grained soils**		
% Fines		**Modifier**	**% Coarse**		**Modifier**
	≤ 5	Omit, or use 'trace'		≤ 15	Omit, or use 'trace'
> 5	≤ 12	Describe as 'with clay/silt', as applicable	> 15	≤ 30	Describe as 'with sand/gravel', as applicable
> 12		Prefix soil as 'silty/clayey', as applicable	> 30		Prefix soil as 'sand/gravelly', as applicable

COHESIVE SOILS

Clay and silt may be described according to their plasticity:

Descriptive Term	**Range of liquid limit (percent)**	
Of low plasticity		≤ 35
Of medium plasticity	> 35	≤ 50
Of high plasticity	> 50	

MOISTURE CONDITION

Term	Description
Dry (D)	Cohesive soils; hard and friable or powdery, well dry of plastic limit. Granular soils; cohesionless and free-running.
Moist (M)	Soil feels cool, darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
Wet (W)	Soil feels cool, darkened in colour. Cohesive soils usually weakened and free water forms on hands when handling. Granular soils tend to cohere.

CONSISTENCY - NON-COHESIVE SOILS

Term	Density index %		SPT "N" value
Very loose		≤ 15	< 5
Loose	> 15	≤ 35	5 - 10
Medium dense	> 35	≤ 65	10 - 30
Dense	> 65	≤ 85	30 - 50
Very dense	> 85		> 50

CONSISTENCY - COHESIVE SOILS

Term	Undrained shear strength (kPa)		Field guide to consistency	SPT "N" value
Very soft		≤ 12	Exudes between the fingers when squeezed in hand.	< 2
Soft	> 12	≤ 25	Can be moulded by light finger pressure.	2 - 4
Firm	> 25	≤ 50	Can be moulded by strong finger pressure.	4 - 8
Stiff	> 50	≤ 100	Cannot be moulded by fingers; can be indented by thumb	8 - 16
Very stiff	> 100	≤ 200	Can be indented by thumb nail.	16 - 32
Hard	> 200		Can be indented with difficulty by thumb nail.	> 32

GRAPHICAL SYMBOLS USED FOR GEOTECHNICAL BOREHOLE AND TEST PIT LOGS

SOIL - COARSE GRAINED


GW


GP


GM


GC

SW

SP


SM


SC

SOIL - FINE GRAINED

CH


CI

CL

MH

ML


OH


OL


Pt

ROCK


Sedimentary rock


Igneous rock


Metamorphic rock

FILL MATERIAL


Fill

GROUNDWATER


Level


Inflow

NGE No Groundwater Encountered

SOIL HORIZON BOUNDARIES

——— Boundary measured or determined from drilling conditions

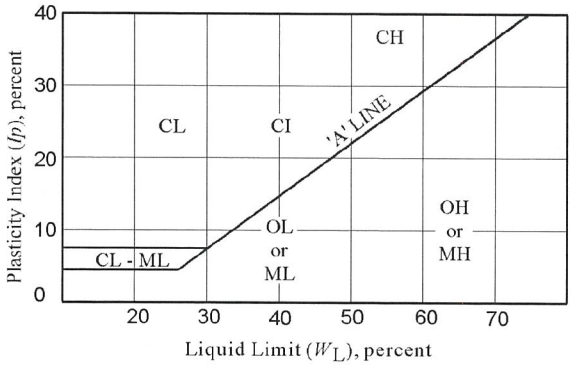
····· Diffuse or uncertain boundary

GUIDE TO THE DESCRIPTION IDENTIFICATION AND CLASSIFICATION OF SOILS

Major Divisions		Particle Size (mm)	Group Symbol	Typical Names	Field Identification Sand and Gravels	Use the gradation curve of material passing 63mm for classification of fractions according to the criteria given in "Major Divisions"	Laboratory Classification				
							% < 0.06mm (see note 2)	Plasticity of Fine Fraction	$C_u = \frac{D_{50}}{D_{10}}$	$C_c = \frac{(D_{30})^2}{D_{10}D_{60}}$	Notes
COARSE GRAINED SOILS (more than half of material less than 63 mm is larger than 0.075 mm)	BOULDERS	200					—	—	—	—	
	COBBLES	63					—	—	—	—	
	GRAVELS (more than half of coarse fraction is larger than 2.36mm)	coarse 20	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength		0-5	—	> 4	between 1 and 3	1. Identify lines by the method given for fine grained soils.
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength		0-5	—	Fails to comply with above	—	
		medium 6	GM	Silty gravels, gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength		12-50	Below 'A' line or $I_p < 4$	—	—	2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.06mm size) is greater than 5% and less than 12%.
			GC	Clayey gravels, gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength		12-50	Above 'A' line or $I_p > 7$	—	—	Borderline classifications require the use of dual symbols e.g. SP-SM, GW-GC
		fine 2.36									
	SANDS (more than half of coarse fraction is smaller than 2.36mm)	coarse 0.6	SW	Well graded sands, gravelly sands, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength		0-5	—	> 6	between 1 and 3	3. I_p = Plasticity Index
			SP	Poorly graded sands and gravelly sands; little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength		0-5	—	Fails to comply with above	Fails to comply with above	
		medium 0.2	SM	Silty sands, sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength		12-50	Below 'A' line or $I_p < 4$	—	—	
		fine 0.075	SC	Clayey sands, sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength		12-50	Above 'A' line or $I_p > 7$	—	—	

GUIDE TO THE DESCRIPTION, IDENTIFICATION AND CLASSIFICATION OF SOILS (CONT.)

Major Divisions		Particle Size (mm)	Group Symbol	Typical Names	Field Identification			Laboratory Classification			Notes
					Dry* Strength	Dilatancy†	Toughness ‡			Plasticity of Fine Fraction	
FINE GRAINED SOILS (more than half of material less than 63 mm is smaller than 0.075 mm)	SILTS & CLAYS (liquid limit < 50%)	<0.075	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	None to low	Quick to slow	None	Use the gradation curve of material passing 63mm for classification of fractions according to the criteria given in "Major Divisions"	More than 50% passing 0.06 mm	Below 'A' line	PLASTICITY CHART FOR CLASSIFICATION OF FINE GRAINED SOILS
			CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium to high	None to very slow	Medium			Above 'A' line	
			OL ✧	Organic silts and organic silty clays of low plasticity	Low to medium	Slow	Low			Below 'A' line	
	SILTS & CLAYS (liquid limit > 50%)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, clastic silts	Low to medium	Slow to none	Low to medium			Below 'A' line	
			CH	Inorganic clays of high plasticity, fat clays	High to very high	None	High			Above 'A' line	
			OH ✧	Organic clays of medium to high plasticity, organic silts	Medium to high	None to very slow	Low to medium			Below 'A' line	
	HIGHLY ORGANIC SOILS		Pt ✧	Peat and other highly organic soils	Identified by colour, odour, spongy feel and generally by fibrous texture					—	✧ Effervesces with H_2O_2



FIELD IDENTIFICATION PROCEDURE FOR FINE GRAINED SOILS OR FRACTIONS

THESE PROCEDURES ARE TO BE PERFORMED ON THE MINUS 0.2MM SIZE PARTICLES. FOR FIELD CLASSIFICATION PURPOSES, SCREENING IS NOT INTENDED, SIMPLY REMOVE BY HAND THE COARSE PARTICLES THAT INTERFERE WITH THE TESTS.

*** Dry strength (Crushing characteristics)**

After removing particles larger than 0.2mm size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity. High dry strength is characteristic for clays of the CH group.

A typical inorganic silt possesses only very slight dry strength.

Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

† Dilatancy (Reaction to shaking)

After removing particles larger than 0.2mm size, prepare a pat of moist soil with a volume of 10 cm^3. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles.

The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, shows a moderately quick reaction.

‡ Toughness (Consistency near plastic limit)

After removing particles larger than 0.2mm size, a specimen of soil about 10cm^3 in size is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. The specimen is then rolled out by hand on a smooth surface or between the palms into a thread about 3mm in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together with a slight kneading action continued until the lump crumbles. The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil.

Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line. Highly organic clays have a very weak and spongy feel at the plastic limit.

EXPLANATION OF LOGGING TERMS FOR ENGINEERING GEOLOGY BOREHOLE LOGGING

ROCK SUBSTANCE WEATHERING CLASSIFICATION

RS	Residual soil
EW	Extremely weathered
HW	Highly weathered
MW	Moderately weathered
SW	Slightly weathered
F(s)	Fresh (stained defects)
F	Fresh

ESTIMATED STRENGTH CLASSIFICATION

EW	Extremely weak
VW	Very weak
W	Weak
MS	Medium strong
S	Strong
VS	Very strong
ES	Extremely strong

DEFECTS

Defects include all joints, bedding planes, fracture zones, seams, veins and cleavage partings.

RQD

Rock quality designation:

$$RQD = \frac{\text{length of core in pieces 100mm or longer}}{\text{length of run}} \times 100\%$$

WATER

Water table, with date

Water inflow

Partial drilling water loss

Complete drilling water loss

Angles of joint inclination (and other geological features and drill holes) are angles between the feature and a horizontal plane. In core, angles of joints (and other geological structures) are angles between the structure and the plane normal to the axis of the core. In vertical holes these angles are then the true inclination (dip) of the structure.

DEFINITIONS OF ENGINEERING GEOLOGICAL TERMS

This classification system provides a standard terminology for the engineering description of rock.

DEGREE OF WEATHERING [1]

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Rock is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.
Extremely Weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly Weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance, and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock, usually as a result of iron bleaching or deposition. The colour and strength of the original substance is no longer recognisable.
Moderately Weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance, and the original colour of the fresh rock is no longer recognisable.
Slightly Weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance, usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh (stained)	F_S	Rock substance unaffected by weathering. Weathering is limited to the surface of major discontinuities, for example an iron-stained joint.
Fresh	F	Rock substance unaffected by weathering.

ROCK STRENGTH [2]

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.

TERM	Is (50)	FIELD GUIDE	APPROX. qu MPa *
Extremely Weak (EW)		Easily remoulded by hand to a material with soil properties.	
	0.03		0.7
Very weak (VW)		May be crumbled in the hand. Sandstone is "sugary" and friable.	
	0.1		2.4
Weak (W)		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.	
	0.3		7
Medium Strong (MS)		A piece of core 150mm long x 50mm dia. may be broken by hand with considerable difficulty. Readily scored with a knife.	
	1		24
Strong (S)		A piece of core 150mm long x 50mm dia. cannot be broken by unaided hands, may be slightly scratched or scored with knife.	
	3		70
Very Strong (VS)		A piece of core 150mm long x 50mm dia. may be broken readily with hand held hammer. Cannot be scratched with pen knife.	
	10		240
Extremely Strong (ES)		A piece of core 150mm long x 50mm dia. is difficult to break with hand held hammer. Rings when struck with hammer.	

* The approximate unconfined compressive strength (qu) shown in the table is based on an assumed ratio to the point load index of 24:1. This ratio may vary widely and should be calibrated on site.

STRATIFICATION SPACING [2]

TERM	SEPARATION OF STRATIFICATION PLANES
Thinly laminated	< 6mm
Laminated	6mm - 20mm
Very thinly bedded	20mm - 60mm
Thinly bedded	60mm - 200mm
Medium bedded	200mm - 600mm
Thickly bedded	600mm - 2m
Very thickly bedded	> 2m

DISCONTINUITY SPACING [3]

TERM	SPACING
Very widely spaced	> 2m
Widely spaced	600mm - 2m
Moderately widely spaced	200mm 600mm
Closely spaced	60mm - 200mm
Very closely spaced	20mm - 60mm
Extremely closely spaced	< 20mm

APERTURE OF DISCONTINUITY SURFACES [4]

The degree to which a discontinuity is open, or to which the faces of the discontinuity have been separated and the space subsequently infilled (such as in a vein, fault or joint).

TERM	APERTURE THICKNESS (Discontinuities, veins, faults, joints)
Wide	> 200mm
Moderately wide	60mm - 200mm
Moderately narrow	20mm - 60mm
Narrow	6mm - 20mm
Very narrow	2mm - 6mm
Extremely narrow	> 0 - 2 mm
Tight	Zero

BLOCK SHAPE AND SIZE [4]

The following descriptive terms define shape:

Blocky	- approximately equidimensional.
Tabular	- one dimension considerably shorter than the other two.
Columnar	- one dimension considerably larger than the other two.

Block sizes are defined by the following descriptive terms:

TERM	BLOCK SIZE	EQUIVALENT DISCONTINUITY SPACINGS IN BLOCKY ROCK
Very large	$> 8m^3$	Extremely wide
Large	$> 0.2m^3$ - $8m^3$	Very wide
Medium	$> 0.008m^3$ - $0.2m^3$	Wide
Small	$> 0.0002m^3$ - $0.008m^3$	Moderately wide
Very small	$\leq 0.0002m^3$	Less than moderately wide

REFERENCES

1. Modifications of:
   (a) McMahon, B.K., Douglas, D.J., & Burgess, P.J., 1975. Engineering classification of sedimentary rocks in the Sydney area. Australian Geomechanics Journal, G5 (1), 51-53.
   (b) Geological Society Engineering Group Working Party, 1977. The description of rock masses for engineering purposes. Quarterly Jour. Engg. Geology, 10 (4), 355-388.

2. McMahon, B.K., Douglas , D.J., & Burgess, P. J., 1975. Engineering classification of sedimentary rocks in the Sydney area. Australian Geomechanics Journal, G5 (1), 51 -53.

3. ISRM Commission on Standardisation of Laboratory and Field Tests, 1978. Suggested methods for the quantitative description of discontinuities in rock masses. J1. Rock Mechanics Min. Sci. and Geomech. Abstra., 15, 319-368.

4. Geological Society Engineering Group Working Party, 1977. The description of rock masses for engineering purposes. Quarterly Journ. Engg Geology, 10 (4), 355-388.

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH1

Sheet 1 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR
DATUM
BEARING —
INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 18.4.2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 18.4.2017

DRILLING DATA			ROCK SUBSTANCE			ROCK MASS DEFECTS			
DEPTH (R.L.) METRES	Method / Casing, Run / Water	GRAPHIC LOG	DESCRIPTION — ROCK TYPE: Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION — TYPE: Inclination, planarity, roughness, coatings or infillings	R.Q.D. / TESTS
0			NOT CORED.						
0.70			SANDSTONE; medium grained; very thinly bedded; orange & light grey; hard.					0.76–0.81 PARTING; 10°; planar; infilled with clayey sand and fragments.	
1	DIAMOND CORING RUN 1		becomes light grey with rare dark grey and dark brown flecks; thinly bedded to medium bedded.					1.13 – PARTING; 0°; planar; rough; Fe-st.	
1.04									
1.40								1.37 – DRILLING BREAK.	RQD = 80%
2	RUN 2				MS			1.97–2.06 PARTINGS; 5° & 0°; planar; rough; Fe-st.	
2.40								2.40 – BOXING BREAK.	RQD = 94%
2.68			becomes light grey with orange laminations; laminated.	SW					
2.90			becomes light grey; medium bedded.					2.90 – PARTING; 5°; planar; rough; Fe-st.	
2.93									
3									
3.19			becomes light grey with orange laminations; laminated to 3.30m then light grey; medium bedded.						
3.30	RUN 3							3.41 – BOXING BREAK.	RQD = 100%
4					S				
4.40								4.40 – PARTING; 0°; planar; rough.	
4.66	RUN 4		becomes brown/orange-brown & light grey laminated to thinly bedded.						RQD = 100%
5									

Remarks: START CORING AT 0.7m DEPTH
Job / Report No. GT37A

Logged by: P.ANDERSON
Date: 3.5.2017
Site Supervisor M.ASHOVER

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH1 Sheet 2 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR DATUM BEARING – INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 18.4.2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 18.4.2017

DRILLING DATA				ROCK SUBSTANCE			ROCK MASS DEFECTS				
DEPTH (R.L.) METRES	Method	Casing, Run	Water	GRAPHIC LOG	DESCRIPTION ROCK TYPE Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION TYPE Inclination, planarity, roughness, coatings or infillings	R.Q.D.	TESTS
5	DIAMOND CORING	RUN 4	1		SANDSTONE; medium grained; laminated to thinly bedded; light grey with brown & orange-brown staining; hard.	SW	S			5.40 - BOXING BREAK.	RQD = 100%	
5.90										5.90 - PARTING; 0°; planar; rough.		
6		RUN 5								6.42 - BOXING BREAK.	RQD = 100%	
7												
7.40										7.40 } PARTINGS; 0° to 10°; sub-planar; rough; Fe		
7.46										7.46 }		
7.57					- becomes laminated to very thinly bedded; light grey, yellow-brown & brown with some orange-red staining.					7.57 } PARTINGS; 15°; planar; rough.		
7.68										7.68 }		
8		RUN 6								8.33 } 8.36 } 8.43 } BOXING BREAKS.	RQD = 80%	
										8.73 - PARTINGS; 15°; planar; rough.		
8.90										8.88 - DRILLING BREAK.		
9		RUN 7								9.16 - PARTING; 5°; planar; rough.	RQD = 100%	
										9.36 - PARTINGS; 5°; planar; rough.		
										9.72 - BOXING BREAK.		
10												

Remarks: END OF BOX 1 AT 5.40m DEPTH.

