Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Assessment of Ground Gases

Proposed Residential Development
Kings Hill, North Raymond Terrace

Prepared for
PM No 1 Pty Ltd

Project 81502.13
September 2020

Douglas Partners
Geotechnics / Environment / Groundwater

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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.

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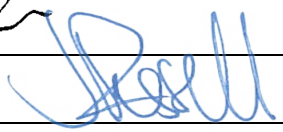
Reviewer		23 September 2020

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Report on Assessment of Ground Gases
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1. Introduction

This report presents the results of an assessment of ground gases undertaken for a proposed residential development at Kings Hill, North Raymond Terrace. The investigation was commissioned on 16 July 2020 and 27 August 2020 by Adam Smith of APP Pty Ltd, acting on behalf of PM No 1 Pty Ltd and was undertaken in accordance with Douglas Partners Pty Ltd (DP) email proposal NCL200179 dated 4 June 2020 and additional email dated 24 August 2020.

It is understood that residential development is proposed for the Kings Hill site, with the development footprint approaching to a position approximately 150 m to 200 m to the north and east of the Suez Landfill and Council Landfill respectively (refer Figure 1).

This report presents the gas well installation and monitoring methods as well as the initial rounds of monitoring and comments on the presence of landfill gas within the wells and suggested frequency for continued monitoring of the installed gas wells.

For the purposes of the assessment, the client provided DP with a report titled “Raymond Terrace Landfill Cell 5 Blasting, Statement of Environmental Effects” (ERM, 2019).

2. Background

Based on a brief review of available information and the topographical mapping within the area the following is understood:

- Both the Suez site and Council landfill have been accepting waste for many years, including putrescible waste;
- The base level of the landfills is not known but is likely to be at about RL 2 m AHD which corresponds to the adjacent wetlands to the north; and
- It is not known whether the landfills were lined prior to placement of waste.

Reference to ERM (2019) and in particular the memorandum titled ‘Geotechnical Risk Assessment – Cell 5, Newline Road Landfill’ from GHD contained within it indicated the following:

- The geological sequence within the proposed Cell 5, located within the central area of the Suez landfill site, as reported by GHD from the basal layer upwards, includes;
    - conglomerate; overlain by
    - sandstone and layers of conglomerate with coaly shales, siltstone with coaly shale and high matrix conglomerate, then

- o tuff; and then intruded and overlain by
- o dacite.

- It is understood that previous inspections by GHD in 2012 indicated that the majority of the proposed Cell 5 excavation would be within dacitic rock.
- Main geological structures include shallow dipping planar/undulating geological structure, inferred as “crushed seams” generally orientated at 22°/098°; and
- Steeply diffing joint sets orientated at approximately 77°/352° and 82°/054° with spacings varying from less than 0.5 m to 2 m.

3. Site Description

The overall development site is a large parcel of land, located approximately 4 km to the north-east of Raymond Terrace and is identified as Lot 4821 in DP852073 and Lot 41 in DP1037411 (refer Figure 1 below).

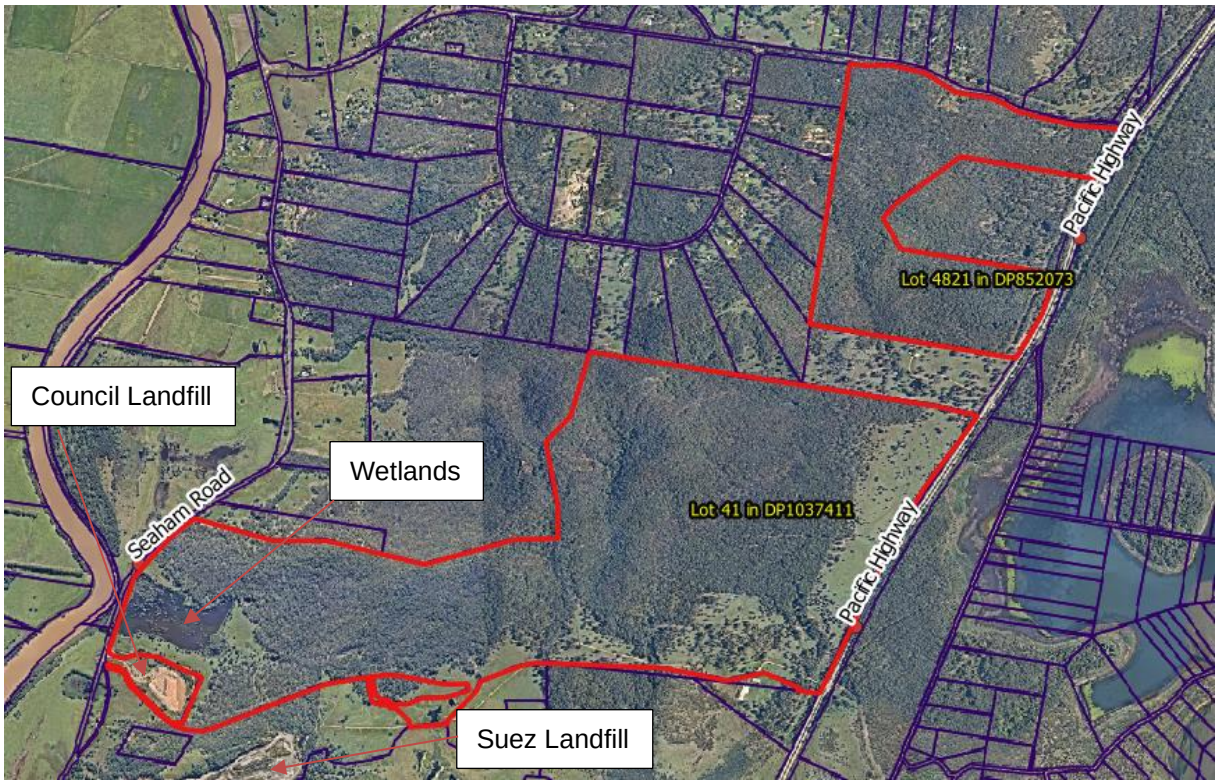


Figure 1: Aerial image showing extent of greater site (red boundaries) and lot boundaries (blue lines)

Two landfills are located to the west and south of the development site, as follows:

- Council landfill, located to the west of the development site and off Seaham Road (refer Figure 1);
- Suez landfill, located to the south of the site (refer Figure 1).

Ground surface levels in the vicinity of the landfills and western portion of the proposed development site typical ranges as follows:

- The elevation of the base of the landfill is likely to be about RL 2 m AHD;
- The ground surface in the area of the proposed residential development ranges from about 6 m AHD to 20 m AHD;
- The surface topography between the Suez landfill and the development site contains a ridgeline, roughly orientated east to west, with surface levels in the order of 28 m AHD to 72 m AHD;
- The wetlands to the north of the landfills is at around RL 2 m AHD;
- The ground surface to the north of the wetland rises to over RL 50 m AHD.

The majority of the development site is covered with a dense coverage of mature trees, however the areas closest to the existing landfills are partially cleared, grassland areas.

