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Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Acid Sulfate Soil Management Plan

Glebe Mid-Rise Project
31 Cowper Street and 2A-2D Wentworth Park Road,
Glebe

Prepared for
New South Wales Land and Housing Corporation

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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.

	Signature	Date
Author		13 May 2020
Reviewer		13 May 2020

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666

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1. Introduction

This Acid Sulfate Soil Management Plan (ASSMP) has been prepared for a Glebe Mid-Rise Project at 31 Cowper Street and 2A-2D Wentworth Park Road, Glebe. The ASSMP was commissioned by New South Wales Land and Housing Corporation via a Letter of Agreement dated 29 January 2020 and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal dated 11 December 2019.

The ASSMP has been prepared based on the results of an assessment of Acid Sulfate Soil (ASS) undertaken as part of the DP *Report on Preliminary and Detailed Site (Contamination) Investigation, Proposed Mixed-Use Development, 31 Cowper Street and 2A-2D Wentworth Park Road, Glebe* (Report 99554.01.R.001.DftA, dated February 2020: the DSI report), which identified ASS to be present at the site.

The most significant impacts from the uncontrolled oxidation of ASS are generally on water quality, with acid and heavy metals mobilised via leachate and potentially entering the local surface water, where fish kills and other impacts can occur. As such, management of water and leachate during excavation, and treatment and management of ASS are paramount to successfully preventing ecological impacts from the works.

This ASSMP provides three strategies for managing ASS, and a mixture of two to three of the strategies may provide the most efficient overall management of ASS for the project.

2. Summary Proposed Development and ASS Results

2.1 Proposed Development

The architectural drawings prepared by Johnson Pilton Walker Pty Ltd (Project 19001, Revision 00, dated 1 May 2020) show that the proposed development is to include two buildings separated by Park Lane, known as the North Site (i.e., 2A-2D Wentworth Park Road) and the South Site (i.e., 31 Cowper Street). Drawings A-1000 and A-1001 show that the South Site is to have two basement levels for car parking and machine rooms, and that the North Site has one level of basement car parking (within the southern portion of the development footprint).

It is expected that more than 1,000 tonnes of ASS will be disturbed by the proposed development, triggering the requirement for a detailed ASSMP (as provided herein), however, the actual mass of ASS disturbed will depend on the final development plans.

2.2 ASS Results

ASS has been positively identified at the site. Extracts from the DSI are appended to this ASSMP as follows: drawing of borehole locations and geological cross sections (Appendix A); borehole logs (Appendix B) and Summary of Laboratory Results (Appendix C).

Based on the available results from the DSI the following is noted:

- Grey and grey-brown alluvium below the water table is likely to be ASS;
- Brown alluvium below the water table may not be ASS, and further testing may be warranted to confirm the presence / absence of ASS in these materials. Material in the southern portion of the site is more likely to not contain ASS than material in the central and northern portion of the site. If no further testing is completed, then the material should be assumed to be ASS;
- Fill beneath the water table is likely to be ASS, and should be assumed to be ASS unless further assessment shows otherwise: this is further discussed in the following sub-sections;
- Alluvium above the water table is likely not to be ASS, however, further assessment during excavation is warranted (i.e., inspection by a geotechnical / environmental engineer / scientist and / or field screening and / or laboratory testing, as required); and
- Residual soil, rock and fill has been found to not contain ASS.

The DSI identified that the northern portion of the site (inferred to be north of the previously mapped high water mark as shown on Drawing 1, Appendix A) had been reclaimed, partly using dredged sediments. Access for drilling in this area was limited, and the extent and nature of the fill has not been characterised. However, available information suggests the fill could be ASS and could also contain asbestos.

3. Guidelines

3.1 ASS Assessment and Management

This ASSMP is devised on the basis of the following current guidelines endorsed by the NSW Environment Protection Authority (EPA), and in accordance with current industry standards:

- NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC), 1998. *Acid Sulfate Soil Manual* (ASSMAC, 1998);
- Ahern CR, McElnea AE, Sullivan LA (2004). *Acid Sulfate Soils Laboratory Methods Guidelines*. Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia (Ahern et al, 2004);
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, *National Acid Sulfate Soils guidance: National acid sulfate soils sampling and identification methods manual*, Department of Agriculture and Water Resources, Canberra ACT. CC BY 4.0 (Sullivan et al, 2018a);
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, *National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual,* Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0 (Sullivan et al, 2018b); and

- NSW Environment Protection Authority (EPA), 2014. *Waste Classification Guidelines* (EPA, 2014), Part 4: Acid sulfate soils.