Job / Report No. GT 37A

Logged by: P. ANDERSON | Date: 3.5.2017 | Site Supervisor M. ASHOVER

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH1 Sheet 3 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR DATUM BEARING – INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 18.4.2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 18-4-2017

DRILLING DATA			ROCK SUBSTANCE			ROCK MASS DEFECTS				
DEPTH (R.L.) METRES	Method	Casing, Run Water	GRAPHIC LOG	DESCRIPTION ROCK TYPE Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION TYPE Inclination, planarity, roughness, coatings or infillings	R.Q.D.	TESTS
10	DIAMOND CORING RUN 7			SANDSTONE; medium grained; laminated to very thinly bedded; light grey with yellow-brown & brown laminations; hard.	SW	S			10.00 - PARTING; 10°; planar; rough; Fe-st.	RQD = 100%	
									10.15 - PARTING; 15°; planar; rough.		
10.40									10.32 - BOXING BREAK. 10.40 - DRILLING BREAK.		
									10.58 - PARTING; 15°; planar; rough.		
11	RUN 8								11.03 } PARTINGS; 10°; planar; rough; with some associated breaks. 11.07 }	RQD = 96%	
									11.31 - PARTING; 10°; planar; rough.		
									11.40 - PARTING; 5°; planar; rough.		
									11.69 } PARTINGS; 5°; planar; rough. 11.70 }		
11.90				END OF HOLE AT 11.90m							
12											
13											
14											
15											

Remarks: END OF BOX 2 AT 10.32m DEPTH, END OF HOLE AT 11.90m DEPTH | Job / Report No. GT37A

Logged by: P.ANDERSON | Date: 3.5.2017 | Site Supervisor M.ASHOVER


20 ILLAWONG AVENUE
TAMARAMA
BH 1
0.70 — 11.90 M
TAMARAMA
20 ILLAWONG AVE
BH 1
0.70
1.40
2.90
4.40
B.B.
(5.40)
5.90
7.40
8.90
B.B.
(10.32m)
10.40
11.90
END BH 1

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH2 Sheet 1 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR DATUM BEARING – INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 18.4.2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 18.4.2017

DRILLING DATA				ROCK SUBSTANCE				ROCK MASS DEFECTS			
DEPTH (R.L.) METRES	Method	Casing, Run	Water	GRAPHIC LOG	DESCRIPTION ROCK TYPE Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION TYPE Inclination, planarity, roughness, coatings or infillings	R.Q.D.	TESTS
0					NOT CORED.							
0.7	DIAMOND CORING.	RUN 1			SANDSTONE; medium grained; yellow, orange-brown + light grey; very thinly bedded to thinly bedded; hard.	MW to SW	MS			0.78 - PARTING; 10°; planar; rough; Fe-st.	RQD = 89%	
1												
1.40					- becomes laminated to very thinly bedded; light grey + yellow with orange-brown laminations.					1.36 - DRILLING BREAK.		
2		RUN 2									RQD = 100%	
2.90										2.39 - BOXING BREAK.		
3		RUN 3				SW	S			2.90 - DRILLING BREAK.		
										3.37 - BOXING BREAK.	RQD = 100%	
4												
4.40		RUN 4			- becomes very thinly bedded to thinly bedded; light grey with orange-brown; laminated zone 4.6m to 4.85m.					4.40 - DRILLING BREAK		
5												

Remarks: START CORING AT 0.7m DEPTH
Job / Report No. GT37A

Logged by: P.ANDERSON Date: 4.5.2017 Site Supervisor M.ASHOVER

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH2 Sheet 2 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR DATUM BEARING - INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 18.4.2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 18.4.2017

DRILLING DATA				ROCK SUBSTANCE			ROCK MASS DEFECTS				
DEPTH (R.L.) METRES	Method	Casing, Run	Water	GRAPHIC LOG	DESCRIPTION ROCK TYPE Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION TYPE Inclination, planarity, roughness, coatings or infillings	R.Q.D.	TESTS
5		RUN 4			SANDSTONE; medium grained; light grey with orange-brown staining; thinly bedded with laminated zones 5.15m to 5.23m, 5.40m to 5.50m and 5.75m to 5.80m. Some rare dark grey tea leaf structures. Becomes medium bedded below 5.90m					5.40 - BOXING BREAK.	RQD = 100%	
5.90										5.89 - DRILLING BREAK.		
6												
6.40					- Laminated zone 6.40m to 6.50m. More orange-brown stained.					6.40 - BOXING BREAK.		
6.70		RUN 5			- laminated zone 6.70m to 6.90m. More orange-brown stained.							
7						SW	S				RQD = 100%	
7.40										7.40 - DRILLING BREAK.		
8		RUN 6								8.42 - BOXING BREAK.	RQD = 100%	
8.90										8.90 - DRILLING BREAK		
9												
9.10					- Some rare gravel inclusions from 9.10m to 9.44m. Some gravel-sized voids.							
9.44		RUN 7			- Becomes laminated to very thinly bedded; light grey to yellow with dark grey laminations. Some cross-bedding evident.					9.42 - PARTING; 10° to 15°; sub-planar; rough. 9.48 - PARTING; 5°; planar; rough. 9.80 - PARTING; 0° to 10°; sub-planar; rough.		
10												

Remarks: END OF BOX 1 AT 5.40m DEPTH. Job / Report No. GT37A

Logged by: P.ANDERSON Date: 4.5.2017 Site Supervisor M.ASHOVER

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH2

Sheet 3 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR
DATUM
BEARING –
INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 18-4-2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 18-4-2017

DRILLING DATA				ROCK SUBSTANCE				ROCK MASS DEFECTS				
DEPTH (R.L.) METRES	Method	Casing, Run	Water	GRAPHIC LOG	DESCRIPTION ROCK TYPE Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION TYPE Inclination, planarity, roughness, coatings or infillings	R.Q.D.	TESTS
10	DIAMOND CORING	RUN 7			SANDSTONE; medium grained; light grey and yellow with dark grey laminations; thinly laminated to laminated; hard.	SW	S			10.26 - PARTING; 10°; planar; rough. 10.40 - DRILLING BREAK. 10.60 - PARTING; 20°; planar; rough. 10.75 - PARTING; 20°; planar; rough. 10.88 - PARTING; 15°; planar; rough. 10.98 - PARTING; 15°; planar; rough. 11.08 - PARTING; 15°; planar; rough.	AQD = 96% RQD = 94%	
10.40												
11		RUN 8										
11.20					- some red staining 11.20m to 11.33m, and then becomes light grey + yellow with orange-brown + trace dark brown laminations.							
11.90					END OF HOLE AT 11.90m.							
12												
13												
14												
15												

Remarks: END OF BOX 2 AT 10.40m DEPTH. END OF HOLE AT 11.90m DEPTH | Job / Report No. GT37A

Logged by: P. ANDERSON | Date: 4-5-2017 | Site Supervisor M. ASHOVER


20 ILLAWONG AVENUE
TAMARAMA
BH 2
0.70 — 11.90 M
20 ILLAWONG AVE TAMARAMA BH 2
070
1·40
2·90
4·40
B.B.
5·90
7·40
8·90
10·40
SPACER
11·90
END BH 2

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH3

Sheet 1 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR
DATUM
BEARING –
INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 19.4.2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 19.4.2017

DRILLING DATA			ROCK SUBSTANCE				ROCK MASS DEFECTS			
DEPTH (R.L.) METRES	Method / Casing, Run / Water	GRAPHIC LOG	DESCRIPTION — ROCK TYPE: Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION — TYPE: Inclination, planarity, roughness, coatings or infillings	R.Q.D.	TESTS
0			NOT CORED.							
0.35		X	CORE LOSS; 0.15m							
	DIAMOND CORING RUN 1		SANDSTONE; medium grained; light grey, orange & yellow-brown; laminated to thinly bedded; hard.	MW to SW	MS			0.68 } FRAGMENTS + FALL IN.	RQD = 56%	
1								1.30 – PARTING; 0°; planar; rough.		
1.45										
1.90	RUN 2								RQD = 100%	
2								2.16 – PARTING; 5°; sub-planar; rough.		
2.45								2.41 – PARTING; 5°; planar; rough.		
3	RUN 3			SW	S			3.15 – BOXING BREAK.	RQD = 100%	
3.81			becomes light grey with yellow-brown, trace orange staining; medium to thickly bedded.					3.81 – PARTING; 0°; planar; rough; clay infill.		
3.95								3.95 – DRILLING BREAK.		
4	RUN 4							4.15 – BOXING BREAK.	RQD = 100%	
5										

Remarks: END OF BOX 1 AT 4.15m DEPTH. Job / Report No. GT37A

Logged by: P.ANDERSON Date: 4.5.2017 Site Supervisor M. ASHOVER

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH3 Sheet 2 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR
DATUM
BEARING –
INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST
CORE BARRELL NMLC DRILLER ANTHONY
COMMENCED 19.4.2017
COMPLETED 19.4.2017

DRILLING DATA				ROCK SUBSTANCE			ROCK MASS DEFECTS			
DEPTH (R.L.) METRES	Method	Casing, Run	Water	GRAPHIC LOG	DESCRIPTION ROCK TYPE Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION TYPE Inclination, planarity, roughness, coatings or infillings	R.Q.D.	TESTS
5	DIAMOND CORING	RUN 4			SANDSTONE; medium grained; light grey with yellow-brown, trace orange staining; thickly bedded with thinly bedded zone 5.85m to 6.19m.					5.17 – BOXING BREAK.	RQD = 100%	
5.45										5.45 – DRILLING BREAK.		
										5.85, 5.86, 5.99, 6.05 – PARTINGS; 5° to 10°; planar; rough.		
6		RUN 5								6.19 – PARTING; 5°; sub-planar; rough.	RQD = 84%	
6.30					becomes laminated to thinly bedded; light grey & yellow-brown with dark brown laminations.							
6.95										6.95 – PARTING; 10°; planar; rough.		
7		RUN 6				SW	S			7.19 – BOXING BREAK.	RQD = 87%	
										7.85 – PARTING; 5°; planar; rough.		
8												
8.20					becomes red-brown, orange-brown, trace yellow-brown; very thinly bedded to thinly bedded.					8.20 – BOXING BREAK.		
										8.26, 8.33, 8.39, 8.45, 8.46 – PARTINGS; 5° to 15°; sub-planar; rough.		
8.46					becomes light grey and yellow-brown with dark brown laminations; laminated to thinly bedded.					8.63 – PARTING; 5°; planar; rough.		
										8.85, 8.88 – PARTINGS; 0° to 5°; planar; rough; minor clay infill.		
9										9.18 – BOXING BREAK.	RQD = 98%	
		RUN 7										
9.40					becomes red-brown, light grey, orange-brown with dark brown laminations.					9.50 – PARTING; 20°; planar; rough.		
9.95										9.95 – PARTING; 15°; planar; rough.		
10										9.99		

Remarks: END OF BOX 2 AT 8.20m DEPTH
Job / Report No. GT37A

Logged by: P. ANDERSON
Date: 4.5.2017
Site Supervisor M. ASHOVER

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH3
Sheet 3 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR DATUM BEARING – INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 19-4-2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 19-4-2017

DRILLING DATA				ROCK SUBSTANCE				ROCK MASS DEFECTS				
DEPTH (R.L.) METRES	Method	Casing, Run	Water	GRAPHIC LOG	DESCRIPTION ROCK TYPE Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION TYPE Inclination, planarity, roughness, coatings or infillings	R.Q.D.	TESTS
10	DIAMOND CORING RUN 8				SANDSTONE; medium grained; light grey, yellow-brown trace orange-brown staining + dark brown laminations; thinly laminated to very thinly bedded.	SW	S			10.07 – PARTING; 5°; planar; rough. 10.41 – PARTING; 20°; sub-planar; rough; clay infill. 10.96 – BOXING BREAK.		
11												
11.30				X	CORE LOSS; 0.15m – left down hole.							
11.45												
12												
13												
14												
15												

Remarks: END OF HOLE AT 11.45m DEPTH. Job / Report No. GT37A

Logged by: P. ANDERSON Date: 4-5-2017 Site Supervisor M. ASHOVER


20 ILLAWONG AVENUE
TAMARAMA
BH 3
0.35 — 11.45 M
20 ILLAWONG TAMARAMA BH 3
0.35
CORE LOSS 0.15 (TOP)
1.45
2.45
3.95
5.45
6.95
8.8 (8.26)
8.45
9.95
SPACER
DOWN HOLE (0.15m)
11.45
END BH 3

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH4

Sheet 1 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR
DATUM
BEARING –
INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 19.4.2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 19.4.2017

DRILLING DATA				ROCK SUBSTANCE			ROCK MASS DEFECTS			
DEPTH (R.L.) METRES	Method	Casing, Run	Water	GRAPHIC LOG	DESCRIPTION ROCK TYPE Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION TYPE Inclination, planarity, roughness, coatings or infillings	R.Q.D.	TESTS
0					NOT CORED							
1												
1.30	DIAMOND CORING	R1			SANDSTONE; medium grained; thinly bedded to thickly bedded; light grey and orange-brown to 1.97m then light grey with yellow & orange-brown staining; hard.	MW to SW	MS			1.37 } FRAGMENTS. 1.47 – PARTING; 10°; sub-planar; rough.	57%	
1.47		RUN 2								1.80 – PARTING; 5°; planar; rough; Fe-st. 1.87 – PARTING; 5°; planar; rough.		
1.97										1.97 – BOXING BREAK	RQD = 95%	
2												
2.90					Becomes light grey & yellow; thickly bedded.					2.90 – DRILLING BREAK.		
2.97												
3		RUN 3				SW	S			3.91 – BOXING BREAK.	RQD = 96%	
4										4.23 } FRAGMENTS. 4.26 } 4.29 – PARTING; 5°; planar; rough; clay infilled 8mm thick. 4.38 } DRILLING BREAK.		
4.47		RUN 4									RQD = 100%	
5										4.92 – BOXING BREAK.		

Remarks: END OF BOX 1 AT 4.92m DEPTH
Job / Report No. GT37A

Logged by: P. ANDERSON
Date: 3.5.2017
Site Supervisor M. ASHOVER

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH4

Sheet 2 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR
DATUM
BEARING -
INCLINATION VERTICAL

DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 19-4-2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 19-4-2017

DRILLING DATA				ROCK SUBSTANCE			ROCK MASS DEFECTS				
DEPTH (R.L.) METRES	Method	Casing, Run	Water	GRAPHIC LOG	DESCRIPTION ROCK TYPE Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION TYPE Inclination, planarity, roughness, coatings or infillings	R.Q.D.	TESTS
6	DIAMOND CORING	RUN 4			SANDSTONE; medium grained, medium to thickly bedded; light grey and yellow with trace orange & brown; hard.							
5.97										5.95 - DRILLING BREAK.		
										6.04, 6.05 } PARTINGS; 0°; planar; rough.		
		RUN 5								6.38, 6.39, 6.46 } PARTINGS; 0° to 10°; sub planar; rough.	RQD = 94%	
7										6.94 - BOXING BREAK.		
						SW	S			7.19 - PARTING; 5°; planar; rough.		
7.47										7.45 - DRILLING BREAK.		
7.94		RUN 6			- Contains some rare gravel below 7.94m; mostly quartz gravel.					7.94 - BOXING BREAK.		
8.35					- Some red-brown staining from 8.35m to 8.80m; becomes thinly bedded to laminated; Some dark grey laminations below 8.65m and some cross-bedding evident.					8.25, 8.27, 8.30 } PARTINGS; 5° to 10°; sub-planar; rough.	RQD = 97%	
8.97		RUN 7								8.92, 8.94 - DRILLING BREAKS.		
										9.41, 9.48, 9.51 } PARTINGS; 0°; planar; rough.	RQD = 91%	
										9.73 - PARTING; 5°; planar; rough.		
10										9.91 - BOXING BREAK.		