4. Previous DP Investigations

DP has undertaken a number of previous investigations for the proposed development and several relevant investigations in the vicinity of the site. Selected bores and pit logs from the most relevant previous investigation (DP, 2020) are provided in Appendix C, and subsurface conditions encountered as summarised as follows:

- 3000 series pits: Residual clay soils overlying sandstone bedrock at depths ranging from 0.6 m to 0.9 m in all pits except Pit 3005, which encountered silty clay and sandy clay to full depth of investigation at 2.4 m;
- Pits 110 and 111. Silty clay, gravelly clay or gravelly clay overlying either shale or sandstone at depths of 0.6 m and 1.1 m in Pits 110 and 111 respectively.
- Bore 7003 Silty clay and sandy clay overlying sandstone bedrock at 0.75 m depth.

5. Review of Mapping

As part of the assessment, a review of the following mapping was undertaken:

- Geological Mapping;
- Soil Landscape Mapping; and
- Acid sulfate soil mapping.

The results of the review are discussed in Sections 5.1 to 5.3.

5.1 Geological Mapping

Figure 2, below, is an extract from the seamless digital geology for NSW.

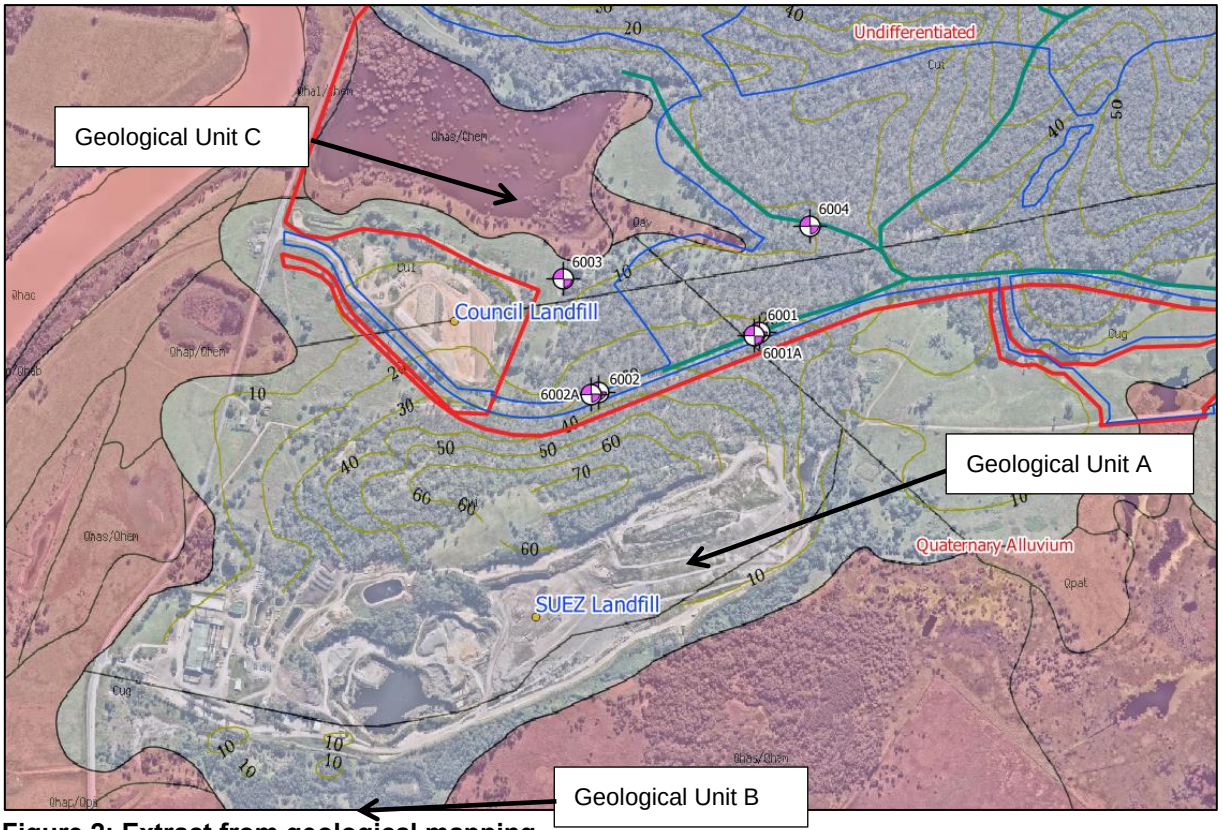


Figure 2: Extract from geological mapping

The mapping indicates the following in relation to geological formations in the vicinity of the existing landfills and residential development site:

- Suez Landfill and Council Landfill (northern part) - Mount Johnstone Formation (Geological Unit A), comprising undifferentiated sediments and coal, lithic arenites with interbedded sandstone, shale, carbonaceous shales, poor coal and mine cherts;
- Suez Landfill (southern part) - Seaham Formation (Geological Unit B), comprising undifferentiated sediments, tillite, siltstone, tuff, mudstone within thick bedded lithic sandstone and conglomerate; and
- Wetland and areas south of Suez Landfill - Alluvial sediments (Geological Unit C) of Holocene age comprising organic mud, peat, silt and clay.

The conditions encountered in the bores were indicative of the Mount Johnstone Formation and soils derived from this formation.

5.2 Soil Landscape Mapping

Figure 3, below, is an extract from the Soil Landscape Mapping for the area.