The thresholds for determining the need to manage ASS are provided in Table 1.

Table 1: Thresholds for ASS Assessment (ASSMAC (1998)

Material Type	Existing and Potential Acidity	
	Equivalent acidity (mol H^+/ tonne) (oven-dry basis)	Equivalent sulfur (%S) (oven-dry basis)
ASSMAC Action Criteria for disturbance of more than 1000 tonnes		
All textures	18	0.03

3.2 General Waste Classification

The guideline for waste classification of soil is *Waste Classification Guidelines* (EPA, 2014), including 'Part 4: Acid Sulfate Soils'.

3.3 Virgin Excavated Natural Material (VENM) Criteria

The Protection of the Environment Operations Act 1997 (POEO Act) defines Virgin Excavated Natural Material (VENM) as:

'natural material (such as clay, gravel, sand, soil or rock fines):

(a) That has been excavated or quarried from areas that are not contaminated with manufactured chemicals, or with process residues, as a result of industrial, commercial, mining or agricultural activities; and

(b) That does not contain any sulfidic ores or soils or any other waste.

and includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved for the time being pursuant to an EPA Gazettal notice.'

3.4 Potential Acid Sulfate Soil (PASS) Criteria

For the purposes of this ASSMP, Potential Acid Sulfate Soil (PASS) is defined in accordance with the NSW Environment Protection Authority (EPA) *Waste Classification Guidelines*, Part 4 (Acid Sulfate Soils) (EPA, 2014).

The PASS criteria include requirements on the material properties and its handling.

EPA (2014) allows direct disposal of ASS as PASS, subject to the following:

- The soils meet the definition of VENM in all aspects, other than the presence of sulfidic soils or ores;
- The pH of soils in their undisturbed state is pH 5.5 or more;
- The soil has not dried out or undergone any oxidation of its sulfidic minerals;
- Soil is received at the disposal point within 16 hours of excavation, and kept wet at all times between excavation and reburial at the disposal point;
- Appropriate records are provided to the receiving site, with every truck load confirming that it meets the above criteria; and
- The receiving site meets its obligations under EPA (2014) and its Licence conditions.

3.5 Water

Disposal of water is regulated under the POEO Act.

The Groundwater Investigation Levels (GIL) for the project are:

- *The Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018), default guideline values (DGV) for water quality for marine ecosystems. The 95% Level of Protection (LOP) has been adopted with the exception of contaminants with the potential to bioaccumulate, which have been assessed with reference to the 99% LOP in accordance with the guidance; and
- NHMRC *Guidelines for Managing Risk in Recreational Waters* 2008 (GMRRW).

4. Management Options

ASSMAC recommends assessment, and management of ASS where works involving the disturbance of more than 1 tonne of soil are proposed in an area identified to be potentially impacted by ASS. A "more detailed" management plan is generally required where more than 1,000 tonnes of ASS are expected to be disturbed.

It is considered that the following management options could be applied for the project:

- Non-excavation or minimal works. This option involves amending the proposed works to minimise the volume of ASS which will be disturbed; and

  This option is not covered herein, but could be applied as part of the project planning and design.
- Disposal of PASS below the water table at an appropriately licenced facility. PASS can be placed beneath the water table at an appropriately licenced facility, if stringent requirements set out by the OEH are met. This option is only allowed for uncontaminated natural in situ PASS and is not available for oxidised ASS; and

This option is considered to be applicable for some ASS at the site, but not all ASS. This is because contamination impacts are expected in some of the ASS. This option has been covered herein.

- Treatment of the ASS. This option involves on-site or off-site treatment of the ASS, followed by on-site re-use, off-site re-use or off-site disposal to a licenced landfill facility. The treatment process is generally straightforward, and this option is feasible for most sites. However, it is noted that:
  - On-site treatment can be difficult on small sites with insufficient space/ time for treatment;
  - Off-site treatment can be relatively expensive; and
  - Off-site re-use is only legal if a specific Resource Recovery Order and Exemption has been obtained from the EPA under Part 9 of the Protection of the Environment Operations (Waste) Regulation 2014.

Based on the above limitations, on-site treatment followed by off-site disposal is considered to be applicable for the project and has been covered herein.

If ASS contaminated with asbestos is identified during excavation, off-site treatment and disposal may reduce the required on-site controls, and as such this option has also been considered herein.

Other combined treatment / disposal / re-use options may be appropriate subject to future understanding of the project limitations and obtaining approvals, as required, however, these are not considered herein.