Remarks: END OF BOX 2 AT 8.92m DEPTH. Job / Report No. GT37A

Logged by: P. ANDERSON Date: 3.5.2017 Site Supervisor M. ASHOVER

NSW GOVERNMENT Public Works Advisory

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING
ENGINEERING GEOLOGY BOREHOLE LOG

BOREHOLE No. BH4 Sheet 3 of 3 Sheets

PROJECT 20 ILLAWONG AVENUE
LOCATION TAMARAMA
CO-ORDINATES E N
R.L. COLLAR DATUM BEARING – INCLINATION VERTICAL

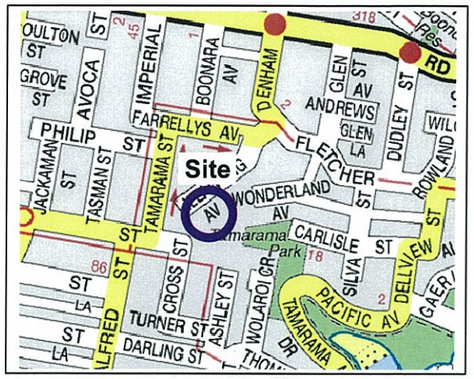
DRILL COMACCHIO 205 CONTRACTOR TERRATEST COMMENCED 19.4.2017
CORE BARRELL NMLC DRILLER ANTHONY COMPLETED 19.4.2017

DRILLING DATA			ROCK SUBSTANCE			ROCK MASS DEFECTS			
DEPTH (R.L.) METRES	Method Casing, Run Water	GRAPHIC LOG	DESCRIPTION ROCK TYPE Grainsize, texture, colour, composition, structure, hardness	WEATHERING	ESTIMATED STRENGTH	DEFECT SPACING (mm) 2000 600 200 60 20	VISUAL LOG	DEFECT DESCRIPTION TYPE Inclination, planarity, roughness, coatings or infillings	R.Q.D. / TESTS
10	DIAMOND CORING RUN 7		SANDSTONE; medium grained; laminated to thinly bedded; some cross-bedding evident; light grey & yellow with dark grey laminations; red-brown staining from 10.25m to 10.48m; hard; some rare quartz gravel.	SW	S			10.43 - PARTING; 20°; planar; rough. 10.52 - PARTING; 10°; planar; rough. 10.65 - PARTING; 5°; planar; rough.	RQD = 91%
10.47									
11	RUN 8							10.91 - BOXING BREAK.	
11.17			- elongated dk brown/black tea leaf structure at 11.17m.						RQD = 90%
11.40			- quartz gravel at base of bed.						
11.87		X	CORE LOSS; 0.10m left down hole.						
11.97 12			END OF HOLE AT 11.97m						
13									
14									
15									

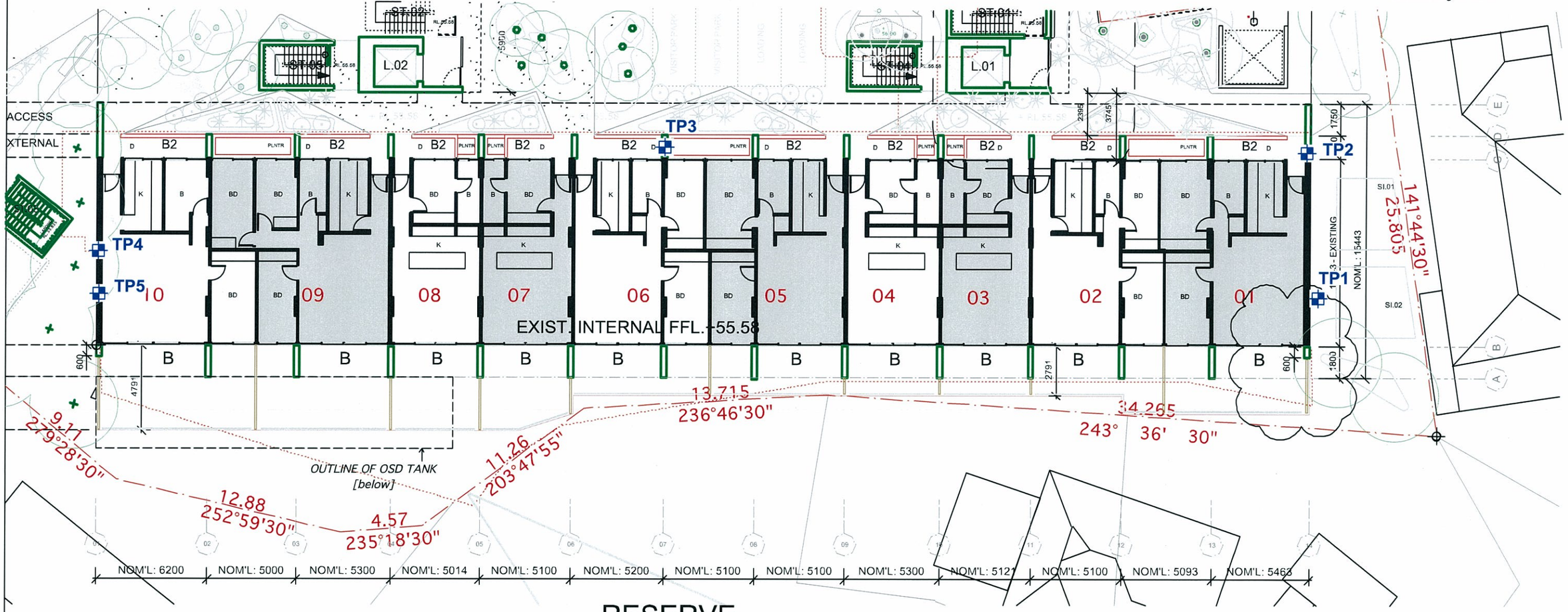
Remarks: END OF HOLE AT 11.97m DEPTH. Job / Report No. GT37A

Logged by: P. ANDERSON Date: 3.5.2017 Site Supervisor M. ASHOVER


20 ILLAWONG AVENUE
TAMARAMA
BH 4
1.30 — 11.97 M
20 ILLAWONG
TAMARAMA BH4
1·30
1·47
2·97
4·47
5·97
7·47
8·97
8·97
10·47
DOWN
HOLE
0·10
11·97



Locality Plan



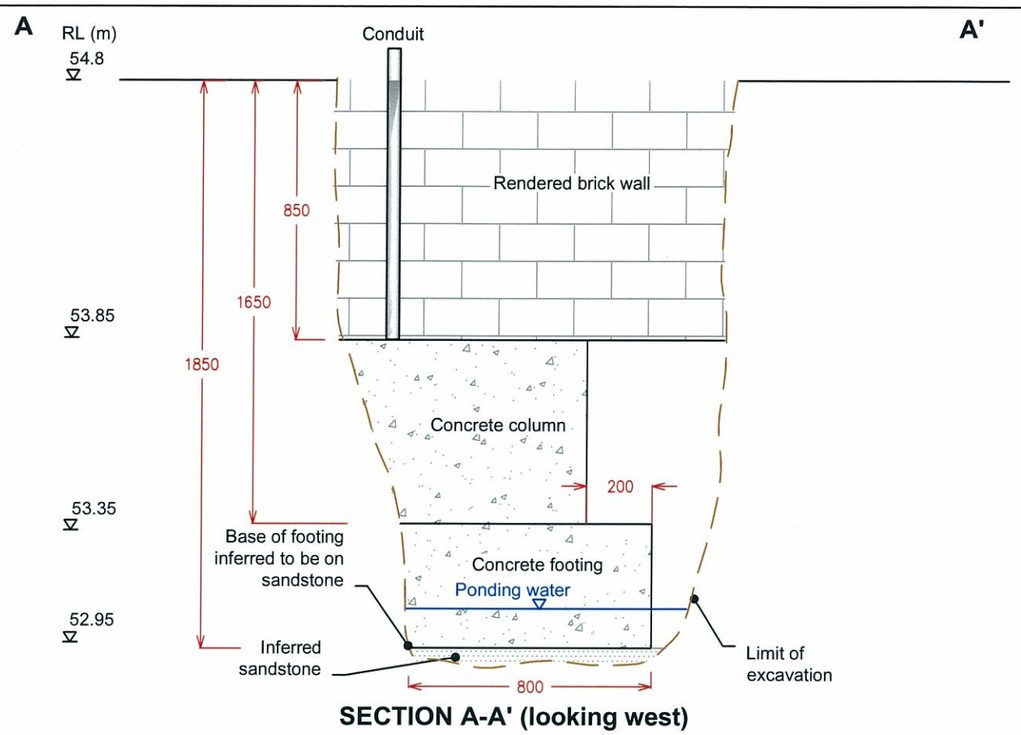
NOTE:
1. Base drawing from Tobias Partners Pty Ltd (Dwg DA.100, dated)
2. Test locations are approximate only and are shown with reference to existing site features.

0 1 2 3 4 6 8 10 15 20 25m
1:250 @ A3

LEGEND
- Test Pit Location

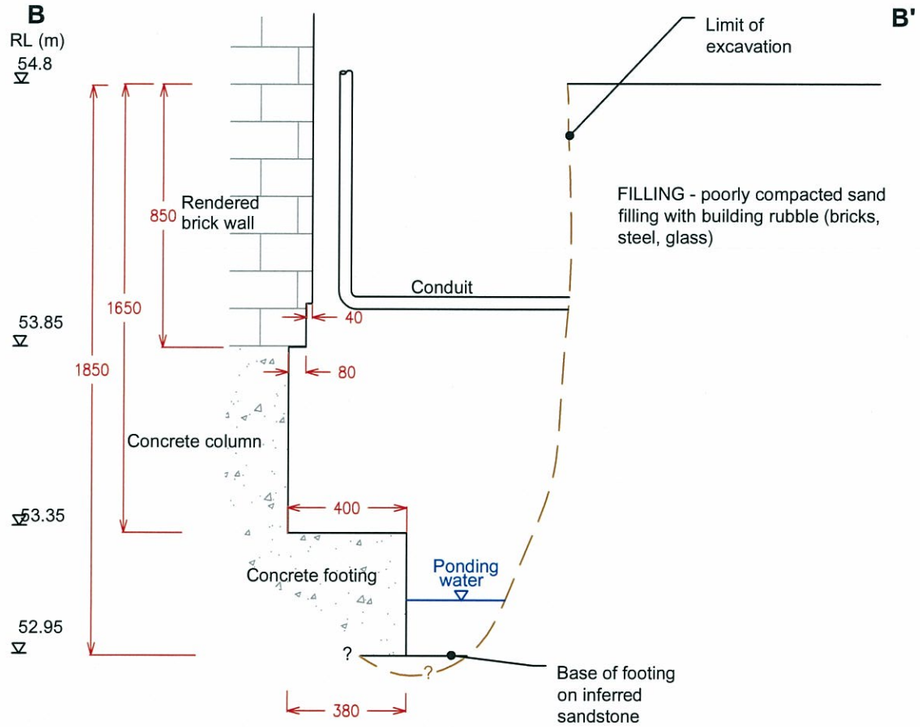
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Owners Strata Plan 1731		TITLE: **Test Pit Location Plan**	PROJECT No: 72261.03
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Car Park Alterations & Additions**	DRAWING No: 1
SCALE: 1:250 @ A3	DATE: 18.11.2014	**20 Illawong Avenue, TAMARAMA**	REVISION: 0



SECTION A-A' (looking west)

Photo 1: Plan view



SECTION B-B' (looking north)

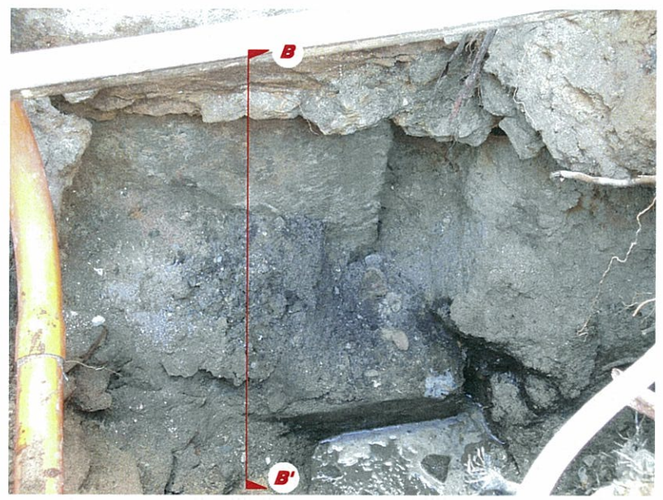
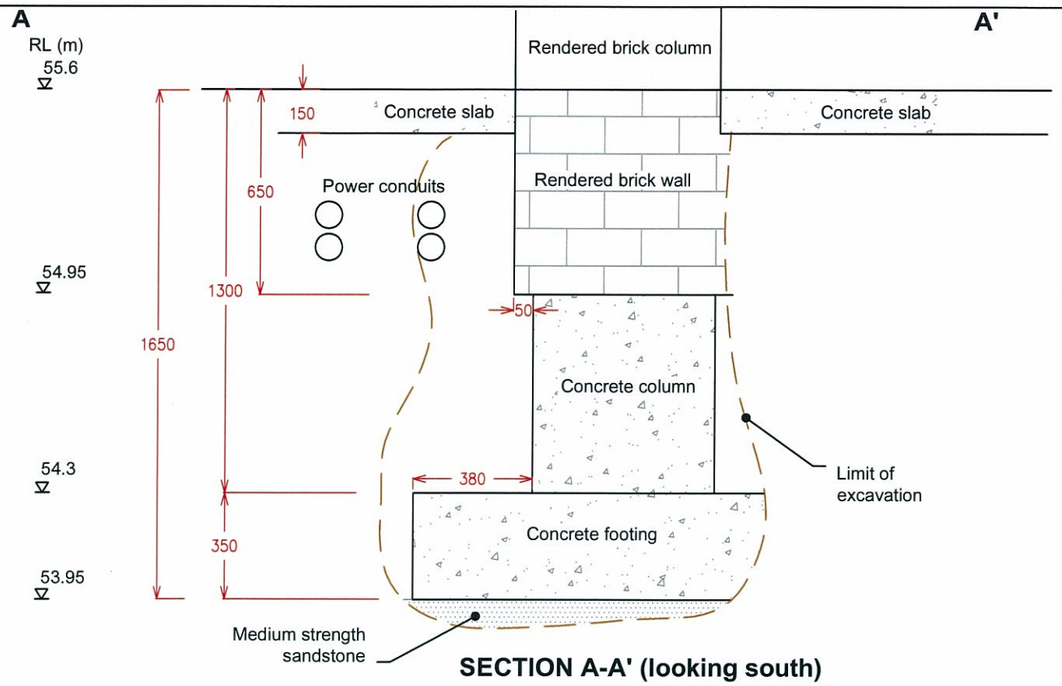


Photo 2: Showing corner of concrete footing

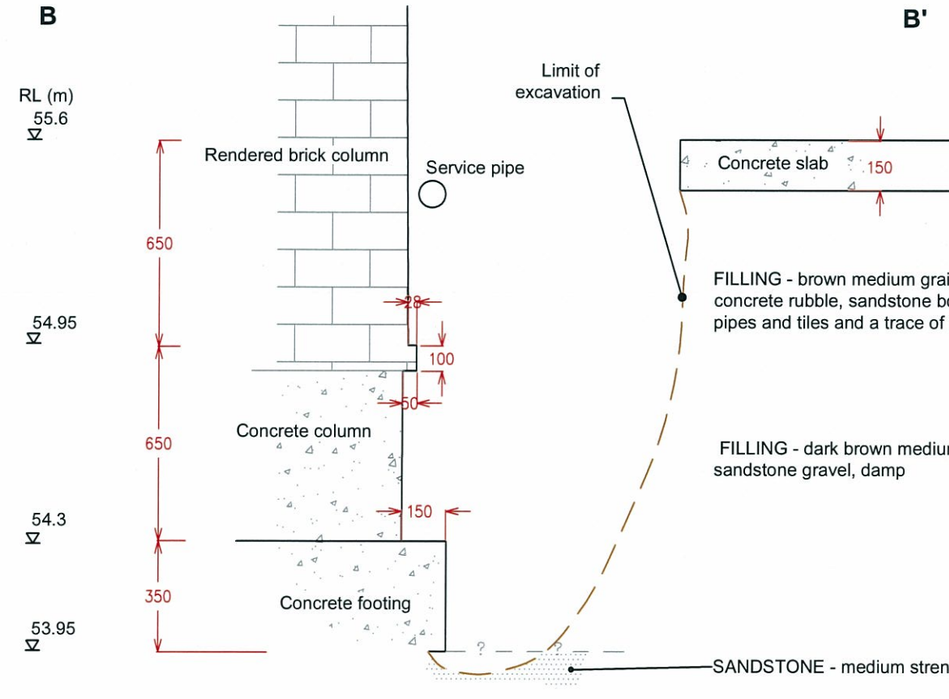
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Owners Strata Plan 1731		TITLE: **Test Pit 1 Details**	PROJECT No: 72261.03
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Car Park Alterations & Additions**	DRAWING No: 2
SCALE: 1:20 @ A3	DATE: 18.11.2014	**20 Illawong Avenue, TAMARAMA**	REVISION: 0



SECTION A-A' (looking south)

Photo 1: Plan view



SECTION B-B' (looking west)

Photo 2: Northern edge of concrete footing

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Owners Strata Plan 1731		TITLE: **Test Pit 2 Details** **Proposed Car Park Alterations & Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.03
	OFFICE: Sydney	DRAWN BY: PSCH		DRAWING No: 3
	SCALE: 1:20 @ A3	DATE: 18.11.2014		REVISION: 0

PLAN VIEW

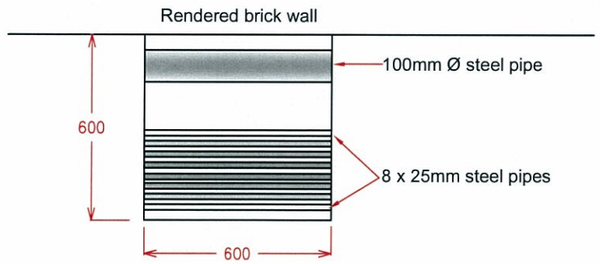
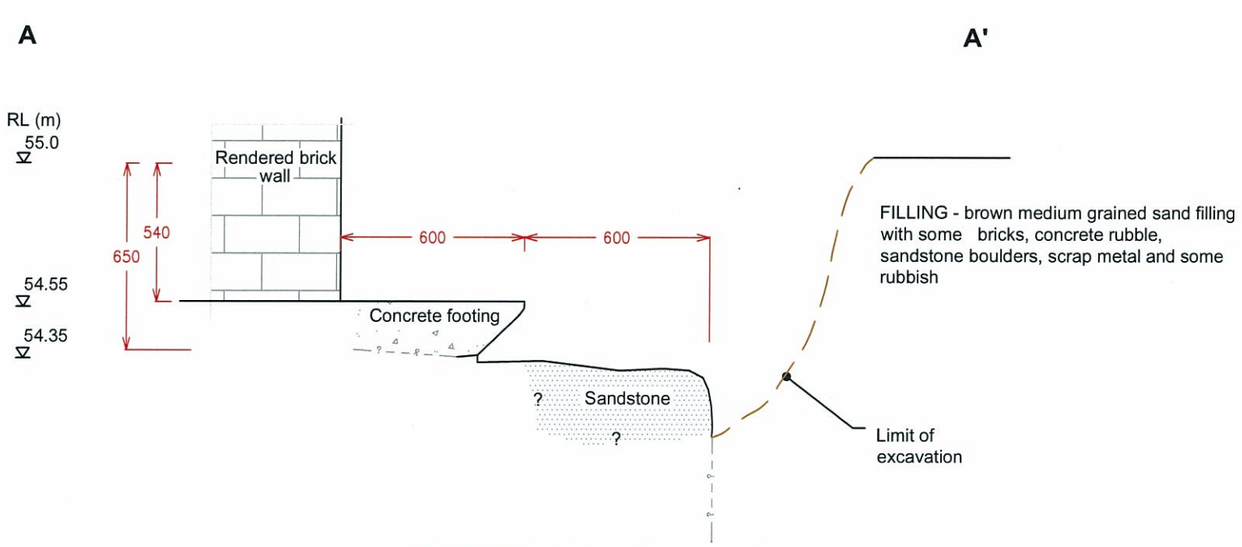