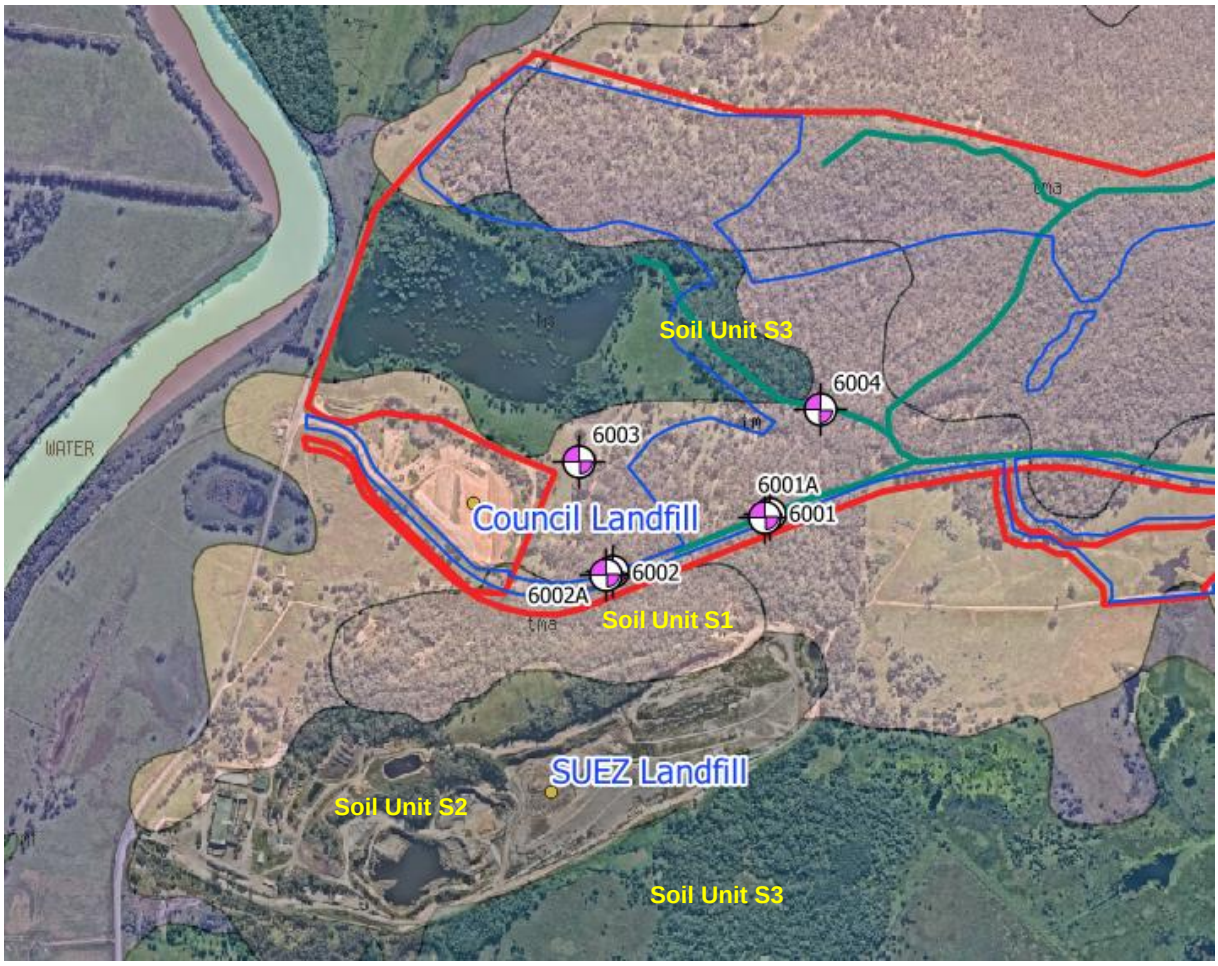


Figure 3: Extract from Soil Landscape Mapping

The mapping indicates the following in relation to geological formations in the vicinity of the existing landfills and residential development site:

- Council Landfill and Residential Development Area (Soil Unit S1): Ten Mile Road Group (erosional) - (Soil Unit S1). These soils are described as moderately deep to deep brown soloths, tallow soloths and well drained loams;
- Suez Landfill: (Soil Unit S2): Disturbed terrain;
- Wetlands and areas south of Suez Landfill: (Soil Unit S3): Hexham Swamp landscape group – deep humic soils.

5.3 Acid Sulfate Soil Mapping

Reference to the statewide digital acid sulfate soil mapping (refer Figure 4) indicates that wetland and the areas to the south of the Suez landfill are located in an area mapped as having a high probability of acid sulfate soils. The remaining areas, including the two landfills and the development site are within areas mapped as having no known occurrence of acid sulfate soils.

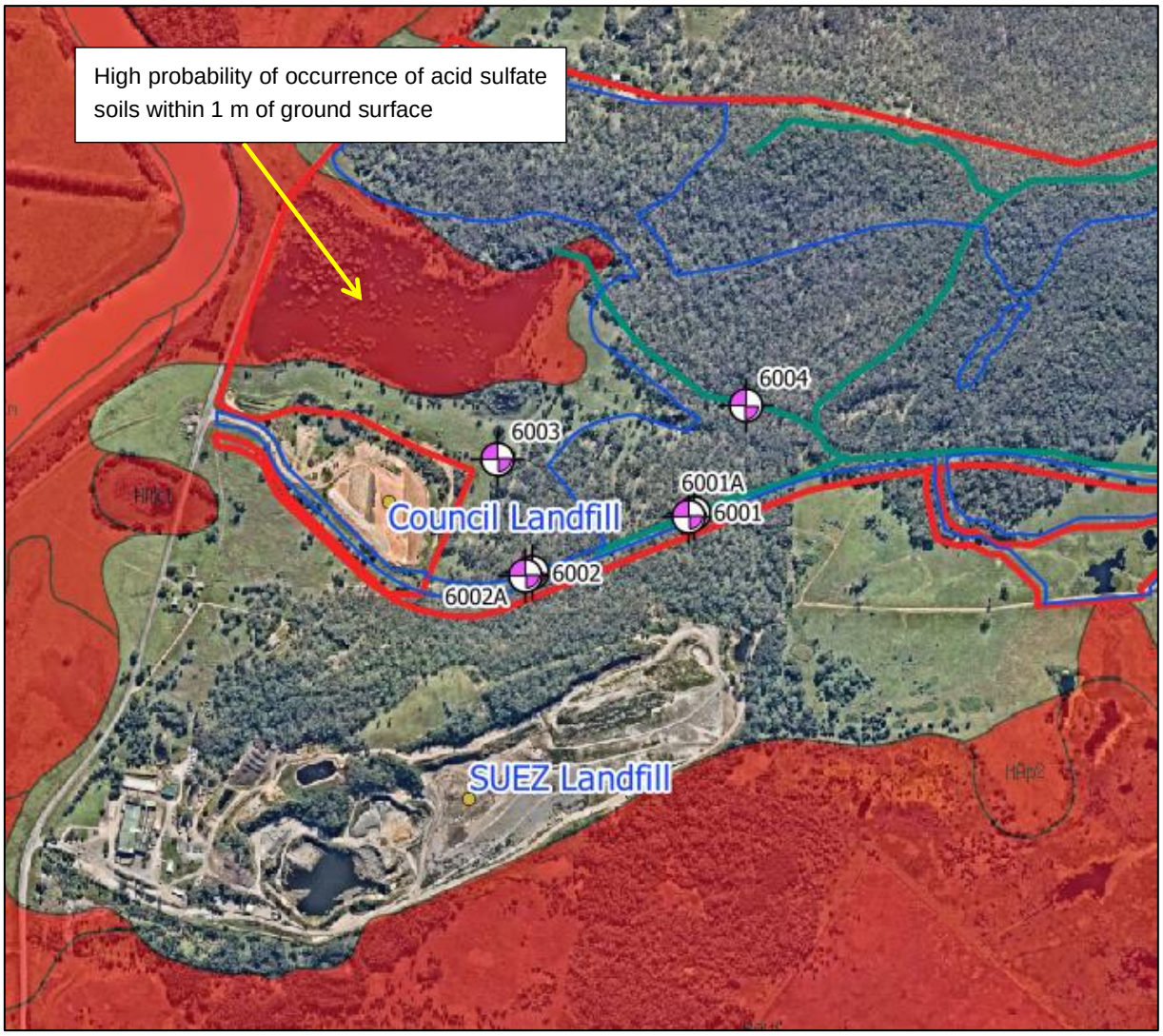


Figure 4: Extract from acid sulfate soil mapping

6. Field Work Methods

6.1 Well Installation

The field work was carried out over the period extending from 27 July 2020 to 31 August 2020 and included the drilling of test bores and the installation of gas monitoring wells. The bores were drilled using a track mounted drilling rig using percussion drilling (refer Figure 5).

Seven bores (Bores 6001 to 6005, 6001A and 6002A) were drilled to depths ranging from 1.5 m to 30.2 m. The deeper boreholes (Bores 6001 and 6002) were drilled to the approximate depth of the inferred groundwater table (i.e. to saturated ground). The remaining shallow bores (Bores 6001A, 6002A, 6003 and 6005) were drilled to about the top of bedrock.

Figure 5: Drilling rig configuration

The borehole logs are included in Appendix B and should be read in conjunction with the accompanying standard notes defining classification methods and descriptive terms.