Photo 1: TP3 location

Photo 2: Services below slab

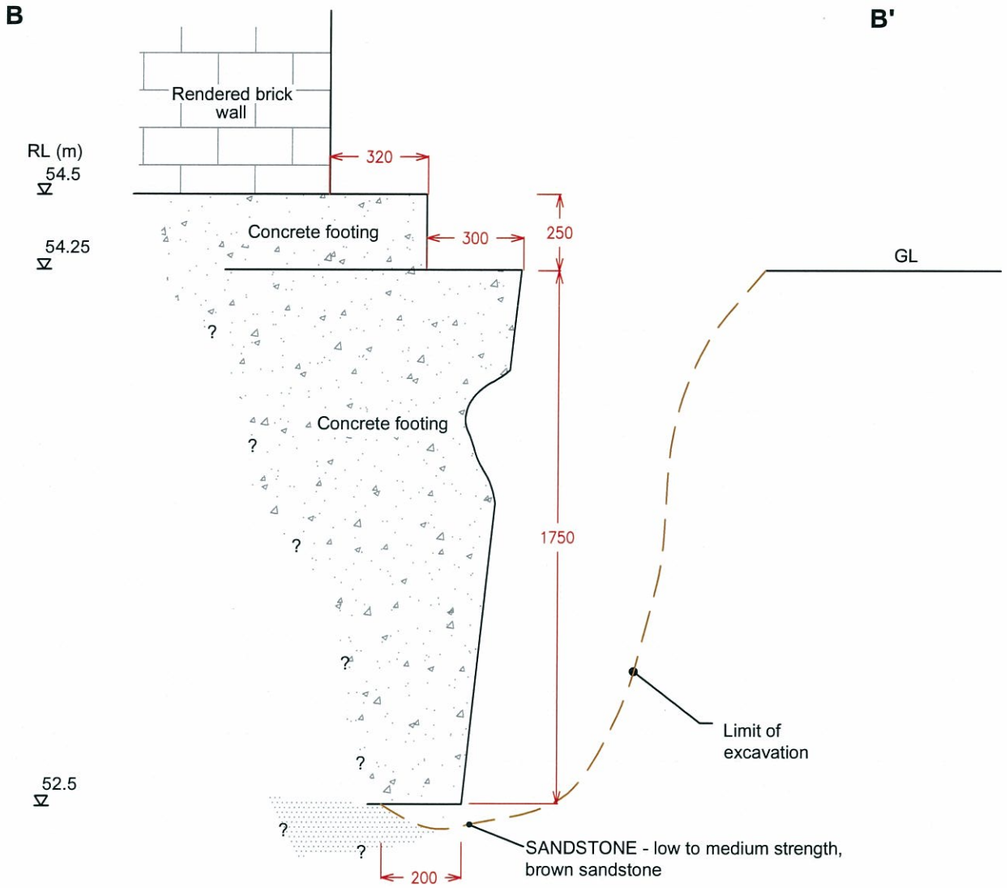
Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Owners Strata Plan 1731		TITLE: **Test Pit 3 Details** **Proposed Car Park Alterations & Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.03
	OFFICE: Sydney	DRAWN BY: PSCH		DRAWING No: 4
	SCALE: 1:20 @ A3	DATE: 18.11.2014		REVISION: 0



SECTION A-A' (looking south)

Photo 1: TP4 looking east

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Owners Strata Plan 1731	TITLE: **Test Pit 4 Section A-A'** **Proposed Car Park Alterations & Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.03
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: 6
	SCALE: 1:20 @ A3 / DATE: 19.11.2014		REVISION: 0



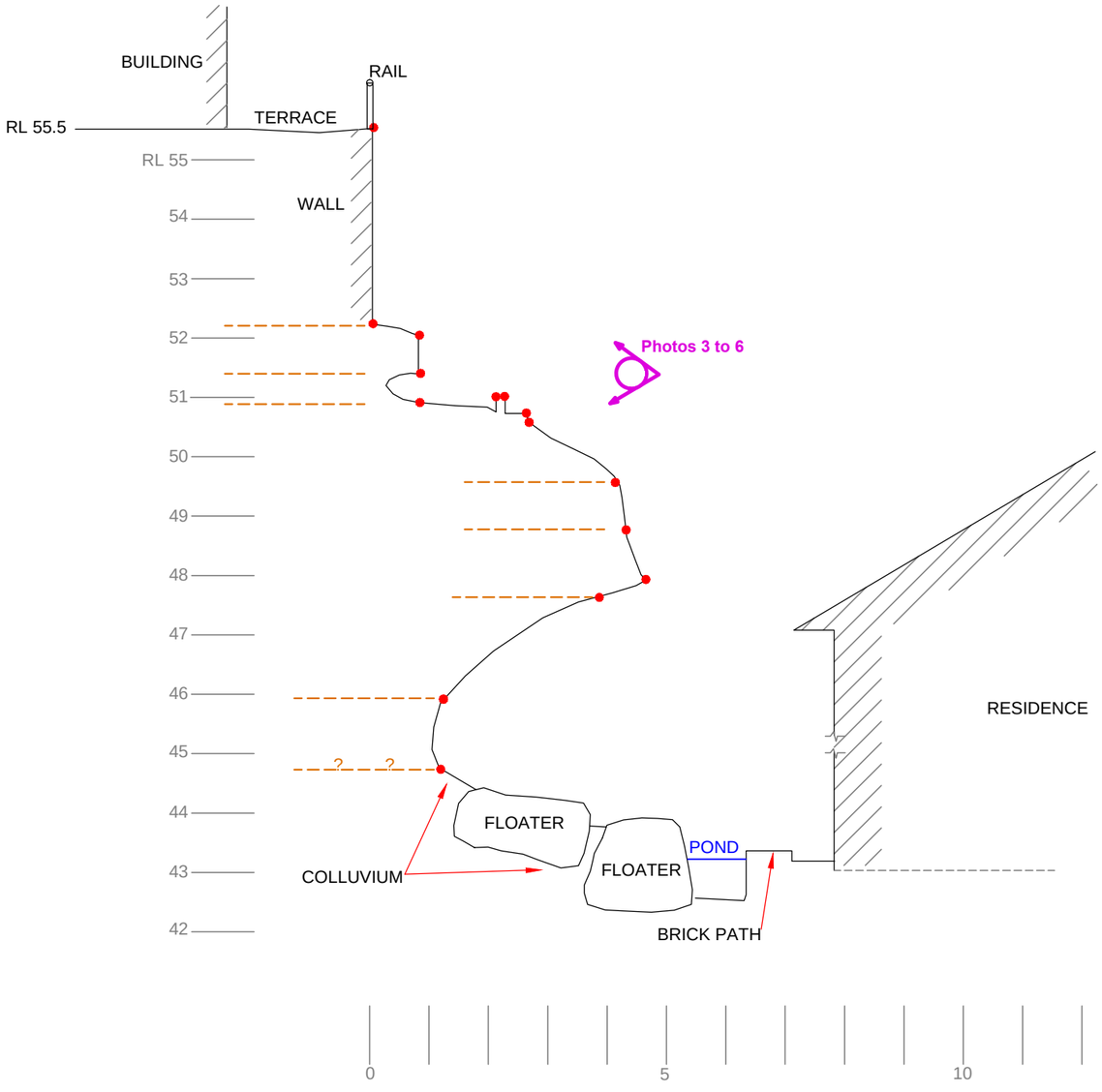
SECTION B-B' (looking south)

Photo 1: TP5 (looking east)

Photo 2: Base of TP5 (looking south)

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Owners Strata Plan 1731	TITLE: **Test Pit 5 Section B-B'** **Proposed Car Park Alterations & Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.03
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: 7
	SCALE: 1:20 @ A3 / DATE: 19.11.2014		REVISION: 0

CROSS SECTION 1



Section 1 viewed towards the north east
(prior to clearing)

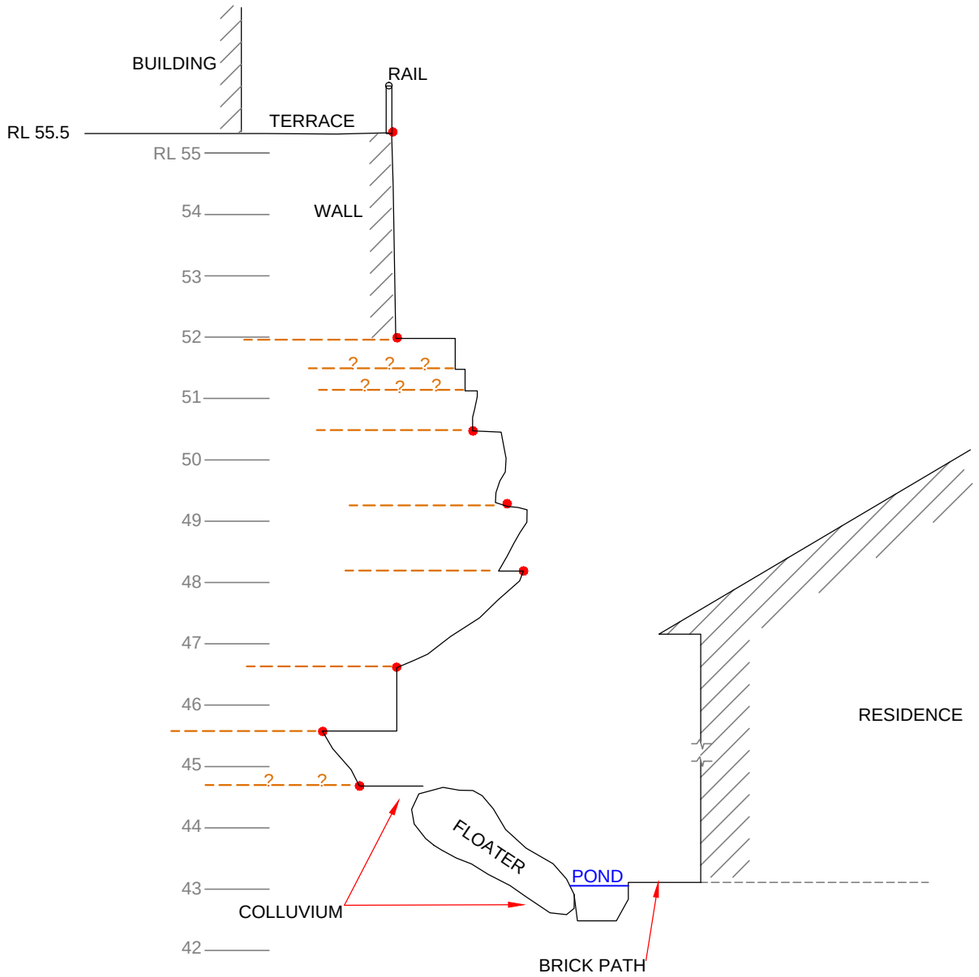
LEGEND

- Measured profile point
- Bedding plane
- Photo number with direction of view

SCALE: 1:100 H=V

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: SP 1731	TITLE: **Cross Section 1** **Proposed Car Park, Alterations & Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.04
	OFFICE: Sydney / DRAWN BY: PSCH		DRAWING No: 2
	SCALE: 1:100 @A3 / DATE: 14.2.2017		REVISION: 0

CROSS SECTION 2



Section 2 viewed towards the north east

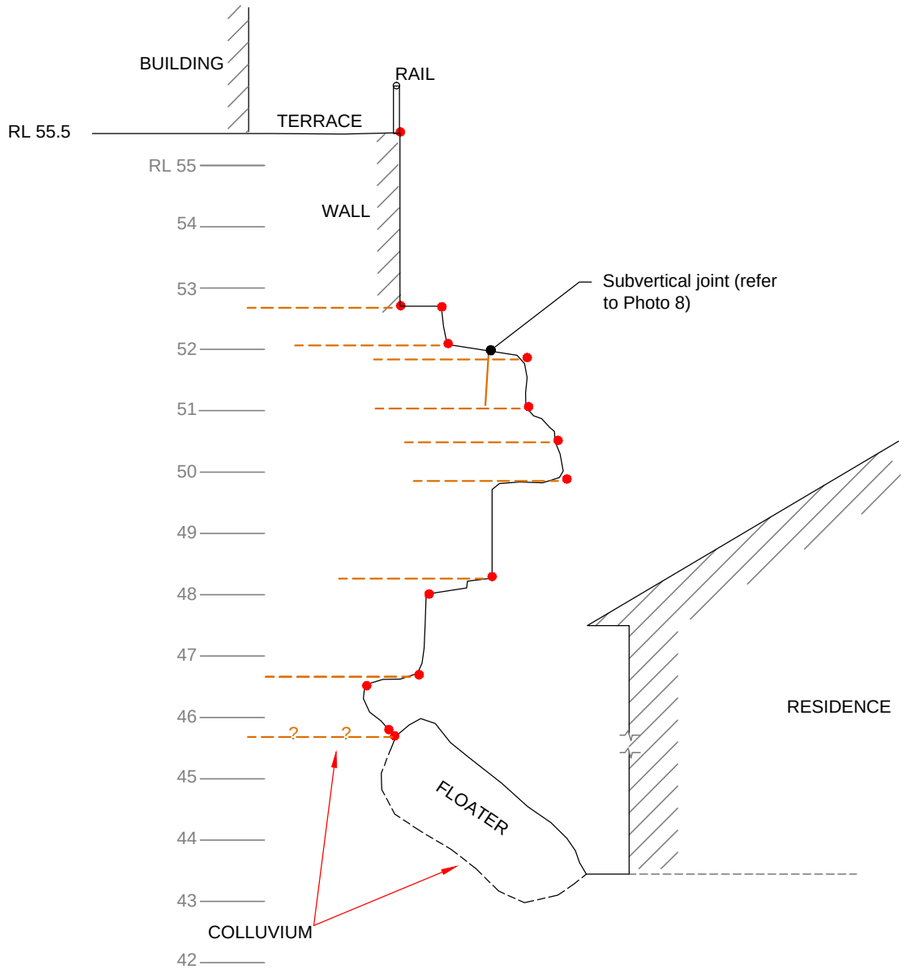
LEGEND

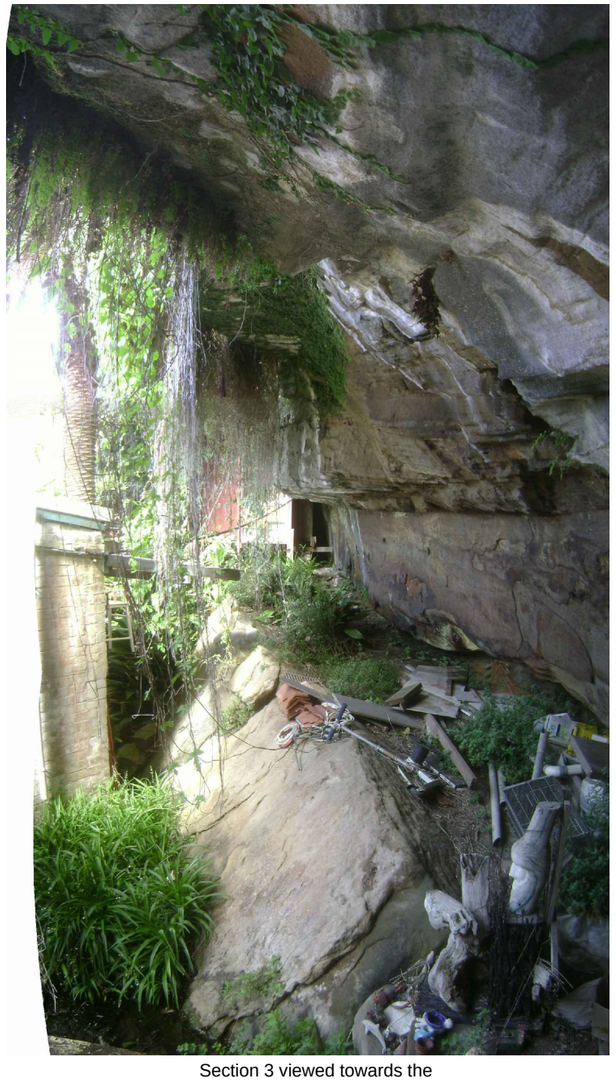
- Measured profile point
- Bedding plane

SCALE: 1:100 H=V

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: SP 1731	TITLE: **Cross Section 2** **Proposed Car Park, Alterations & Additions** **20 Illawong Avenue, TAMARAMA**	PROJECT No: 72261.04
	OFFICE: Sydney DRAWN BY: PSCH		DRAWING No: 3
	SCALE: 1:100 @A3 DATE: 14.2.2017		REVISION: 0

CROSS SECTION 3





Section 3 viewed towards the south west

LEGEND

- Measured profile point
- Bedding

SCALE: 1:100 H=V

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: SP1731	TITLE: **Cross Section 3**	PROJECT No: 72261.04
	OFFICE: Sydney / DRAWN BY: PSCH	**Proposed Car Park, Alterations & Additions**	DRAWING No: 4
	SCALE: 1:100 @A3 / DATE: 14.2.2017	**20 Illawong Avenue, TAMARAMA**	REVISION: 0

Photo 1. Southern side of building showing rope attachment locations to enable measurements for Cross Sections 1 and 2/3.