The locations of all pits and bores are shown on Drawing 1 of Appendix D.

Following the completion of drilling gas monitoring wells were installed within the bores to facilitate on-going gas monitoring. The monitoring wells were constructed of 50 mm diameter flush threaded Class 18 uPVC and machine slotted screens. A sand filter was installed to approximately 0.5 m to 2 m above the screened section, with an approximately 0.6 m to 1 m thick bentonite sealing layer above. The upper section of the annulus of the piezometers was backfilled with cuttings and 7 mm screened sand to approximately 1 m below the surface where a 1 m concrete plug was installed. Each well was fitted with a gas-tight cap with quick connect gas fitting. A steel monument cover was placed at the surface (refer Figure 6).

Figure 6: Typical Well installation on site

Details of the well construction are shown on the borehole logs in Appendix B and the depth to well screen are summarised in Table 1 and in Section 7.1.

The bores were set out by a geotechnical engineer from DP who also logged the subsurface profile in each bore and took regular samples for identification purposes.

The MGA coordinates were recorded at each test location using a differential GPS unit which is normally accurate to within about ±0.1 m depending on satellite coverage. The approximate co-ordinates and surface level of the test locations are shown on the individual borehole logs in Appendix B.

6.2 Gas Monitoring

Landfill gas monitoring was carried out in accordance with DP standard operating procedures and NSW EPA (2020). The monitoring method is described as follows:

- Record the barometric pressure;
- Connect the tube on the calibrated landfill gas analyser (GA5000) to the quick connect gas fitting on the well cap (refer Figure 7); and

- Set the analyser pump on and record concentrations of methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide, generally at 30 second intervals, for a minimum of ten minutes and until concentrations have generally stabilised.

Figure 7: Gas monitoring set up

The general weather conditions and atmospheric pressure were recorded during the monitoring event.

7. Field Work Results

7.1 Subsurface Investigations

The subsurface conditions encountered in the bores are presented in detail in the attached borehole logs. These should be read in conjunction with the accompanying notes preceding them, which explain the descriptive terms and classification methods used in the logs.

The site stratigraphy can be divided into the following units:

UNIT 1 – RESIDUAL CLAY/SANDY SILT, generally described as brown silty clay, silty sand or sandy silt. There was a gradual transition from residual sandy silt into weathered bedrock.

UNIT 2 – Sandstone BEDROCK, sandstone or conglomerate bedrock with occasional carbonaceous layers (refer Figure 8).

Figure 8: Carbonaceous seams within sandstone bedrock (Bore 6001)

The depth to the base (soils) and top (rock) of each geotechnical unit is presented in Table 1 below.

Table 1: Summary of Subsurface Conditions and Well Construction

Bore/Pit	Surface Level (m AHD)	Depth of Investigation (m)	Depth to Base of Each Unit (m)		Depth to Top of Screen (m)	Depth to Bottom of Screen (m)
			Unit 1	Unit 2		
6001	18.7	22.3	1.0	>22.3	8.3	22.3
6001A	18.7	2	>2.0	NE	0.5	2.0
6002	27.0	30.2	2.0	>30.2	7.2	30.2
6002A	27.0	2	>2.0	NE	0.5	2.0
6003	2.9	1.5	1.35	>1.5	0.5	1.5
6004	9.3	2	>2.0	NE	0.5	2.0
6005	4.0	0.6	0.4	>0.6	-	-

Notes to Table 1:
NE = Not encountered

7.2 Landfill Gas Monitoring

Two initial monitoring events were completed at well locations (two in initial round and six in second round). In accordance with NSW EPA (2020), the landfill gas flow rate, methane concentration and carbon dioxide concentration have been used to calculate the gas screening value (GSV) and the characteristic gas situation (CS) in order to provide comment on the general risks posed by ground gas (if present) and associated level of protection required for future development of the site.

The landfill gas monitoring data has been summarised in Table 2, below.

Table 2: Summary of Gas Monitoring Results

Well ID	Depth of Well (m)	Flow Rate Peak	CH_4 Peak %	GSV	CO_2 Peak %	GSV	CS [1]
Initial Round of Monitoring – 14 August 2020 [atmospheric pressure start 1015 mb end 1015 mb]							
6001	22.3	0.2	<0.1	<0.01	12.9	0.03	1 to 2
6002	30.2	0.1	<0.1	<0.01	10.1	<0.01	1 to 2
Second Round of Monitoring – 11 September 2020 [atmospheric pressure start 1030 mb end 1029 mb]							
6001	22.3	0.1	<0.1	<0.01	17.7	0.02	1 to 2
6001A	2	0.1	<0.1	<0.01	6.7	<0.01	1
6002	30.2	0.1	<0.1	<0.01	15.1	0.02	1 to 2
6002A	2	0.1	<0.1	<0.01	4.5	<0.01	1
6003	1.5	0.1	<0.1	<0.01	2	<0.01	1
6004 (background)	2	0.1	<0.1	<0.01	4.8	<0.01	1

Notes to Table 2:

1. Where methane >1% or CO_2 >5% CS consider increasing a CS1 to CS 2, as per Table 7 of NSW EPA (2020)

8. Comments

The readings from the monitoring wells undertaken to date, as summarised in Table 2 in Section 7.2, were assessed with reference to NSW EPA (2020) to assess for the presence of hazardous ground gases which may have originated from the existing landfills.

A multi-level risk assessment for the presence of hazardous ground gases was undertaken based on the procedures outlined in NSW EPA (2020).

Based on a preliminary screening, as outlined in Section 4.3.1 of NSW EPA (2020), the site has the following:

- A potential source of ground gas (Suez and Council landfills to the south and west of the development site);
- The proposed residential development approaches to within 250 m of the edge of the existing landfills and would be considered a potential receptor for ground gas;

- The elevation of the base of the landfill is likely to be about RL 2 m AHD. With the ground surface in the area of the proposed residential development in the range of 6 m AHD to 20 m AHD. The surface topography between the Suez landfill and the development site contains a ridgeline, roughly orientated east to west, with surface levels in the order of 28 m AHD to 72 m AHD. The results of the bores indicate that the intervening strata is predominantly sandstone, although some carbonaceous and coal seams may be present. This is consistent with information provided in ERM (2019) which indicated that coal seams may be present within the northern wall of the Suez landfill.

Figure 9: Aerial image of landfills with surface level contours

Based on the above, a Level 2 risk assessment was undertaken for the site based on the procedures outlined in NSW EPA (2020).

The gas screening value (GSV) was derived based on the results of the gas monitoring and using the Wilson and Card method. This method defines the characteristics situation (CS) value for the site based on the limiting borehole gas volumetric flow for methane and carbon dioxide. The gas flow from a 50 mm borehole is, very conservatively, assumed to represent the upward flow of gas through soil across a site surface area of 10 m^2.

The GSV is derived as follows:

GSV = maximum borehole flow rate (L/hr) x maximum gas concentrations (% v/v).

The results of this assessment are shown in Table 2 in Section 7.2 and the following conclusions are made in relation to the results:

- The gas flow rate were typically quite low (generally 0.1 L/hr) for all wells;
- Concentrations of methane in all of the wells were below the defection limit of the instrument (ie: <0.1%);
- Shallow bores (Wells 6001A, 6002A and 6003) were all CS1. It is noted that the peak CO_2 was recorded marginally above 5% however stabilised readings were less than 4% (after about 7 minutes of readings) and therefore DP considers that the CS1 is the appropriate CS for these bores;
- The concentrations of CO_2 in the shallow wells are considered likely to be attributable to breakdown of naturally occurring organic matter soils and are consistent with readings encountered within the background well (Well 6004); and
- The higher concentrations of CO_2 in the deeper wells (Wells 600 and 6002) are considered likely to be attributable to both naturally occurring breakdown of organic matter in soils and carbonaceous seams within the rock strata at depth.

Overall, the results to date indicate a CS1 classification based on the procedures outlined in NSW EPA (2020) which is defined as 'very low risk'. DP note that the absence of methane in the subsurface gas mixture suggests the gas present is unlikely to be sourced from landfill gas (ie: the biodegradation of putrescible waste) but rather from naturally occurring sources (ie: breakdown of organic matter in soils and carbonaceous seams within the rock strata at depth).

It is recommended, however, that continued monitoring of the installed wells is undertaken to confirm that the gas concentrations remain consistent over a longer monitoring period thereby ruling out any increasing (or decreasing) trends over time.

9. References

DP. (2020). *Report on Geotechnical Investigation, Proposed Residential Development, Kings Hill, North Raymond Terrace.* Douglas Partners Pty Ltd.

ERM. (2019). *Raymond Terrace Landfill Cell 5 Blasting, Statement of Environmental Effects, Project 0450875.* Environmental Resources Management Australia Pty Ltd.

NSW EPA. (2020). *Assessment and Management of Hazardous Ground Gases.* NSW Environment Protection Authority.

10. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Kings Hill, North Raymond Terrace with reference to DP's email proposal NCL200179 dated 4 June 2020 and additional email dated 24 August 2020, and acceptance received from Adam Smith of APP Pty Ltd, acting on behalf of PM No 1 Pty Ltd in emails dated 16 July 2020 and 27 August 2020.

The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of PM No 1 Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site 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 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 (beyond hazardous ground gases), 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 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 environmental 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
Sampling Methods
Soil Descriptions
Symbols and Abbreviations

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.

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.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. 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	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

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

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

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
Friable	Fr	-

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	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

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;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w <PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w >PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈LL' (i.e. near the liquid limit).
- 'Wet' or 'w >LL' (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners

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

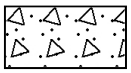
Symbols & Abbreviations

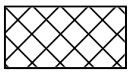
Graphic Symbols for Soil and Rock

General


Asphalt


Road base

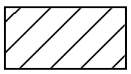

Concrete

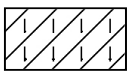

Filling

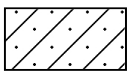
Soils


Topsoil

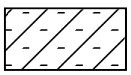

Peat

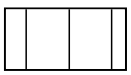

Clay

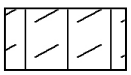

Silty clay

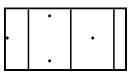

Sandy clay

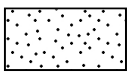

Gravelly clay

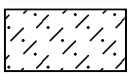

Shaly clay

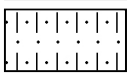

Silt


Clayey silt


Sandy silt

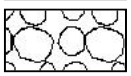

Sand

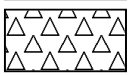

Clayey sand


Silty sand


Gravel

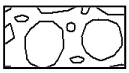

Sandy gravel


Cobbles, boulders

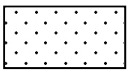

Talus

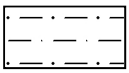
Sedimentary Rocks

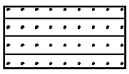

Boulder conglomerate

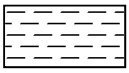

Conglomerate


Conglomeratic sandstone

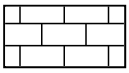

Sandstone


Siltstone

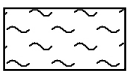

Laminite

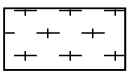

Mudstone, claystone, shale


Coal


Limestone

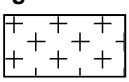
Metamorphic Rocks

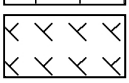

Slate, phyllite, schist

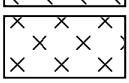

Gneiss

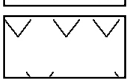

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Appendix B

Borehole Logs – Bores 6001 to 6005, 6001A and 6002A

BOREHOLE LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

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

BORE No: 6001
PROJECT No: 81502.13
DATE: 22/7/2020
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SANDY SILT (MH) - High plasticity, dark brown, sand is fine grained, with some clay, with trace rootlets, M+Wp		D	0.0				Concrete
1	1.0	SANDSTONE - Pale orange		D	1.0				
				D	2.0				Fill
				D	3.0				
		From 4.0m, brown		D	4.0				Blank
				D	5.0				Bentonite
				D	6.0				
				D	7.0				
				D	8.0				
				D	9.0				
				D	10.0				

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** 0-2.5m

TYPE OF BORING: Air Hammer to 22.3m

WATER OBSERVATIONS: Free groundwater observed from 18.5m to 20.0m

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: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

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

BORE No: 6001
PROJECT No: 81502.13
DATE: 22/7/2020
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SANDSTONE - Pale orange *(continued)*			10.0				
		From 10.0m, grey		D					
	11				11.0				11
				D					
	12				12.0				12
				D					
	13				13.0				13
				D					
	14				14.0				14
				D					Gravel
	15				15.0				15
				D					Sceen
	16				16.0				16
				D					
	17	from 17.0m, black, carbonaceous			17.0				17
				D					
	18				18.0				18
		From 18.5m, to 20.0m, water		D				▼	
	19	From 19.0m, grey			19.0				19
				D					
					20.0				

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** 0-2.5m

TYPE OF BORING: Air Hammer to 22.3m

WATER OBSERVATIONS: Free groundwater observed from 18.5m to 20.0m

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: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

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

BORE No: 6001
PROJECT No: 81502.13
DATE: 22/7/2020
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SANDSTONE - Pale orange *(continued)*		D	20.0				
	21				21.0				
	22								
	22.3	Bore discontinued at 22.3m, limit of investigation							
	23								
	24								
	25								
	26								
	27								
	28								
	29								

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** 0-2.5m

TYPE OF BORING: Air Hammer to 22.3m

WATER OBSERVATIONS: Free groundwater observed from 18.5m to 20.0m

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: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

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

BORE No: 6002
PROJECT No: 81502.13
DATE: 23/7/2020
SHEET 1 OF 4

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SILTY SAND / SANDY SILT - Low plasticity, sand is fine grained, with trace organics, M<Wp		D	1.0				Stickup (blank); Concrete
	2.0	(SANDSTONE) - Orange		D	2.0				
				D	3.0				Fill; Blank
				D	4.0				
				D	5.0				
				D	6.0				
		From .0m, pale grey		D	7.0				Bentonite
				D	8.0				
				D	9.0				
				D	10.0				

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** 0-2.5m
TYPE OF BORING: Hammer drill to 30.2m
WATER OBSERVATIONS: No free groundwater observed
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: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

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

BORE No: 6002
PROJECT No: 81502.13
DATE: 23/7/2020
SHEET 2 OF 4

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		(SANDSTONE) - Orange *(continued)*		D	10.0				
	11			D	11.0				11
	12			D	12.0				12
	13			D	13.0				13
	14			D	14.0				14
	15			D	15.0				15
	16			D	16.0				16
	17			D	17.0				17
	18			D	18.0				18 Sceen Gravel
	19			D	19.0				19
				D	20.0				