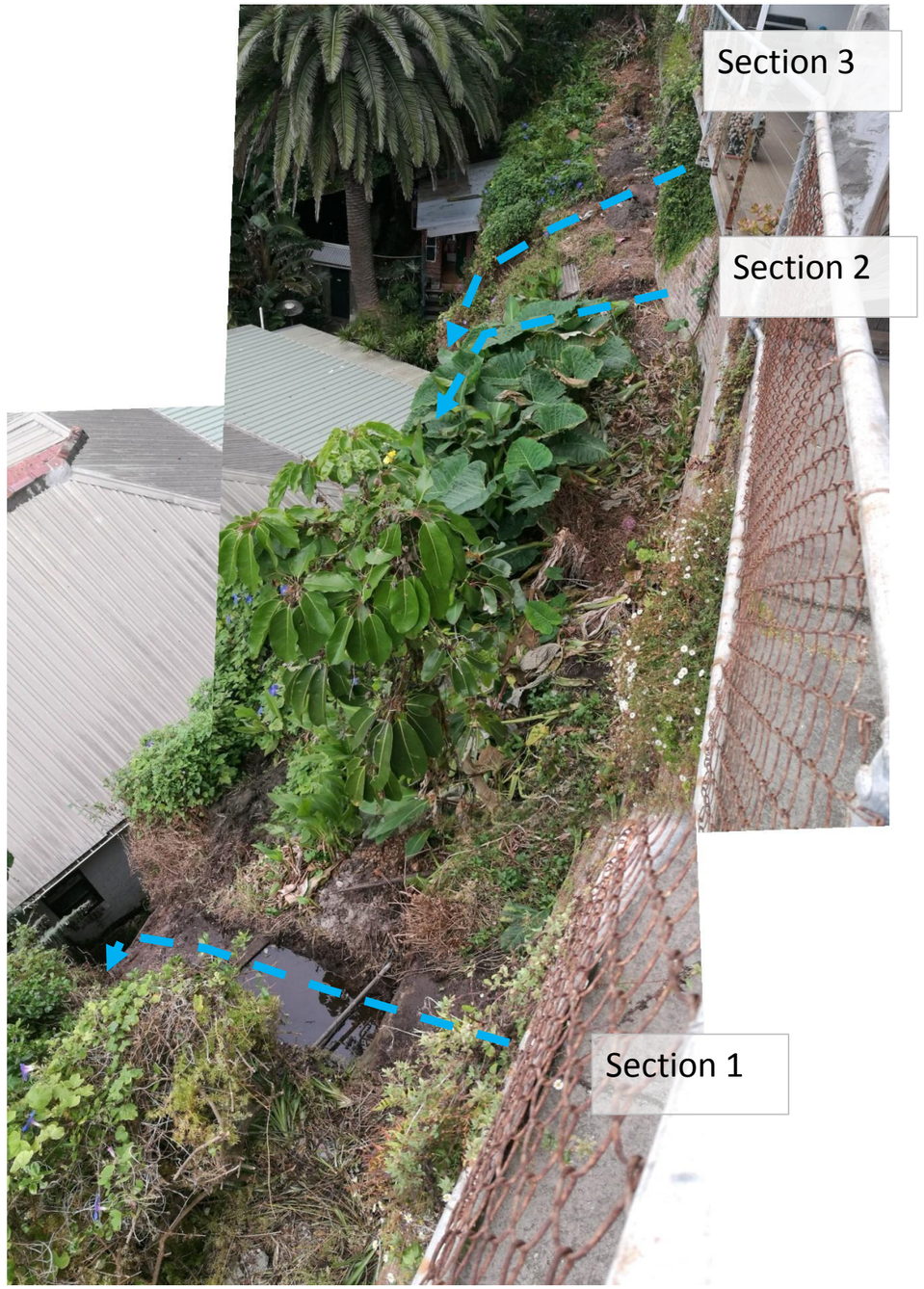


Photo 2. Top of the cliff, viewed towards the south-west at the time of vegetation clearing in 2016. Cross Section Numbers and locations indicated.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: SP 1731	TITLE: **Site Photographs** **Supplementary Geotechnical Assessment of Southern Cliff Line** **20 Illawong Avenue, Tamarama**	PROJECT No: 72261.04	
	OFFICE: Sydney / DRAWN BY: RKL		PLATE No: 1	
	SCALE: As shown / DATE: 26/3/2017		REVISION: -	

Photo 3. Cross Section 1; contact between brick terrace wall and sandstone bedrock showing lower very low strength rock.

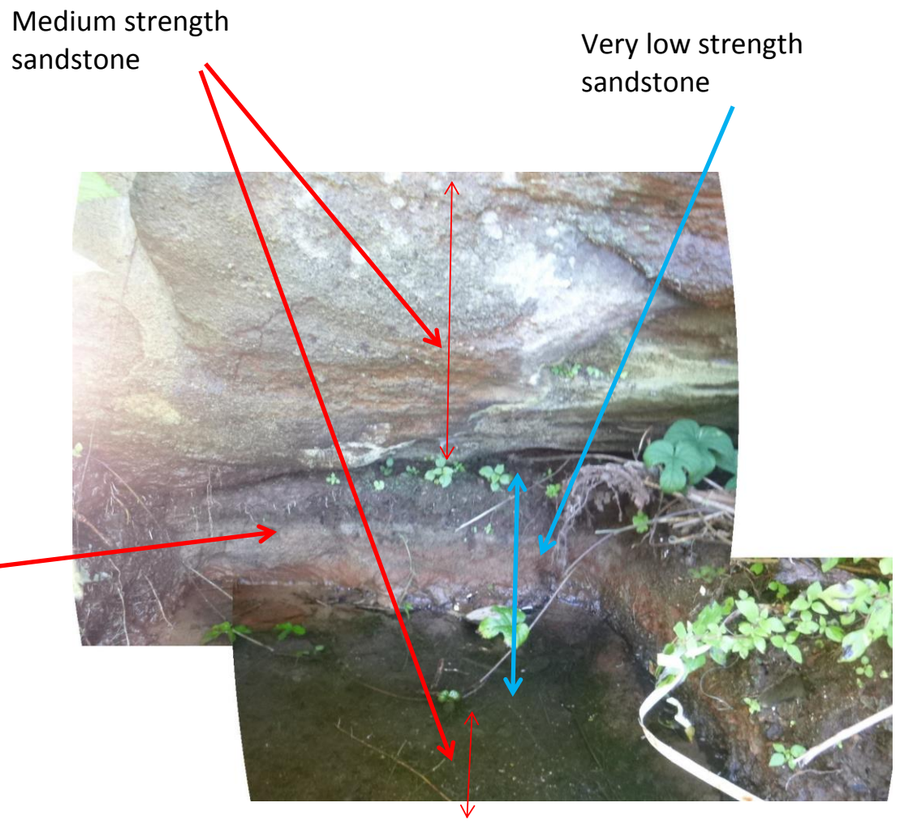


Photo 4.. Close up of Medium strength sandstone over very low strength, clayey sandstone then medium strength sandstone

Photo 5. To north of Section 3 showing 1900mm penetration of tape measure into void/weathered seam.

Photo 6. View into the weathered void.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: SP 1731	TITLE: **Site Photographs**	PROJECT No: 72261.04
	OFFICE: Sydney / DRAWN BY: RKL	**Supplementary Geotechnical Assessment of Southern Cliff Line**	PLATE No: 2
	SCALE: As shown / DATE: 26/3/2017	**20 Illawong Avenue, Tamarama**	REVISION: -

Photo 7. Cross Section 3 viewed towards the south-west. Note adjacent terrace wall has been cut down through detached sandstone block of the outcrop .

Photo 8. Outer edge of Section 3. Note 1m long steel test probe inserted 700mm into an open, though sand filled, joint, approximately 700mm back from the cliff crest.

Photo 8a. Close up of test probe inserted into the open joint.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: SP 1731	TITLE: **Site Photographs** **Supplementary Geotechnical Assessment of Southern Cliff Line** **20 Illawong Avenue, Tamarama**	PROJECT No: 72261.04	
	OFFICE: Sydney / DRAWN BY: RKL		PLATE No: 3	
	SCALE: As shown / DATE: 26/3/2017		REVISION: -	

Photo 9. Area to the south-west of Section 3. Note higher level (of less extensive) undercut than the major undercut (refer to Drawing 2 to 4 photos) further to the north at Sections 1 to 3.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: SP 1731		TITLE: **Site Photographs**	PROJECT No: 72261.04
	OFFICE: Sydney	DRAWN BY: RKL	**Supplementary Geotechnical Assessment of Southern Cliff Line**	PLATE No: 4
	SCALE: As shown	DATE: 26/3/2017	**20 Illawong Avenue, Tamarama**	REVISION: -

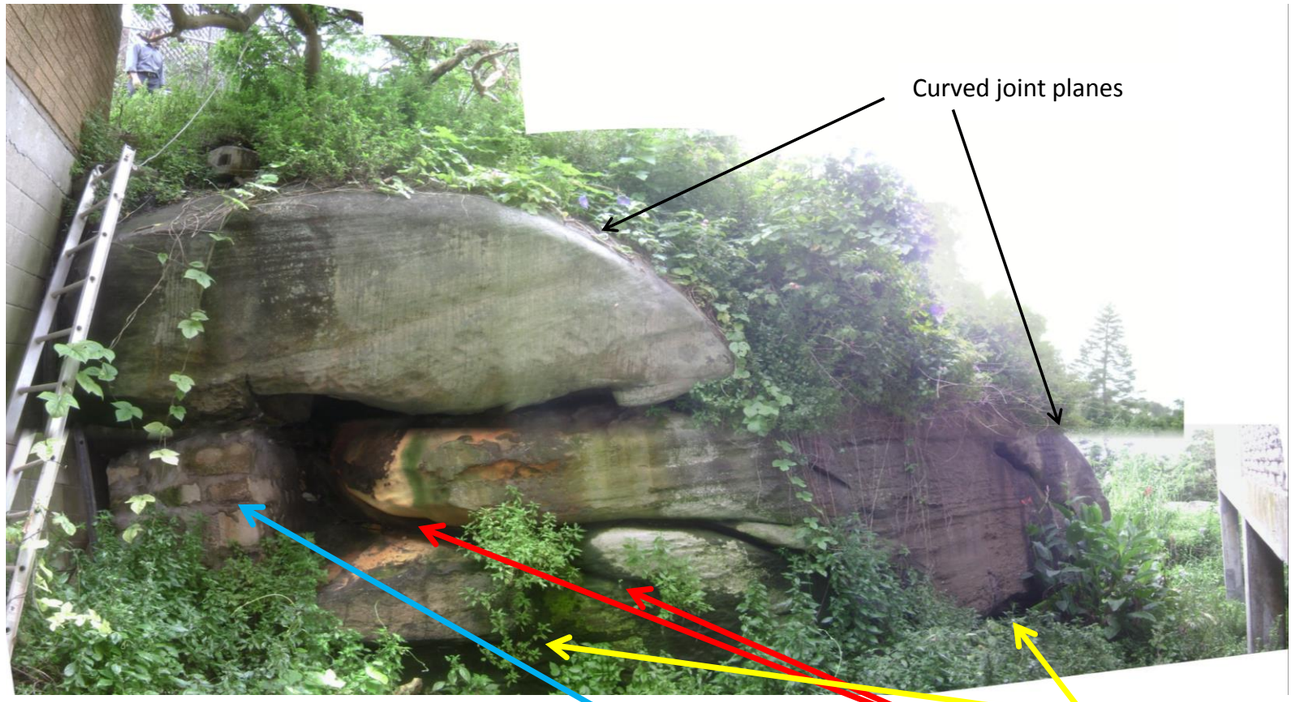


Photo 10. Southern end of cliff showing underpinning column, weathered joint and bedding planes and curved joint planes.

Photo 11. "Eastern end" of the southern most portion of the sandstone outcrop/cliff.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: SP1731		TITLE: **Site Photographs**	PROJECT No: 72261.04
	OFFICE: Sydney	DRAWN BY: RKL	**Supplementary Geotechnical Assessment of Southern Cliff Line**	PLATE No: 5
	SCALE: As shown	DATE: 26/3/2017	**20 Illawong Avenue, Tamarama**	REVISION: -

Historical Site Photograph of Sewer Diversion Trench, Photo 1 – View to east near Borehole BH3. Solid sandstone exposed at shallow depth along trench excavation.

Douglas Partners Geotechnics / Environment / Groundwater	**Historical Site Photographs – Sewer Diversion Trench** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: F1 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 19/11/2018

Historical Site Photograph of Sewer Diversion Trench, Photo 2 – View to west near Borehole BH3. Solid sandstone exposed at shallow depth along trench excavation.

Douglas Partners Geotechnics / Environment / Groundwater	**Historical Site Photographs – Sewer Diversion Trench** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: F2 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 19/11/2018

Historical Site Photograph of Sewer Diversion Trench, Photo 3 – View to south-west near Borehole BH5. Solid sandstone exposed at shallow depth along trench excavation. The approximate position of the clayey feature shown in Photo 4 is indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Historical Site Photographs – Sewer Diversion Trench** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: F3 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 19/11/2018

Historical Site Photograph of Sewer Diversion Trench, Photo 4 – View to north-west near Borehole BH5 and BH103. Sub-vertical, clay-infilled undulating defect in rock (indicated between arrows as shown), inferred to be an intrusive dyke weathered to clay, or a clay-infilled joint defect.

Douglas Partners Geotechnics / Environment / Groundwater	**Historical Site Photographs – Sewer Diversion Trench** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: F4 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 19/11/2018

Historical Site Photograph of Sewer Diversion Trench, Photo 5 – View to north near Borehole BH101. Solid sandstone exposed at shallow depth along trench excavation. The approximate position of Borehole BH5 indicated as shown for reference.

Douglas Partners Geotechnics / Environment / Groundwater	**Historical Site Photographs – Sewer Diversion Trench** **Alterations and Additions** **20 Illawong Avenue, Tamarama**	PROJECT: 72261.06 PLATE No: F5 REV: 0
	CLIENT: Strata Plan SP1731	DATE: 19/11/2018

Appendix G

Historical Laboratory Test Results

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

CERTIFICATE OF ANALYSIS 119989

Client:
Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: Peter Hartcliff

Sample log in details:

Your Reference:	**72261.03**		
No. of samples:	3 soils 1 material		
Date samples received / completed instructions received	26/11/14	/	26/11/14

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	3/12/14	/	3/12/14
Date of Preliminary Report:	Not Issued		

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Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

vTRH(C6-C10)/BTEXN in Soil				
Our Reference:	UNITS	119989-1	119989-2	119989-3
Your Reference	----------	TP1	TP4	TP5
Date Sampled	----------	25/11/2014	25/11/2014	25/11/2014
Type of sample		SOIL	SOIL	SOIL
Date extracted	-	27/11/2014	27/11/2014	27/11/2014
Date analysed	-	27/11/2014	27/11/2014	27/11/2014
TRHC$_6$ - C$_9$	mg/kg	<25	<25	<25
TRHC$_6$ - C$_{10}$	mg/kg	<25	<25	<25
vTPHC$_6$ - C$_{10}$ less BTEX (F1)	mg/kg	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	92	97	92

svTRH (C10-C40) in Soil				
Our Reference:	UNITS	119989-1	119989-2	119989-3
Your Reference	----------	TP1	TP4	TP5
Date Sampled	----------	25/11/2014	25/11/2014	25/11/2014
Type of sample		SOIL	SOIL	SOIL
Date extracted	-	27/11/2014	28/11/2014	27/11/2014
Date analysed	-	27/11/2014	01/12/2014	27/11/2014
TRHC$_{10}$ - C$_{14}$	mg/kg	<50	<50	<50
TRHC$_{15}$ - C$_{28}$	mg/kg	<100	<100	180
TRHC$_{29}$ - C$_{36}$	mg/kg	<100	<100	150
TRH>C$_{10}$-C$_{16}$	mg/kg	<50	<50	<50
TRH>C$_{10}$ - C$_{16}$ less Naphthalene (F2)	mg/kg	<50	<50	<50
TRH>C$_{16}$-C$_{34}$	mg/kg	<100	150	300
TRH>C$_{34}$-C$_{40}$	mg/kg	<100	<100	110
Surrogate o-Terphenyl	%	87	121	91