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** 0-2.5m
TYPE OF BORING: Hammer drill to 30.2m
WATER OBSERVATIONS: No free groundwater observed
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: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

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

BORE No: 6002
PROJECT No: 81502.13
DATE: 23/7/2020
SHEET 3 OF 4

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		(SANDSTONE) - Orange *(continued)*		D	20.0				
	21			D	21.0				21
	22			D	22.0				22
	23			D	23.0				23
	24			D	24.0				24
	25			D	25.0				25
	26			D	26.0				26
	27			D	27.0				27
	28			D	28.0				28
	29			D	29.0				29
				D	30.0				

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** 0-2.5m

TYPE OF BORING: Hammer drill to 30.2m

WATER OBSERVATIONS: No free groundwater observed

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: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

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

BORE No: 6002
PROJECT No: 81502.13
DATE: 23/7/2020
SHEET 4 OF 4

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	30.2	(SANDSTONE) - Orange *(continued)*							
		Bore discontinued at 30.2m, limit of investigation							

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** 0-2.5m
TYPE OF BORING: Hammer drill to 30.2m
WATER OBSERVATIONS: No free groundwater observed
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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BOREHOLE LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: 2.9 AHD
EASTING: 383159
NORTHING: 6378506
DIP/AZIMUTH: 90°/--

BORE No: 6003
PROJECT No: 81502.13
DATE: 31/8/2020
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
		SILTY CLAY (CH): High plasticity, brown, with trace roots, M<Wp		D	0.1				From 0.0m to 0.2m, concrete
	0.15	SILTY CLAY (CH): High plasticity, brown, M<Wp							From 0.2m to 0.5m, bentonite
2									
	1			D	1.0				1 From 0.5m to 1.5m, gravel From 0.5 to 1.5m, slotted PVC
	1.35	From 1.3m, grading to rock		D	1.4				End cap
		Bore discontinued at 1.5m, limit of investigation							
1									
	2								2
0									

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** Nil

TYPE OF BORING: Auger to 1.5m

WATER OBSERVATIONS: No free groundwater observed

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: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: 9.3 AHD
EASTING: 383617
NORTHING: 6378599
DIP/AZIMUTH: 90°/--

BORE No: 6004
PROJECT No: 81502.13
DATE: 31/8/2020
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
9	0.15	SILTY CLAY (CH): High plasticity, brown, with rootlets, M<Wp		D	0.1				From 0.0m to 0.2m, concrete
		SILTY CLAY (CH): High plasticity, brown, M,<Wp							From 0.2m to 0.5m, bentonite
8	1			D	1.0				From 0.5m to 2.0m, gravel From 0.5 to 1.5m, screen
	2 2.0	Bore discontinued at 2.0m, limit of investigation							End cap
7									

Stick up = 0.7m

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** Nil

TYPE OF BORING: Auger to 2.0m

WATER OBSERVATIONS: No free groundwater observed

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: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: 4.0 AHD
EASTING: 383165
NORTHING: 6378505
DIP/AZIMUTH: 90°/--

BORE No: 6005
PROJECT No: 81502.13
DATE: 31/8/2020
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
4		SILTY CLAY (CH): High plasticity, brown, with trace roots, M<Wp		D	0.1				
	0.15	SILTY CLAY (CH): High plasticity, brown, M<Wp							
	0.4	SANDSTONE: Pale brown From 0.5m, grading to rock		D	0.5				
	0.6	Bore discontinued at 0.6m, refusal							
3	1								1
2	2								2

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** Nil
TYPE OF BORING: Auger to 0.6m
WATER OBSERVATIONS: No free groundwater observed
REMARKS: No well installed

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: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: 18.7 AHD
EASTING: 383517
NORTHING: 6378408
DIP/AZIMUTH: 90°/--

BORE No: 6001A
PROJECT No: 81502.13
DATE: 31/8/2020
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
18	0.15	SILTY CLAY (CH): High plasticity, brown, with trace rootlets, M<Wp		D	0.1				Stick up = 0.7m From 0.0m to 0.2m, concrete
		SILTY CLAY (CH): High plasticity, brown / pale brown, M<Wp							From 0.2m to 0.5m, bentonite
	1			D	1.0				1 From 0.5m to 2.0m, gravel From 0.5 to 2.0m, slotted PVC
17	2 2.0								End cap 2
		Bore discontinued at 2.0m, limit of investigation							
16									

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** Nil

TYPE OF BORING: Auger to 2.0m

WATER OBSERVATIONS: No free groundwater observed

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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BOREHOLE LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: 27.0 AHD
EASTING: 383230
NORTHING: 6378293
DIP/AZIMUTH: 90°/--

BORE No: 6002A
PROJECT No: 81502.13
DATE: 31/8/2020
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
27	0.12	SILTY CLAY (CI): Low plasticity, brown, with trace rootlets, fine grained sand, M<Wp		P	0.1				Stcik up = 0.7m From 0.0m to 0.2m, concrete
		SILTY CLAY (CL): Low plasticity, brown, with trace to some fine grained sand, M<Wp							From 0.2m to 0.5m, bentonite
26	1			D	1.0				1
				D	1.9				From 0.5m to 2.0m, gravel 5mm From 0.5m to 2.0m, screen End cap
25	2 2.0	Bore discontinued at 2.0m, limit of investigation							2

RIG: Hanjin **DRILLER:** Tim (Total Drilling) **LOGGED:** Lambert **CASING:** Nil

TYPE OF BORING: Auger to 2.0m

WATER OBSERVATIONS: No free groundwater observed

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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Appendix C

Relevant Logs from Previous Investigations – Pits 3001 to 3005, Pits 110 and 111, Bore 7003

TEST PIT LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: --
EASTING: 383349
NORTHING: 6378682

PIT No: 3001
PROJECT No: 81502.12
DATE: 18/6/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL / SILTY CLAY (CI): High plasticity, brown, W>PL, firm, abundant rootlets		D	0.1				
	0.3	SILTY CLAY (CI): Medium to high plasticity, orange brown mottled grey, W>PL, very stiff, hard, residual, trace rootlets		D	0.5		pp = 400		
		From 0.7m, pale brown / with fine to medium grained sand		D	0.8				
	0.9	SANDSTONE: Highly weathered, orange brown, low to medium strength							
1	1.1	Pit discontinued at 1.1m, refusal on rock							1
2									2

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 6.5 tonne excavator with 450mm bucket with teeth

LOGGED: Heslop

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: --
EASTING: 383313
NORTHING: 6378783

PIT No: 3002
PROJECT No: 81502.12
DATE: 18/6/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.15	TOPSOIL / SILTY CLAY (CI): High plasticity, brown, W>PL, firm, abundant rootlets		D	0.1		pp = 100		
	0.6	SILTY CLAY (CI): Medium to high plasticity, orange brown mottled grey, with fine to medium grained sand, W>PL, residual		D	0.5				
	1.0	SHALE: Highly weathered, brown, low to medium strength							
		Pit discontinued at 1.0m, refusal on rock							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 6.5 tonne excavator with 450mm bucket with teeth

LOGGED: Heslop

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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TEST PIT LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: --
EASTING: 383343
NORTHING: 6378589