PAHs in Soil Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- ----------	119989-1 TP1 25/11/2014 SOIL	119989-2 TP4 25/11/2014 SOIL	119989-3 TP5 25/11/2014 SOIL
Date extracted	-	27/11/2014	27/11/2014	27/11/2014
Date analysed	-	27/11/2014	27/11/2014	27/11/2014
Naphthalene	mg/kg	<0.1	<0.1	0.1
Acenaphthylene	mg/kg	<0.1	0.2	0.6
Acenaphthene	mg/kg	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	0.2
Phenanthrene	mg/kg	0.3	1.0	4.0
Anthracene	mg/kg	<0.1	0.2	1.0
Fluoranthene	mg/kg	0.6	2.5	7.2
Pyrene	mg/kg	0.6	2.8	7.5
Benzo(a)anthracene	mg/kg	0.3	1.3	3.6
Chrysene	mg/kg	0.3	1.3	3.5
Benzo(b,j+k)fluoranthene	mg/kg	0.6	2.3	6.0
Benzo(a)pyrene	mg/kg	0.3	1.6	4.1
Indeno(1,2,3-c,d)pyrene	mg/kg	0.2	0.9	2.3
Dibenzo(a,h)anthracene	mg/kg	<0.1	0.1	0.3
Benzo(g,h,i)perylene	mg/kg	0.2	0.9	2.2
Benzo(a)pyrene TEQ NEPM B1	mg/kg	<0.5	2.2	5.7
Total Positive PAHs	mg/kg	3.5	15	43
Surrogate p-Terphenyl-d14	%	106	92	108

Organochlorine Pesticides in soil				
Our Reference:	UNITS	119989-1	119989-2	119989-3
Your Reference	----------	TP1	TP4	TP5
Date Sampled	----------	25/11/2014	25/11/2014	25/11/2014
Type of sample		SOIL	SOIL	SOIL
Date extracted	-	27/11/2014	27/11/2014	27/11/2014
Date analysed	-	27/11/2014	27/11/2014	27/11/2014
HCB	mg/kg	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1
pp-DDE	mg/kg	0.2	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1
pp-DDT	mg/kg	0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1
Surrogate TCMX	%	98	77	104

Organophosphorus Pesticides				
Our Reference:	UNITS	119989-1	119989-2	119989-3
Your Reference	----------	TP1	TP4	TP5
Date Sampled	----------	25/11/2014	25/11/2014	25/11/2014
Type of sample		SOIL	SOIL	SOIL
Date extracted	-	27/11/2014	27/11/2014	27/11/2014
Date analysed	-	27/11/2014	27/11/2014	27/11/2014
Diazinon	mg/kg	<0.1	<0.1	<0.1
Dimethoate	mg/kg	<0.1	<0.1	<0.1
Chlorpyriphos-methyl	mg/kg	<0.1	<0.1	<0.1
Ronnel	mg/kg	<0.1	<0.1	<0.1
Chlorpyriphos	mg/kg	<0.1	<0.1	<0.1
Fenitrothion	mg/kg	<0.1	<0.1	<0.1
Bromophos-ethyl	mg/kg	<0.1	<0.1	<0.1
Ethion	mg/kg	<0.1	<0.1	<0.1
Surrogate TCMX	%	98	77	104

PCBs in Soil				
Our Reference:	UNITS	119989-1	119989-2	119989-3
Your Reference	----------	TP1	TP4	TP5
Date Sampled	----------	25/11/2014	25/11/2014	25/11/2014
Type of sample		SOIL	SOIL	SOIL
Date extracted	-	27/11/2014	27/11/2014	27/11/2014
Date analysed	-	27/11/2014	27/11/2014	27/11/2014
Arochlor 1016	mg/kg	<0.1	<0.1	<0.1
Arochlor 1221	mg/kg	<0.1	<0.1	<0.1
Arochlor 1232	mg/kg	<0.1	<0.1	<0.1
Arochlor 1242	mg/kg	<0.1	<0.1	<0.1
Arochlor 1248	mg/kg	<0.1	<0.1	<0.1
Arochlor 1254	mg/kg	<0.1	<0.1	<0.1
Arochlor 1260	mg/kg	<0.1	<0.1	<0.1
Surrogate TCLMX	%	98	77	104

Total Phenolics in Soil				
Our Reference:	UNITS	119989-1	119989-2	119989-3
Your Reference	----------	TP1	TP4	TP5
Date Sampled	----------	25/11/2014	25/11/2014	25/11/2014
Type of sample		SOIL	SOIL	SOIL
Date extracted	-	27/11/2014	27/11/2014	27/11/2014
Date analysed	-	27/11/2014	27/11/2014	27/11/2014
Total Phenolics (as Phenol)	mg/kg	<5	<5	<5

Acid Extractable metals in soil				
Our Reference:	UNITS	119989-1	119989-2	119989-3
Your Reference	----------	TP1	TP4	TP5
Date Sampled	----------	25/11/2014	25/11/2014	25/11/2014
Type of sample		SOIL	SOIL	SOIL
Date digested	-	28/11/2014	28/11/2014	28/11/2014
Date analysed	-	28/11/2014	28/11/2014	28/11/2014
Arsenic	mg/kg	5	<4	<4
Cadmium	mg/kg	<0.4	2	1
Chromium	mg/kg	6	10	8
Copper	mg/kg	20	35	51
Lead	mg/kg	100	320	470
Mercury	mg/kg	0.2	0.1	0.2
Nickel	mg/kg	5	5	5
Zinc	mg/kg	160	770	510

Moisture Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- ----------	119989-1 TP1 25/11/2014 SOIL	119989-2 TP4 25/11/2014 SOIL	119989-3 TP5 25/11/2014 SOIL
Date prepared	-	27/11/2014	27/11/2014	27/11/2014
Date analysed	-	28/11/2014	28/11/2014	28/11/2014
Moisture	%	7.1	6.0	5.0

Asbestos ID - soils				
Our Reference:	UNITS	119989-1	119989-2	119989-3
Your Reference	----------	TP1	TP4	TP5
Date Sampled	----------	25/11/2014	25/11/2014	25/11/2014
Type of sample		SOIL	SOIL	SOIL
Date analysed	-	2/12/2014	2/12/2014	2/12/2014
Sample mass tested	g	Approx 40g	Approx 40g	Approx 40g
Sample Description	-	Brown sandy soil & rocks	Brown sandy soil & rocks	Brown sandy soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg	No asbestos detected at reporting limit of 0.1g/kg	No asbestos detected at reporting limit of 0.1g/kg
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected

Asbestos ID - materials		
Our Reference:	UNITS	119989-4
Your Reference	----------	TP5
Date Sampled	----------	25/11/2014
Type of sample		Material
Date analysed	-	1/12/2014
Mass / Dimension of Sample	-	57x50x5mm
Sample Description	-	Grey compressed fibre cement material
Asbestos ID in materials	-	Chrysotile asbestos detected Amosite asbestos detected Crocidolite asbestos detected

Method ID	Methodology Summary
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-012 subset	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-008	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Inorg-031	Total Phenolics by segmented flow analyser (in line distillation with colourimetric finish). Solids are extracted in a caustic media prior to analysis.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.
Metals-021 CV-AAS	Determination of Mercury by Cold Vapour AAS.
Inorg-008	Moisture content determined by heating at 105+/-5 deg C for a minimum of 12 hours.
ASB-001	Asbestos ID - Qualitative identification of asbestos in bulk samples using Polarised Light Microscopy and Dispersion Staining Techniques including Synthetic Mineral Fibre and Organic Fibre as per Australian Standard 4964-2004.

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base || Duplicate || %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Date analysed	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
TRHC$_{6}$ - C$_{9}$	mg/kg	25	Org-016	<25	119989-1	<25 || <25	LCS-1	99%
TRHC$_{6}$ - C$_{10}$	mg/kg	25	Org-016	<25	119989-1	<25 || <25	LCS-1	99%
Benzene	mg/kg	0.2	Org-016	<0.2	119989-1	<0.2 || <0.2	LCS-1	98%
Toluene	mg/kg	0.5	Org-016	<0.5	119989-1	<0.5 || <0.5	LCS-1	98%
Ethylbenzene	mg/kg	1	Org-016	<1	119989-1	<1 || <1	LCS-1	99%
m+p-xylene	mg/kg	2	Org-016	<2	119989-1	<2 || <2	LCS-1	100%
o-Xylene	mg/kg	1	Org-016	<1	119989-1	<1 || <1	LCS-1	97%
naphthalene	mg/kg	1	Org-014	<1	119989-1	<1 || <1	[NR]	[NR]
Surrogate aaa-Trifluorotoluene	%		Org-016	92	119989-1	92 || 87 || RPD: 6	LCS-1	90%

QUALITY CONTROL svTRH (C10-C40) in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base || Duplicate || %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Date analysed	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
TRHC$_{10}$ - C$_{14}$	mg/kg	50	Org-003	<50	119989-1	<50 || <50	LCS-1	128%
TRHC$_{15}$ - C$_{28}$	mg/kg	100	Org-003	<100	119989-1	<100 || <100	LCS-1	129%
TRHC$_{29}$ - C$_{36}$	mg/kg	100	Org-003	<100	119989-1	<100 || <100	LCS-1	110%
TRH>C$_{10}$-C$_{16}$	mg/kg	50	Org-003	<50	119989-1	<50 || <50	LCS-1	128%
TRH>C$_{16}$-C$_{34}$	mg/kg	100	Org-003	<100	119989-1	<100 || <100	LCS-1	129%
TRH>C$_{34}$-C$_{40}$	mg/kg	100	Org-003	<100	119989-1	<100 || <100	LCS-1	110%
Surrogate o-Terphenyl	%		Org-003	80	119989-1	87 || 84 || RPD: 4	LCS-1	100%

QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base || Duplicate || %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Date analysed	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Naphthalene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	<0.1 || <0.1	LCS-1	103%
Acenaphthylene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Acenaphthene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Fluorene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	<0.1 || <0.1	LCS-1	100%
Phenanthrene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	0.3 || 0.1 || RPD: 100	LCS-1	104%
Anthracene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Fluoranthene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	0.6 || 0.3 || RPD: 67	LCS-1	105%

QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Pyrene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	0.6 || 0.4 || RPD: 40	LCS-1	106%
Benzo(a)anthracene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	0.3 || 0.2 || RPD: 40	[NR]	[NR]
Chrysene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	0.3 || 0.2 || RPD: 40	LCS-1	99%
Benzo(b,j+k) fluoranthene	mg/kg	0.2	Org-012 subset	<0.2	119989-1	0.6 || 0.4 || RPD: 40	[NR]	[NR]
Benzo(a)pyrene	mg/kg	0.05	Org-012 subset	<0.05	119989-1	0.3 || 0.3 || RPD: 0	LCS-1	119%
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	0.2 || 0.2 || RPD: 0	[NR]	[NR]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012 subset	<0.1	119989-1	0.2 || 0.2 || RPD: 0	[NR]	[NR]
Surrogate p-Terphenyl-d14	%		Org-012 subset	89	119989-1	106 || 104 || RPD: 2	LCS-1	97%

QUALITY CONTROL Organochlorine Pesticides in soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Date analysed	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
HCB	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	LCS-1	110%
gamma-BHC	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
beta-BHC	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	LCS-1	111%
Heptachlor	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	LCS-1	92%
delta-BHC	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Aldrin	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	LCS-1	99%
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	LCS-1	90%
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
pp-DDE	mg/kg	0.1	Org-005	<0.1	119989-1	0.2 || 0.2 || RPD: 0	LCS-1	102%
Dieldrin	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	LCS-1	91%
Endrin	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	LCS-1	100%
pp-DDD	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	LCS-1	123%
Endosulfan II	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
pp-DDT	mg/kg	0.1	Org-005	<0.1	119989-1	0.1 || 0.2 || RPD: 67	[NR]	[NR]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	LCS-1	100%
Methoxychlor	mg/kg	0.1	Org-005	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Surrogate TCMX	%		Org-005	78	119989-1	98 || 89 || RPD: 10	LCS-1	83%

QUALITY CONTROL Organophosphorus Pesticides	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Date analysed	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Diazinon	mg/kg	0.1	Org-008	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Dimethoate	mg/kg	0.1	Org-008	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Chlorpyriphos-methyl	mg/kg	0.1	Org-008	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Ronnel	mg/kg	0.1	Org-008	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Chlorpyriphos	mg/kg	0.1	Org-008	<0.1	119989-1	<0.1 || <0.1	LCS-1	107%
Fenitrothion	mg/kg	0.1	Org-008	<0.1	119989-1	<0.1 || <0.1	LCS-1	104%
Bromophos-ethyl	mg/kg	0.1	Org-008	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Ethion	mg/kg	0.1	Org-008	<0.1	119989-1	<0.1 || <0.1	LCS-1	111%
Surrogate TCMX	%		Org-008	78	119989-1	98 || 89 || RPD: 10	LCS-1	77%
QUALITY CONTROL PCBs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Date analysed	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Arochlor 1016	mg/kg	0.1	Org-006	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Arochlor 1221	mg/kg	0.1	Org-006	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Arochlor 1232	mg/kg	0.1	Org-006	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Arochlor 1242	mg/kg	0.1	Org-006	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Arochlor 1248	mg/kg	0.1	Org-006	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Arochlor 1254	mg/kg	0.1	Org-006	<0.1	119989-1	<0.1 || <0.1	LCS-1	94%
Arochlor 1260	mg/kg	0.1	Org-006	<0.1	119989-1	<0.1 || <0.1	[NR]	[NR]
Surrogate TCLMX	%		Org-006	78	119989-1	98 || 89 || RPD: 10	LCS-1	76%
QUALITY CONTROL Total Phenolics in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Date analysed	-			27/11/2014	119989-1	27/11/2014 || 27/11/2014	LCS-1	27/11/2014
Total Phenolics (as Phenol)	mg/kg	5	Inorg-031	<5	119989-1	<5 || <5	LCS-1	102%
QUALITY CONTROL Acid Extractable metals in soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date digested	-			28/11/2014	119989-1	28/11/2014 || 28/11/2014	LCS-7	28/11/2014
Date analysed	-			28/11/2014	119989-1	28/11/2014 || 28/11/2014	LCS-7	28/11/2014
Arsenic	mg/kg	4	Metals-020 ICP-AES	<4	119989-1	5 || 6 || RPD: 18	LCS-7	111%
Cadmium	mg/kg	0.4	Metals-020 ICP-AES	<0.4	119989-1	<0.4 || <0.4	LCS-7	106%

QUALITY CONTROL Acid Extractable metals in soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Chromium	mg/kg	1	Metals-020 ICP-AES	<1	119989-1	6 || 6 || RPD: 0	LCS-7	107%
Copper	mg/kg	1	Metals-020 ICP-AES	<1	119989-1	20 || 19 || RPD: 5	LCS-7	108%
Lead	mg/kg	1	Metals-020 ICP-AES	<1	119989-1	100 || 140 || RPD: 33	LCS-7	100%
Mercury	mg/kg	0.1	Metals-021 CV-AAS	<0.1	119989-1	0.2 || <0.1	LCS-7	102%
Nickel	mg/kg	1	Metals-020 ICP-AES	<1	119989-1	5 || 5 || RPD: 0	LCS-7	104%
Zinc	mg/kg	1	Metals-020 ICP-AES	<1	119989-1	160 || 180 || RPD: 12	LCS-7	104%

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	119989-2	27/11/2014
Date analysed	-	[NT]	[NT]	119989-2	27/11/2014
TRHC$_6$ - C$_9$	mg/kg	[NT]	[NT]	119989-2	106%
TRHC$_6$ - C$_{10}$	mg/kg	[NT]	[NT]	119989-2	106%
Benzene	mg/kg	[NT]	[NT]	119989-2	103%
Toluene	mg/kg	[NT]	[NT]	119989-2	103%
Ethylbenzene	mg/kg	[NT]	[NT]	119989-2	106%
m+p-xylene	mg/kg	[NT]	[NT]	119989-2	109%
o-Xylene	mg/kg	[NT]	[NT]	119989-2	103%
naphthalene	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate aaa-Trifluorotoluene	%	[NT]	[NT]	119989-2	91%

QUALITY CONTROL svTRH (C10-C40) in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	119989-2	27/11/2014
Date analysed	-	[NT]	[NT]	119989-2	1/12/2014
TRHC$_{10}$ - C$_{14}$	mg/kg	[NT]	[NT]	119989-2	130%
TRHC$_{15}$ - C$_{28}$	mg/kg	[NT]	[NT]	119989-2	#
TRHC$_{29}$ - C$_{36}$	mg/kg	[NT]	[NT]	119989-2	#
TRH>C$_{10}$-C$_{16}$	mg/kg	[NT]	[NT]	119989-2	130%
TRH>C$_{16}$-C$_{34}$	mg/kg	[NT]	[NT]	119989-2	#
TRH>C$_{34}$-C$_{40}$	mg/kg	[NT]	[NT]	119989-2	#
Surrogate o-Terphenyl	%	[NT]	[NT]	119989-2	105%

QUALITY CONTROL PAHs in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	119989-2	27/11/2014 || 27/11/2014	119989-2	27/11/2014
Date analysed	-	119989-2	27/11/2014 || 27/11/2014	119989-2	27/11/2014
Naphthalene	mg/kg	119989-2	<0.1 || <0.1	119989-2	100%
Acenaphthylene	mg/kg	119989-2	0.2 || 0.2 || RPD: 0	[NR]	[NR]
Acenaphthene	mg/kg	119989-2	<0.1 || <0.1	[NR]	[NR]
Fluorene	mg/kg	119989-2	<0.1 || <0.1	119989-2	123%
Phenanthrene	mg/kg	119989-2	1.0 || 1.4 || RPD: 33	119989-2	#
Anthracene	mg/kg	119989-2	0.2 || 0.3 || RPD: 40	[NR]	[NR]
Fluoranthene	mg/kg	119989-2	2.5 || 3.3 || RPD: 28	119989-2	#
Pyrene	mg/kg	119989-2	2.8 || 3.6 || RPD: 25	119989-2	#
Benzo(a)anthracene	mg/kg	119989-2	1.3 || 1.7 || RPD: 27	[NR]	[NR]
Chrysene	mg/kg	119989-2	1.3 || 1.7 || RPD: 27	119989-2	93%
Benzo(b,j+k)fluoranthene	mg/kg	119989-2	2.3 || 2.8 || RPD: 20	[NR]	[NR]
Benzo(a)pyrene	mg/kg	119989-2	1.6 || 1.9 || RPD: 17	119989-2	103%
Indeno(1,2,3-c,d)pyrene	mg/kg	119989-2	0.9 || 1.1 || RPD: 20	[NR]	[NR]
Dibenzo(a,h)anthracene	mg/kg	119989-2	0.1 || 0.2 || RPD: 67	[NR]	[NR]
Benzo(g,h,i)perylene	mg/kg	119989-2	0.9 || 1.1 || RPD: 20	[NR]	[NR]
Surrogate p-Terphenyl-d14	%	119989-2	92 || 132 || RPD: 36	119989-2	98%

QUALITY CONTROL Organochlorine Pesticides in soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	119989-2	27/11/2014
Date analysed	-	[NT]	[NT]	119989-2	27/11/2014
HCB	mg/kg	[NT]	[NT]	[NR]	[NR]
alpha-BHC	mg/kg	[NT]	[NT]	119989-2	110%
gamma-BHC	mg/kg	[NT]	[NT]	[NR]	[NR]
beta-BHC	mg/kg	[NT]	[NT]	119989-2	111%
Heptachlor	mg/kg	[NT]	[NT]	119989-2	99%
delta-BHC	mg/kg	[NT]	[NT]	[NR]	[NR]
Aldrin	mg/kg	[NT]	[NT]	119989-2	94%
Heptachlor Epoxide	mg/kg	[NT]	[NT]	119989-2	94%
gamma-Chlordane	mg/kg	[NT]	[NT]	[NR]	[NR]
alpha-chlordane	mg/kg	[NT]	[NT]	[NR]	[NR]
Endosulfan I	mg/kg	[NT]	[NT]	[NR]	[NR]
pp-DDE	mg/kg	[NT]	[NT]	119989-2	101%
Dieldrin	mg/kg	[NT]	[NT]	119989-2	104%
Endrin	mg/kg	[NT]	[NT]	119989-2	119%
pp-DDD	mg/kg	[NT]	[NT]	119989-2	129%
Endosulfan II	mg/kg	[NT]	[NT]	[NR]	[NR]
pp-DDT	mg/kg	[NT]	[NT]	[NR]	[NR]
Endrin Aldehyde	mg/kg	[NT]	[NT]	[NR]	[NR]
Endosulfan Sulphate	mg/kg	[NT]	[NT]	119989-2	107%

QUALITY CONTROL Organochlorine Pesticides in soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Methoxychlor	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate TCMX	%	[NT]	[NT]	119989-2	91%
QUALITY CONTROL Organophosphorus Pesticides	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	119989-2	27/11/2014
Date analysed	-	[NT]	[NT]	119989-2	27/11/2014
Diazinon	mg/kg	[NT]	[NT]	[NR]	[NR]
Dimethoate	mg/kg	[NT]	[NT]	[NR]	[NR]
Chlorpyriphos-methyl	mg/kg	[NT]	[NT]	[NR]	[NR]
Ronnel	mg/kg	[NT]	[NT]	[NR]	[NR]
Chlorpyriphos	mg/kg	[NT]	[NT]	119989-2	110%
Fenitrothion	mg/kg	[NT]	[NT]	119989-2	108%
Bromophos-ethyl	mg/kg	[NT]	[NT]	[NR]	[NR]
Ethion	mg/kg	[NT]	[NT]	119989-2	115%
Surrogate TCMX	%	[NT]	[NT]	119989-2	91%
QUALITY CONTROL PCBs in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	119989-2	27/11/2014
Date analysed	-	[NT]	[NT]	119989-2	27/11/2014
Arochlor 1016	mg/kg	[NT]	[NT]	[NR]	[NR]
Arochlor 1221	mg/kg	[NT]	[NT]	[NR]	[NR]
Arochlor 1232	mg/kg	[NT]	[NT]	[NR]	[NR]
Arochlor 1242	mg/kg	[NT]	[NT]	[NR]	[NR]
Arochlor 1248	mg/kg	[NT]	[NT]	[NR]	[NR]
Arochlor 1254	mg/kg	[NT]	[NT]	119989-2	90%
Arochlor 1260	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate TCLMX	%	[NT]	[NT]	119989-2	90%
QUALITY CONTROL Acid Extractable metals in soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date digested	-	[NT]	[NT]	119989-2	28/11/2014
Date analysed	-	[NT]	[NT]	119989-2	28/11/2014
Arsenic	mg/kg	[NT]	[NT]	119989-2	103%
Cadmium	mg/kg	[NT]	[NT]	119989-2	103%
Chromium	mg/kg	[NT]	[NT]	119989-2	96%
Copper	mg/kg	[NT]	[NT]	119989-2	113%
Lead	mg/kg	[NT]	[NT]	119989-2	90%
Mercury	mg/kg	[NT]	[NT]	119989-2	100%
Nickel	mg/kg	[NT]	[NT]	119989-2	99%
Zinc	mg/kg	[NT]	[NT]	119989-2	#

Report Comments:

PAH_S: # Percent recovery is not possible to report as the high concentration of analytes in the sample/s have caused interference and
The RPD for duplicate results is accepted due to the non homogenous nature of the sample/s.

TRHs in soil (semivol):
Percent recovery is not possible to report due to interference from analytes (other than those being tested) in the sample/s.

METALS_S: # Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

Asbestos: A portion of the supplied sample was sub-sampled for asbestos analysis according to Envirolab procedures. We cannot guarantee that this sub-sample is indicative of the entire sample. Envirolab recommends supplying 40-50g of sample in its own container.

Asbestos ID was analysed by Approved Identifier: Paul Ching
Asbestos ID was authorised by Approved Signatory: Paul Ching

INS: Insufficient sample for this test
NA: Test not required
<: Less than

PQL: Practical Quantitation Limit
RPD: Relative Percent Difference
>: Greater than

NT: Not tested
NA: Test not required
LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

CHAIN OF CUSTODY

Douglas Partners
Geotechnics / Environment / Groundwater

Client: Douglas Partners	**Project Number** 72261.03	**To:**	Envirolab Services
Contact Person: Peter Hartcliff	**Project Name:** Supplementary Geotechnical Investigation of Existing Footings	**Contact Person:**	Aileen Hie
Project Mgr: Peter Hartcliff	**PO No.:**	**Address:**	12 Ashley Street
	lab Quote No. :		Chatswood NSW 2068
Address: 96 Hermitage Road	**Date results required:** Standard	**Phone:**	02 9910 6200
West Ryde NSW 2114	**Or choose:** standard	**Fax:**	02 9910 6201
	Note: Inform lab in advance if urgent turnaround is required - surcharges apply	**Email:**	ahie@envirolab.com.au
Phone: 9809 0666 **Mob:** 0423 564 775	**Report format:** esdat / PDF / Excel	**Laboratory Report No:**	
Email: peter.hartcliff @douglaspartners.com.au	**Comments:**	**Lab Comments:**	

Sample information						Tests Required											Comments
Lab Sample ID	Field Sample ID	Depth	Date sampled	Container Type	Type of sample	Combo 8a	Asbestos									Combo	Provide as much information about the sample as you can
1	TP1		25.11.14	bag		✓											
2	TP4		25.11.15	bag		✓											
3	TP5		25.11.16	bag		✓											
4	TP5		25.11.17	bag			✓										
				✓ (small sample)													

ENVIROLAB GROUP
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 119989

Date Received: 26/11/14
Time Received 17:00
Received by: PT
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by: Douglas Partners	**Sample Receipt**	***Lab use only:***
Hand delivered / Courier (by whom) Peter Hartcliff	**Received by (Company):** EL	**Samples Received: Cool or Ambient (circle one)**
Condition of Sample at dispatch Cool or Ambient (circle)	**Print Name:** PT	**Temperature Received at:** (if applicable)
Temperature (if Applicable):	**Date & Time:** 26/11/14 17:00	**Transported by: Hand delivered / courier**
Print Name:	**Signature:** PT	
Date & Time:		
Signature:		

GEOTECHNICAL CENTRE
Unit W4K, 42 Wattle St, ULTIMO, NSW 2007
Telephone 02 - 9552 4864 Facsimile 02 - 9552 3615
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works NSW Water Solutions

CLIENT: REPORT No: S88/BS1004

COMPRESSIVE STRENGTH OF DIMENSION STONE

PROJECT: DOUGLAS PARTNERS SAMPLE No: S88

LOCATION: TAMARAMA

STONE TYPE / DESCRIPTION: Yellow Block

QUARRY NAME / LOCATION: Drill Core Borehole 72261 BH 1

SPECIMEN PREPARATION: "dry" specimens oven dried for 48 hrs at 60 +/- 2° C
"wet" specimens immersed for 48 hrs at 20 +/- 2° C

TESTED BY: ZG/JFY DATE TESTED: 7/03/2011

SPECIMEN NUMBER	AVERAGE DIAMETER (mm)	LENGTH (mm)	LOAD AT FAILURE (kN)	COMPRESSIVE STRENGTH (MPa)	AVERAGE STRENGTH (MPa)	RATIO OF WET TO DRY STRENGTH
1 dry	51.79	132.68	143.0	67.9	67.9	0.59
2 dry						
3 dry						
4 dry						
5 dry						
6 wet	51.80	130.53	88.85	42.2	40.0	
7 wet	51.79	130.98	79.85	37.9		
8 wet						
9 wet						
10 wet						

Remarks: Specimens cut and lapped in-house from core as received from client

Method: ASTM C170/C 170M - 09
Variation: H / D ratio 2.5/1 approx.

APPROVED SIGNATORY: _____
Zoran Gusevski 9/03/2011

Douglas Partners

Tamarama

Opera House

Geotechnical Centre
110B King Street, Manly Vale, NSW 2093
Telephone 02- 9949 0253
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT:	Minister's Stone Program	REPORT No:	17015/S270/BS1004

COMPRESSIVE STRENGTH OF DIMENSION STONE

PROJECT:	M.S.P. STOCKPILE MANAGEMENT	SAMPLE No:	S270
LOCATION:	20 Illawong Ave Tamarama		

STONE TYPE / DESCRIPTION: Sandstone, medium grained, massive
QUARRY NAME / LOCATION: 20 Illawong Ave, Tamarama
SPECIMEN PREPARATION: "dry" specimens oven dried for 48 hrs at 60 +/- 2° C
"wet" specimens immersed for 48 hrs at 20 +/- 2° C

TESTED BY: ZG/MA DATE TESTED: 15/06/2017

SPECIMEN NUMBER	BOREHOLE NUMBER	SAMPLE DEPTH (m)	LOAD AT FAILURE (kN)	COMPRESSIVE STRENGTH (MPa)	AVERAGE COMPRESSIVE STRENGTH (MPa)	RATIO OF WET TO DRY STRENGTH
1 dry	3	4.42-4.55	152.5	73.0	DRY	
2 dry	3	5.72-5.85	149.0	71.3		
3 dry					72.1	
4 dry						
5 dry						
6 wet	3	4.22-4.35	79.5	37.9	WET	0.55
7 wet	3	5.52-5.65	85.8	41.1		
8 wet					39.5	
9 wet						
10 wet						

Remarks: Specimens cut and prepared from NMLC drill core.

NATA Accredited for compliance with ISO/IEC 17025 - Testing

Method: ASTM C170/C 170M - 09
Variation: H / D ratio 2.5/1 approx.

Approved Signatory: M. Ashover

Mark Ashover, 20/06/2017

Geotechnical Centre
110B King Street, Manly Vale, NSW 2093
Telephone 02- 9949 0253
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT:	Minister's Stone Program	REPORT No:	17015/S271-1/BS1004

COMPRESSIVE STRENGTH OF DIMENSION STONE

PROJECT:	M.S.P. STOCKPILE MANAGEMENT	SAMPLE No:	S271-1
LOCATION:	20 Illawong Ave Tamarama		

STONE TYPE / DESCRIPTION: Sandstone, medium grained, massive
QUARRY NAME / LOCATION: 20 Illawong Ave, Tamarama
SPECIMEN PREPARATION: "dry" specimens oven dried for 48 hrs at 60 +/- 2° C
"wet" specimens immersed for 48 hrs at 20 +/- 2° C

TESTED BY: ZG/MA DATE TESTED: 15/06/2017

SPECIMEN NUMBER	BOREHOLE NUMBER	SAMPLE DEPTH (m)	LOAD AT FAILURE (kN)	COMPRESSIVE STRENGTH (MPa)	AVERAGE COMPRESSIVE STRENGTH (MPa)	RATIO OF WET TO DRY STRENGTH
1 dry	4	3.27-3.40	143.3	68.4	DRY	
2 dry						
3 dry					68.4	
4 dry						
5 dry						
6 wet	4	3.07-3.20	96.9	46.2	WET	0.68
7 wet						
8 wet					46.2	
9 wet						
10 wet						

Remarks: Specimens cut and prepared from NMLC drill core.

NATA Accredited for compliance with ISO/IEC 17025 - Testing

Method: ASTM C170/C 170M - 09
Variation: H / D ratio 2.5/1 approx.

Approved Signatory: M. Ashover

Mark Ashover, 20/06/2017

Geotechnical Centre
110B King Street, Manly Vale, NSW 2093
Telephone 02- 9949 0253
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT:	Minister's Stone Program	REPORT No:	17015/S271-3/BS1004

COMPRESSIVE STRENGTH OF DIMENSION STONE

PROJECT:	M.S.P. STOCKPILE MANAGEMENT	SAMPLE No:	S271-3
LOCATION:	20 Illawong Ave Tamarama		

STONE TYPE / DESCRIPTION: Sandstone, medium grained, laminated
QUARRY NAME / LOCATION: 20 Illawong Ave, Tamarama
SPECIMEN PREPARATION: "dry" specimens oven dried for 48 hrs at 60 +/- 2° C
"wet" specimens immersed for 48 hrs at 20 +/- 2° C
TESTED BY: ZG/MA DATE TESTED: 15/06/2017

SPECIMEN NUMBER	BOREHOLE NUMBER	SAMPLE DEPTH (m)	LOAD AT FAILURE (kN)	COMPRESSIVE STRENGTH (MPa)	AVERAGE COMPRESSIVE STRENGTH (MPa)	RATIO OF WET TO DRY STRENGTH
1 dry					DRY	0.93
2 dry	4	8.74-8.87	129.8	67.0		
3 dry					67.0	
4 dry						
5 dry						
6 wet					WET	
7 wet	4	8.50-8.63	129.8	62.0		
8 wet					62.0	
9 wet						
10 wet						

Remarks: Specimens cut and prepared from NMLC drill core.

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Method: ASTM C170/C 170M - 09
Variation: H / D ratio 2.5/1 approx.

Approved Signatory: M. Ashover

Mark Ashover, 20/06/2017

Geotechnical Centre

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NSW GOVERNMENT | Public Works Advisory

CLIENT: Minister's Stone Program — REPORT No: 17015/S270-1/BS1001

ABSORPTION, APPARENT POROSITY AND BULK SPECIFIC GRAVITY

PROJECT: M.S.P. STOCKPILE MANAGEMENT — SAMPLE No: S270-1

LOCATION: 20 Illawong Avenue, Tamarama

STONE TYPE / DESCRIPTION: Sandstone, medium grained, massive
QUARRY NAME / LOCATION: 20 Illawong Avenue, Tamarama - BH 3
SPECIMEN PREPARATION: Oven dried for 48 hrs at 60 +/- 2° C, Immersed for 48 hrs at 20 +/- 2° C

TESTED BY: ZG — DATE TESTED: 29/05/2017

SPECIMEN No		1	2	3	4	5
BOREHOLE No: BH 3	Depth (m):	4.15	4.35	-	-	-
DIMENSIONS (mm)	Diameter:	51.68	51.65	-	-	-
	Height:	49.54	46.64	-	-	-
WEIGHT OVEN DRY (g)	(A)	229.29	235.05	-	-	-
WEIGHT UNDER WATER (g)	(C)	136.64	141.39	-	-	-
WEIGHT SAT-SURFACE DRY (g)	(B)	238.81	243.26	-	-	-

	1	2	3	4	5	Average
WATER ABSORPTION (% by weight)	4.152	3.493	-	-	-	**3.82**
APPARENT POROSITY (% by volume)	9.318	8.059	-	-	-	**8.69**
BULK SPECIFIC GRAVITY (t/m³)	2.244	2.307	-	-	-	**2.28**

REMARKS: Cylindrical specimens prepared from core samples.

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Test Method: ASTM C 97/C 97M - 09

Approved Signatory: M. Ashover

Mark Ashover, 20/06/2017

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CLIENT: Minister's Stone Program — REPORT No: 17015/S270-2/BS1001

ABSORPTION, APPARENT POROSITY AND BULK SPECIFIC GRAVITY

PROJECT: M.S.P. STOCKPILE MANAGEMENT — SAMPLE No: S270-2

LOCATION: 20 Illawong Avenue, Tamarama

STONE TYPE / DESCRIPTION: Sandstone, medium grained, massive
QUARRY NAME / LOCATION: 20 Illawong Avenue, Tamarama - BH 3
SPECIMEN PREPARATION: Oven dried for 48 hrs at 60 +/- 2° C, Immersed for 48 hrs at 20 +/- 2° C

TESTED BY: ZG — DATE TESTED: 29/05/2017

SPECIMEN No		1	2	3	4	5
BOREHOLE No: BH 3	Depth (m):	5.45	5.65	-	-	-
DIMENSIONS (mm)	Diameter:	51.68	51.68	-	-	-
	Height:	50.00	49.80	-	-	-
WEIGHT OVEN DRY (g)	(A)	242.48	243.13	-	-	-
WEIGHT UNDER WATER (g)	(C)	146.90	147.72	-	-	-
WEIGHT SAT-SURFACE DRY (g)	(B)	250.25	250.55	-	-	-

	1	2	3	4	5	Average
WATER ABSORPTION (% by weight)	3.204	3.052	-	-	-	**3.13**
APPARENT POROSITY (% by volume)	7.518	7.216	-	-	-	**7.37**
BULK SPECIFIC GRAVITY (t/m³)	2.346	2.364	-	-	-	**2.36**

REMARKS: Cylindrical specimens prepared from core samples.