PIT No: 3003
PROJECT No: 81502.12
DATE: 18/6/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL / SILTY CLAY (CI): Medium to high plasticity, dark grey, trace fine to coarse grained sand, W>PL, very stiff, abundant rootlets		D	0.1				
	0.3	SILTY CLAY (CI): High plasticity, grey mottled orange, W>PL, very stiff, residual, trace rootlets		D	0.5		pp = 200-250		
		From 0.6m, orange brown		D	0.7		pp = 200		
	0.8	SANDSTONE: Slightly weathered, orange brown, (low to medium strength)							
	0.95	Pit discontinued at 0.95m, refusal on rock							
	1								1
	2								2

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 6.5 tonne excavator with 450mm bucket with teeth

LOGGED: Heslop

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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TEST PIT LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: --
EASTING: 383260
NORTHING: 6378666

PIT No: 3004
PROJECT No: 81502.12
DATE: 18/6/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL / SILTY CLAY (CI): Medium to high plasticity, dark brown, trace fine to coarse grained sand, W>PL, abundant rootlets		D	0.1				
	0.2	SILTY CLAY (CI): Medium to high plasticity, grey mottled brown, W>PL, very stiff, residual, trace rootlets		D	0.5		pp = 250		
		From 0.6m, grey							
		From 0.7m, hard		D	0.7		pp = 400		
	0.85	SANDSTONE: Highly weathered, brown, low to medium strength							
	0.9	Pit discontinued at 0.9m, refusal on rock							
	1								1
	2								2

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 6.5 tonne excavator with 450mm bucket with teeth

LOGGED: Heslop

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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TEST PIT LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: --
EASTING: 383133
NORTHING: 6378548

PIT No: 3005
PROJECT No: 81502.12
DATE: 18/6/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	TOPSOIL / SILTY CLAY (CI): Medium to high plasticity, dark grey, trace fine to coarse grained sand, W>PL, very stiff, abundant rootlets		D	0.1				
	0.2	SILTY CLAY (CI): High plasticity, dark grey, W>PL, very stiff, trace rootlets, (possible topsoil)			0.2		pp = 250-300		
				D	0.5				
	0.7	SILTY CLAY (CI): High plasticity, grey mottled orange, W>PL, very stiff, residual, trace rootlets		D	0.8				
	1	From 1.0m, trace fine to coarse grained sand		D	1.2				
					1.3		pp = 200		
					1.5		pp = 150	▼ 18-06-20	
	2			D	2.0				
	2.1	SANDY CLAY (CI): High plasticity, grey, fine to medium grained sand, W>PL, stiff, residual			2.1		pp = 150		
	2.4	Pit discontinued at 2.4m, limit of investigation							

RIG: 6.5 tonne excavator with 450mm bucket with teeth

LOGGED: Heslop

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Free groundwater observed at 1.7m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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TEST PIT LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL: --
EASTING: 383133
NORTHING: 6378548

PIT No: 3006
PROJECT No: 81502.12
DATE: 18/6/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL / SILTY CLAY (CI): High plasticity, brown, W>PL, firm, abundant rootlets		D	0.1				
	0.2	SILTY CLAY (CI): High plasticity, grey - brown, trace fine to coarse grained sand, W>PL, firm, residual, trace rootlets		D	0.5		pp = 50-100		
		From 0.6m, grey mottled brown		D	0.7		pp = 200-250		
	1			D	1.0			18-06-20	
		From 1.5m, grey, trace carbonaceous clay lenses throughout							
	2			D	2.0		pp = 150		
	2.1	Pit discontinued at 2.1m, limit of investigation							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 6.5 tonne excavator with 450mm bucket with teeth

LOGGED: Heslop

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Free groundwater observed at 1.2m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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TEST PIT LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, Northern Raymond Terrace

SURFACE LEVEL: 10 AHD
COORDINATE **E:**383432.844 **N:** 6378781.538
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 110
PROJECT No: 81502.12
DATE: 05/05/20
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL ORIGIN(#)	SOIL CONSIS.(*) DENSITY.(*)	SOIL MOISTURE	ROCK WEATH.	ROCK DEPTH (m)	ROCK STRENGTH	ROCK RECOVERY (%)	ROCK RQD	ROCK FRACTURE SPACING (m)	ROCK DEFECTS & REMARKS	SAMPLE REMARKS	SAMPLE TYPE	SAMPLE INTERVAL	DEPTH (m)	TEST TYPE	TESTING RESULTS AND REMARKS
No free groundwater observed		0.0	TOPSOIL/ Clayey SILT; grey brown; rootlets		TOP											D		0.0	DCP9/150	PP >600
		0.1	(CH) Silty CLAY, trace sand; grey brown; clay fraction high plasticity; sand fraction fine; roots		RES	H	>PL									D		0.1		
		0.35	(CI) Gravelly CLAY; grey brown; clay fraction high plasticity; gravel fraction fine to coarse, angular to sub-angular, up to 65mm in size		RES	H	>PL									B		0.25		
		0.6						MW	0.6	M								0.35 0.4 0.6		
		0.65	SHALE lithic sandstone; grey and orange brown						0.65							D		0.65		
			Test pit discontinued at 0.65m depth Refusal on medium strength lithic sandstone																	

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 13 t Excavator
METHOD: 600mm toothed bucket
REMARKS:

OPERATOR: SH
CASING:

LOGGED: DM

EXPORTED 12/06/20 11:44. TEMPLATE ID: DP_103.02.00_COMBINED

TEST PIT LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, Northern Raymond Terrace

SURFACE LEVEL: 12.8 AHD
COORDINATE **E:**383379.737 **N:** 6378462.15
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 111
PROJECT No: 81502.12
DATE: 05/05/20
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL ORIGIN(#)	SOIL CONSIS.(*) DENSITY.(*)	SOIL MOISTURE	ROCK WEATH.	ROCK DEPTH (m)	ROCK STRENGTH	ROCK RECOVERY (%)	ROCK RQD	ROCK FRACTURE SPACING (m)	DEFECTS & REMARKS	SAMPLE REMARKS	SAMPLE TYPE	SAMPLE INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed	12	0.0	TOPSOIL/ Sandy SILT; dark brown; sand fraction fine; rootlets		TOP											D		0.0	DCP9/150	5 10 15
		0.15	(Cl) Silty CLAY, trace sand; grey brown; clay fraction high plasticity; sand fraction fine		RES	ST	>PL									D		0.15	PP	180
		0.7	(GW) Sandy GRAVEL, with; brown; gravel fraction fine to coarse; sand fraction fine to coarse; fraction subangular sandstone up to 100mm in size		RES	VD	M									D		0.5		25
	1	1.1	SANDSTONE; pale grey / yellow brown; fine to medium; sub-vertical joints (0.1-0.3m)					MW	1.1	M						D		0.9		
	11																	1.0		
	2	2.1	SANDSTONE; pale grey / yellow brown; fine to medium; sub-vertical joints (0.1-0.3m)					DW	2.1	H								2		
		2.2	Test pit discontinued at 2.20m depth Refusal on high strength sandstone						2.2											
	10																	3		
	3																			
	9																			

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 13 t Excavator
METHOD: 600mm toothed bucket
REMARKS:

OPERATOR: SH
CASING:

LOGGED: DM

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BOREHOLE LOG

CLIENT: PM No 1 Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Kings Hill, North Raymond Terrace

SURFACE LEVEL:
COORDINATE E:384704 **N:** 6378855
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 7003
PROJECT No: 81502.12
DATE: 22/07/20
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL ORIGIN(#)	SOIL CONSIS.(*) DENSITY.(*)	SOIL MOISTURE	ROCK WEATH.	ROCK DEPTH (m)	ROCK STRENGTH	ROCK RECOVERY (%)	ROCK RQD	FRACTURE SPACING (m)	DEFECTS & REMARKS	SAMPLE REMARKS	SAMPLE TYPE	SAMPLE INTERVAL	DEPTH (m)	TESTING TEST TYPE	TESTING RESULTS AND REMARKS
No free groundwater observed		0.0	(CH) Silty CLAY, trace gravel, trace sand; grey brown; clay fraction high plasticity; gravel fraction fine to medium, sub-angular up to 20mm in size; sand fraction fine; abundant rootlets		RES	VST TO H	>PL									D		0.05	PP	>400
		0.5	(GP) Sandy CLAY; yellow brown; clay fraction medium plasticity; sand fraction fine to medium		RES	H	<PL									D		0.6		
		0.75	0.6m: weathered sandstone						0.75									0.75		
			SANDSTONE; yellow brown; fine to medium											0.82m: B sh un						
		1	0.82-0.86m: pebbly sandstone, subrounded to rounded clasts up to 5mm in size					SW		M				0.86m: J sh ir, ro, cly 0.91m: J 20° ir, ro 1.04m: J sh pl, ro, cly				1	PLT	PL(A)=0.69 MPa
			1.4-1.47m: clay seam, pale grey					HW	1.4 1.47	VL	100	80		1.19m: J 30° pl, ro 1.35m: J 10° pl, sm, cly 1.4-1.47m: cly seam		C				
								SW		M				1.64m: Pt sh pl, cly						
			1.76-1.78m: clay seam, pale grey					HW	1.76 1.78					1.76-1.78m: cly seam 1.78m: J 20° ir, ro, cly 1.89m: J sv ir, ro, fe						
		2								H-M								2.22	PLT	PL(A)=0.68 MPa
									2.5					2.29m: J sh pl, ro, mn						
								FS			100	100				C				
		3								H				3.09m: J 30° pl, ro, mn				3	PLT	PL(A)=2.00 MPa
																			PLT	PL(A)=2.60 MPa
		3.63	Borehole discontinued at 3.63m depth Limit of investigation						3.63									3.63		
		4																4		
		5																5		

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: DT 100
METHOD: Solid flight auger to 0.7m, NMLC to 3.63m
REMARKS:

OPERATOR: Hickman
CASING: HW to 0.7m

LOGGED: JSC

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Refer to explanatory notes for symbol and abbreviation definitions

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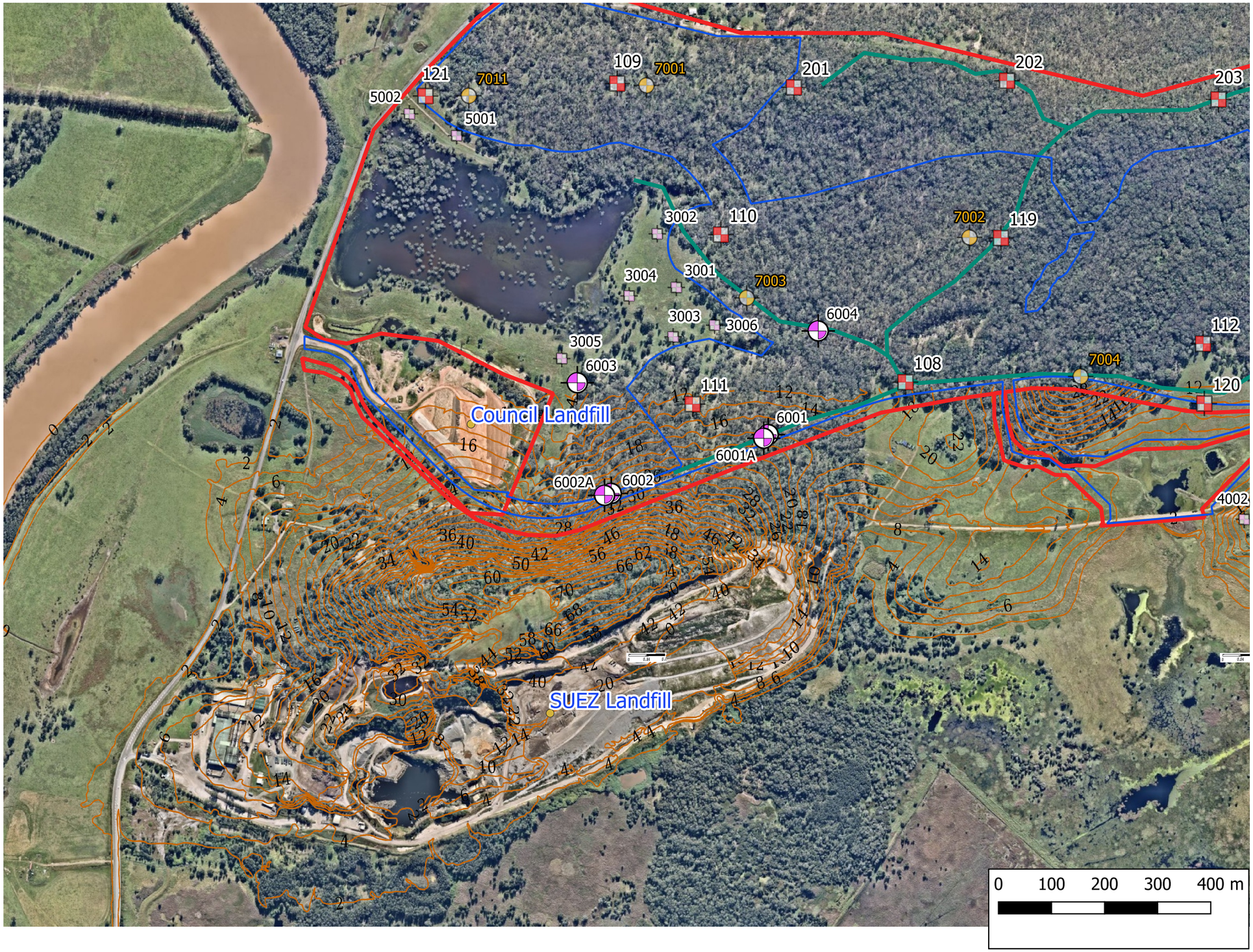
Appendix D

Drawing 1 – Test Location Plan



Locality Plan

Legend

- Gas Bores
- Bore Locations (Project 81502.12)
- Pit Locations (Project 81502.12)
- Pit Locations (Project 81502.12)
- site boundaries
- Extent of proposed development

Drawing adapted from plan by Northrop Engineers and NearMap image

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Geotechnics / Environment / Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:7500 @A3	DATE:	21.09.2020

TITLE: **Test Location Plan - Ground Gas Assessment**
Proposed Kings Hill Development
North Raymond Terrace

N

PROJECT No:	81502.13
DRAWING No:	1
REVISION:	0