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Test Method: ASTM C 97/C 97M - 09

Approved Signatory: M. Ashover

Mark Ashover, 20/06/2017

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CLIENT: Minister's Stone Program	REPORT No: 17015/S271-1/BS1001

ABSORPTION, APPARENT POROSITY AND BULK SPECIFIC GRAVITY

PROJECT: M.S.P. STOCKPILE MANAGEMENT	SAMPLE No: S271-1
LOCATION: 20 Illawong Avenue, Tamarama	

STONE TYPE / DESCRIPTION: Sandstone, medium grained, massive
QUARRY NAME / LOCATION: 20 Illawong Avenue, Tamarama - BH 4
SPECIMEN PREPARATION: Oven dried for 48 hrs at 60 +/- 2° C, Immersed for 48 hrs at 20 +/- 2° C

TESTED BY: ZG DATE TESTED: 29/05/2017

SPECIMEN No		1	2	3	4	5
BOREHOLE No: BH 4	Depth (m):	3.00	3.20	-	-	-
DIMENSIONS (mm)	Diameter:	51.67	51.68	-	-	-
	Height:	50.75	50.77	-	-	-
WEIGHT OVEN DRY (g)	(A)	241.96	241.36	-	-	-
WEIGHT UNDER WATER (g)	(C)	146.11	145.67	-	-	-
WEIGHT SAT-SURFACE DRY (g)	(B)	250.74	250.32	-	-	-

	1	2	3	4	5	Average
WATER ABSORPTION (% by weight)	3.629	3.712	-	-	-	**3.67**
APPARENT POROSITY (% by volume)	8.391	8.562	-	-	-	**8.48**
BULK SPECIFIC GRAVITY (t/m³)	2.313	2.306	-	-	-	**2.31**

REMARKS: Cylindrical specimens prepared from core samples.

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Test Method: ASTM C 97/C 97M - 09

Approved Signatory: M. Ashover

Mark Ashover, 20/06/2017

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CLIENT: Minister's Stone Program	REPORT No: 17015/S271-3/BS1001

ABSORPTION, APPARENT POROSITY AND BULK SPECIFIC GRAVITY

PROJECT: M.S.P. STOCKPILE MANAGEMENT	SAMPLE No: S271-3
LOCATION: 20 Illawong Avenue, Tamarama	

STONE TYPE / DESCRIPTION: Sandstone, medium grained, laminated
QUARRY NAME / LOCATION: 20 Illawong Avenue, Tamarama - BH 4
SPECIMEN PREPARATION: Oven dried for 48 hrs at 60 +/- 2° C, Immersed for 48 hrs at 20 +/- 2° C

TESTED BY: ZG DATE TESTED: 29/05/2017

SPECIMEN No		1	2	3	4	5
BOREHOLE No: BH 4	Depth (m):	8.43	8.55	-	-	-
DIMENSIONS (mm)	Diameter:	51.68	51.67	-	-	-
	Height:	51.00	51.17	-	-	-
WEIGHT OVEN DRY (g)	(A)	244.67	245.44	-	-	-
WEIGHT UNDER WATER (g)	(C)	147.55	148.55	-	-	-
WEIGHT SAT-SURFACE DRY (g)	(B)	252.95	253.92	-	-	-

	1	2	3	4	5	Average
WATER ABSORPTION (% by weight)	3.384	3.455	-	-	-	**3.42**
APPARENT POROSITY (% by volume)	7.856	8.048	-	-	-	**7.95**
BULK SPECIFIC GRAVITY (t/m³)	2.321	2.329	-	-	-	**2.33**

REMARKS: Cylindrical specimens prepared from core samples.

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Test Method: ASTM C 97/C 97M - 09

Approved Signatory: M. Ashover

Mark Ashover, 20/06/2017

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NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT: Minister's Stone Program REPORT No: 17015/S271-2/BS1009

RESISTANCE TO SALT ATTACK

PROJECT: M.S.P. STOCKPILE MANAGEMENT SAMPLE No: S271-2

LOCATION: 20 Illawong Avenue, Tamarama

STONE TYPE / DESCRIPTION: Sandstone, medium grained, massive
QUARRY NAME / LOCATION: 20 Illawong Ave, Tamarama
SPECIMEN PREPARATION: Cylindrical specimens washed then oven dried 48 hrs at 62°C -

TESTED BY: ZG DATE TESTED: 29/05/17 to 20/06/17

SPECIMEN No:		1	2	3	4	5
BOREHOLE No: BH 4	Depth (m):	5.60	5.65	5.70	5.75	5.80
SPECIMEN DIMENSIONS (mm)	Diameter:	51.66	51.67	51.68	51.67	51.68
	Height:	51.00	50.85	50.97	51.04	51.10
DESCRIPTION OF DAMAGE:		Some Residue	Some Residue	Some Residue	Some Residue	Some Residue
MASS LOSS AFTER 15 CYCLES:		0.2%	0.2%	0.2%	0.2%	0.2%
DISINTEGRATION AT CYCLE:		---	---	---	---	---

MEAN PERCENTAGE MASS LOSS: **0.2 %**

REMARKS: Cylindrical specimens prepared from core samples.

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Test Solution: Sodium Sulphate 6.2%
Test Method : AS/NZS 4456.10:2003, Method A

Approved Signatory: M. Ashover

Mark Ashover, 20/06/2017

GEOTECHNICAL CENTRE

110B King Street Manly Vale NSW 2093
Telephone 02 - 9949 0253

KEYWORD: ROCK TESTING
TITLE: POINT LOAD STRENGTH INDEX WORKSHEET

PROJECT: 20 Illawong Avenue
LOCATION: Tamarama

Date of Drilling: 18/04/2017

Equipment: Load Frame: Robertson Research
Callipers: R131
Load Cell: HH4WT - 100kN
Serial No: 18L07-017
Drilling Method: NMLC coring
Core Diameter (mm): 51.52

BORE	DEPTH (m)	TEST TYPE	LENGTH (mm)	FORCE (kN)	De (mm)	Is (MPa)	Is_{50} (MPa)	LITHOLOGY	WEATHERING	FAILURE DESCRIPTION
BH 1	1.20	d	-	1.51	51.52	0.57	0.58	Sandstone, medium grained	SW	Rock Substance
	2.35	d	-	2.36	51.52	0.89	0.90	Sandstone, medium grained	SW	Rock Substance
	2.40	a	60.00	3.12	62.74	0.79	0.88	Sandstone, medium grained	SW	Rock Substance
	3.35	d	-	3.33	51.52	1.25	1.27	Sandstone, medium grained	SW	Rock Substance
	3.40	a	49.50	4.25	56.98	1.31	1.39	Sandstone, medium grained	SW	Rock Substance
	4.45	d	-	3.73	51.52	1.41	1.42	Sandstone, medium grained	SW	Rock Substance
	5.35	d	-	2.98	51.52	1.12	1.14	Sandstone, m.g. banded	SW	Rock Substance
	5.40	a	58.00	4.47	61.68	1.17	1.29	Sandstone, m.g. banded	SW	Rock Substance
	6.35	d	-	3.74	51.52	1.41	1.43	Sandstone, m.g. banded	SW	Rock Substance
	6.40	a	51.00	3.70	57.84	1.11	1.18	Sandstone, m.g. banded	SW	Rock Substance
	7.65	d	-	3.38	51.52	1.27	1.29	Sandstone, m.g. banded	SW	Rock Substance
	9.30	d	-	4.10	51.52	1.54	1.57	Sandstone, m.g. banded	SW	Rock Substance
	9.35	a	47.00	4.09	55.53	1.33	1.39	Sandstone, m.g. banded	SW	Rock Substance
	10.36	d	-	4.43	51.52	1.67	1.69	Sandstone, m.g. banded	SW	Rock Substance
	11.34	d	-	3.08	51.52	1.16	1.18	Sandstone, m.g. banded	SW	Lamination

Tested by: MA Date Tested: 4/05/2017

Note: For Diametral test : Length >= Diameter
For Axial test : 0.9Diameter < Length < Diameter

Explanatory Notes:
Test Types: a - axial , d = diametral
De = Equivalent Core Diameter, Size Correction Factor $F = (De/50)^{0.45}$
Is_{50} = 50mm Point Load Strength Index
Test Method : AS4133.4.1

GEOTECHNICAL CENTRE
110B King Street Manly Vale NSW 2093
Telephone 02 - 9949 0253

KEYWORD: **ROCK TESTING**
TITLE: **POINT LOAD STRENGTH INDEX WORKSHEET**

PROJECT: 20 Illawong Avenue
LOCATION: Tamarama

Date of Drilling: 18/04/2017

Equipment: Load Frame: Robertson Research
Callipers: R131
Load Cell: HH4WT - 100kN
Serial No: 18L07-017
Drilling Method: NMLC coring
Core Diameter (mm): 51.52

BORE	DEPTH (m)	TEST TYPE	LENGTH (mm)	FORCE (kN)	De (mm)	Is (MPa)	Is_{50} (MPa)	LITHOLOGY	WEATHERING	FAILURE DESCRIPTION
BH 2	1.32	d	-	2.05	51.52	0.77	0.78	Sandstone, medium grained	SW to MW	Rock Substance
	2.38	d	-	3.27	51.52	1.23	1.25	Sandstone, medium grained	SW	Rock Substance
	2.43	a	51.00	3.77	57.84	1.13	1.20	Sandstone, medium grained	SW	Rock Substance
	3.32	d	-	2.96	51.52	1.12	1.13	Sandstone, medium grained	SW	Rock Substance
	4.43	d	-	2.91	51.52	1.10	1.11	Sandstone, medium grained	SW	Preferred bedding direction
	5.45	d	-	2.86	51.52	1.08	1.09	Sandstone, medium grained	SW	Rock Substance
	6.35	d	-	2.60	51.52	0.98	0.99	Sandstone, medium grained	SW	Rock Substance
	7.35	d	-	2.43	51.52	0.92	0.93	Sandstone, medium grained	SW	Rock Substance
	8.38	d	-	3.19	51.52	1.20	1.22	Sandstone, medium grained	SW	Rock Substance
	8.43	a	45.50	3.65	54.63	1.22	1.27	Sandstone, medium grained	SW	Rock Substance
	9.75	d	-	2.04	51.52	0.77	0.78	Sandstone, m.g. banded	SW	Lamination
	11.02	d	-	3.07	51.52	1.16	1.17	Sandstone, m.g. banded	SW	Preferred bedding direction
	11.12	d	-	4.74	51.52	1.79	1.81	Sandstone, m.g. banded	SW	Rock Substance
	11.15	a	45.00	4.72	54.33	1.60	1.66	Sandstone, m.g. banded	SW	Rock Substance

Tested by: MA Date Tested: 5/05/2017

Note: For Diametral test : Length >= Diameter
For Axial test : 0.9Diameter < Length < Diameter

Explanatory Notes:
Test Types: a - axial , d = diametral
De = Equivalent Core Diameter, Size Correction Factor $F = (De/50)^{0.45}$
Is_{50} = 50mm Point Load Strength Index
Test Method : AS4133.4.1

GEOTECHNICAL CENTRE

110B King Street Manly Vale NSW 2093
Telephone 02 - 9949 0253

KEYWORD: **ROCK TESTING**
TITLE: **POINT LOAD STRENGTH INDEX WORKSHEET**

PROJECT: 20 Illawong Avenue
LOCATION: Tamarama

Date of Drilling: 19/04/2017

Equipment: Load Frame: Robertson Research
Callipers: R131
Load Cell: HH4WT - 100kN
Serial No: 18L07-017
Drilling Method: NMLC coring
Core Diameter (mm): 51.52

BORE	DEPTH (m)	TEST TYPE	LENGTH (mm)	FORCE (kN)	De (mm)	Is (MPa)	Is_{50} (MPa)	LITHOLOGY	WEATHERING	FAILURE DESCRIPTION
BH 3	1.25	d	-	2.12	51.52	0.80	0.81	Sandstone, m.g. banded	SW to MW	Rock Substance
	2.35	d	-	3.04	51.52	1.15	1.16	Sandstone, m.g. banded	SW	Rock Substance
	2.40	a	52.00	3.05	58.40	0.89	0.96	Sandstone, m.g. banded	SW	Rock Substance
	3.25	d	-	3.11	51.52	1.17	1.19	Sandstone, m.g. banded	SW	Rock Substance
	4.10	d	-	2.78	51.52	1.05	1.06	Sandstone, medium grained	SW	Rock Substance
	5.10	d	-	4.33	51.52	1.63	1.65	Sandstone, medium grained	SW	Rock Substance
	5.15	a	59.00	5.88	62.21	1.52	1.68	Sandstone, medium grained	SW	Rock Substance
	5.25	d	-	4.93	51.52	1.86	1.88	Sandstone, medium grained	SW	Rock Substance
	6.25	d	-	3.31	51.52	1.25	1.26	Sandstone, m.g. banded	SW	Rock Substance
	7.90	d	-	3.35	51.52	1.26	1.28	Sandstone, m.g. banded	SW	Part lamination
	9.13	d	-	4.14	51.52	1.56	1.58	Sandstone, m.g. banded	SW	Lamination
	9.18	a	47.00	5.94	55.53	1.93	2.02	Sandstone, m.g. banded	SW	Rock Substance
	9.90	d	-	1.52	51.52	0.57	0.58	Sandstone, m.g. banded	SW	Lamination
	10.97	d	-	4.11	51.52	1.55	1.57	Sandstone, m.g. banded	SW	Rock Substance
	11.02	a	44.00	5.63	53.72	1.95	2.01	Sandstone, m.g. banded	SW	Rock Substance

Tested by: MA/ZG Date Tested: 5/05/2017

Note: For Diametral test : Length >= Diameter
For Axial test : 0.9Diameter < Length < Diameter

Explanatory Notes:
Test Types: a - axial , d = diametral
De = Equivalent Core Diameter, Size Correction Factor $F = (De/50)^{0.45}$
Is_{50} = 50mm Point Load Strength Index
Test Method : AS4133.4.1

GEOTECHNICAL CENTRE
110B King Street Manly Vale NSW 2093
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KEYWORD: **ROCK TESTING**
TITLE: **POINT LOAD STRENGTH INDEX WORKSHEET**

PROJECT: 20 Illawong Avenue
LOCATION: Tamarama

Date of Drilling: 19/04/2017

Equipment: Load Frame: Robertson Research
Callipers: R131
Load Cell: HH4WT - 100kN
Serial No: 18L07-017
Drilling Method: NMLC coring
Core Diameter (mm): 51.52

BORE	DEPTH (m)	TEST TYPE	LENGTH (mm)	FORCE (kN)	De (mm)	Is (MPa)	Is_{50} (MPa)	LITHOLOGY	WEATHERING	FAILURE DESCRIPTION
BH 4	1.92	d	-	2.53	51.52	0.95	0.97	Sandstone, m.g. banded	SW to MW	Rock Substance
	2.75	d	-	3.79	51.52	1.43	1.45	Sandstone, medium grained	SW	Rock Substance
	2.80	a	53.00	5.85	58.96	1.68	1.81	Sandstone, medium grained	SW to Fr	Rock Substance
	3.96	d	-	4.56	51.52	1.72	1.74	Sandstone, medium grained	SW to Fr	Rock Substance
	4.87	d	-	4.35	51.52	1.64	1.66	Sandstone, medium grained	SW to Fr	Rock Substance
	4.92	a	52.50	5.96	58.68	1.73	1.86	Sandstone, medium grained	SW to Fr	Rock Substance
	6.00	d	-	4.07	51.52	1.53	1.55	Sandstone, medium grained	SW to Fr	Rock Substance
	6.95	d	-	5.08	51.52	1.91	1.94	Sandstone, medium grained	SW to Fr	Rock Substance
	7.00	a	53.00	6.33	58.96	1.82	1.96	Sandstone, medium grained	SW to Fr	Rock Substance
	7.99	d	-	4.83	51.52	1.82	1.84	Sandstone, medium grained	SW	Rock Substance
	8.87	d	-	5.73	51.52	2.16	2.19	Sandstone, m.g. banded	SW	Rock Substance
	9.45	d	-	2.03	51.52	0.76	0.78	Sandstone, m.g. banded	SW	Lamination
	10.39	d	-	3.81	51.52	1.44	1.45	Sandstone, m.g. banded	SW	Rock Substance
	11.30	d	-	4.66	51.52	1.76	1.78	Sandstone, m.g. banded	SW	Rock Substance

Tested by: MA/ZG Date Tested: 5/05/2017

Note: For Diametral test : Length >= Diameter
For Axial test : 0.9Diameter < Length < Diameter

Explanatory Notes:
Test Types: a - axial , d = diametral
De = Equivalent Core Diameter, Size Correction Factor $F = (De/50)^{0.45}$
Is_{50} = 50mm Point Load Strength Index
Test Method : AS4133.4.1