Any off-site facilities to be used for treatment or disposal of the ASS must be appropriately licenced and have an Environment Protection Licence (EPL) issued by the EPA under the POEO Act.

5. General Management Requirements

5.1 Dewatering Management

Dewatering is expected to be required for the project. The final dewatering requirements will depend on the excavations to be undertaken, which had not been finalised at the time of reporting.

The reduction of the groundwater table may expose sulphidic soils to oxygen which may generate acidic leachate. The greater the spatial area exposed and the longer the groundwater is lowered from its usual state, the higher the risk of acidic leachate entering the environment.

Dewatering should therefore be planned to minimised the extent and duration of drawdown.

5.2 Contaminated Soil

Contaminated soil (other than ASS) has been identified at the site by the DSI, and contamination may also be present in the ASS.

A Remediation Action Plan (RAP) detailing how contamination at the site is to be remediated / managed should be prepared. All contaminated / potentially contaminated soil and groundwater should be managed in accordance with the RAP, as well as this ASSMP as applicable.

The ASS should be inspected for signs of contamination concern, such as anthropogenic odours, staining or inclusions during all stages of handling / management. If any signs of contamination are observed the potentially impacted material will be segregated, and appropriate assessment of the issue will be undertaken by the Environmental Consultant, with the requirements based on the RAP (to be prepared). Based on the results of this assessment the Environmental Consultant will provide advice on the implication, if any, of the potential issue.

5.3 Materials Awaiting Confirmation of ASS Status

Any fill beneath the water table or alluvium which has not been assessed for the presence / absence of ASS should be treated as ASS. If ASS assessment on these materials then shows that they do not contain ASS, further management / treatment for ASS will not be required.

5.4 Stockpiling of Acid Sulfate Soils

If ASS are proposed to be stockpiled, the ASS should be placed in a stockpile area prepared in accordance with Section 7.2.

5.5 Excavation and Transport Considerations

Given that ASS can be highly reactive, particularly in sandy mediums, soils should be removed from site as soon as is practicable following excavation.

It should be noted that ASS excavated from below the groundwater table are likely to have a high moisture content. Therefore, soils will need to be transported in lined trucks, so as to prevent water leakage during transport.

The moisture content will also increase the weight of the ASS, and this should be considered when loading trucks to ensure that trucks are not overloaded.

5.6 Impacts on Engineered Materials

The engineered materials, such as concrete and steel, to be used in the project should be selected with reference to the site conditions, including the presence of ASS.

If engineered materials which are potentially sensitive to acid are to be installed in excavations near where ASS has been exposed, a suitable “guard layer” should be placed to protect these materials. Following completion of the excavation, the newly-exposed ASS should be covered with a guard layer (which can also serve as a working platform) to counteract the generation of acidic leachate due to the

soils being exposed to air. This layer could be constructed of crushed recycled concrete[1] mixed with limestone to form a 300 mm thick layer.

6. Off-Site Reburial as PASS

6.1 Overview

This option involves excavation of PASS and direct trucking of the untreated PASS to a facility licenced to receive it. This option is only applicable to PASS (i.e., not to AASS) and only if the PASS is not contaminated and is managed in accordance with Part 4 (Acid Sulfate Soils) of the EPA (2014). This option will only be able to be implemented if the status and properties of the ASS have been determined prior to excavation.

Any material which does not meet the EPA requirements for Virgin Excavated Natural Material (VENM) for any reason other than the presence of ASS cannot be classifiable as PASS for the purposes of EPA (2014) and is not suitable for off-site reburial.

In addition to this ASSMP, any specific requirements of the receiving facility must also be complied with.

Prior to this option being adopted, an agreement must be made with the receiving facility to accept the materials and detailing the requirements for the management of the material for it to be accepted, and the protocol and responsibility for the treatment and handling of any material rejected by the facility (i.e., due to it arriving at the facility in a condition which the facility cannot accept).

Based on the field investigations, it is considered that deeper alluvium at the site is likely to be suitable for off-site reburial in accordance with this ASSMP. Shallow alluvium at the site has been found to be impacted by contaminants, and is therefore, not classifiable as PASS for off-site reburial.

6.2 Management Process

The following works are required:

- Sampling and testing of field pH of at least one sample per truckload of untreated material, to confirm the pH is greater than the EPA (2014) requirements (i.e., pH ≥ 5.5) as well as above the receiving site acceptance requirements. Note some lowering of the field pH is likely to occur during transport, and as such the contractor may wish to consider on-site treatment of PASS with a field pH close to this limit (e.g., a field pH of 5.5 - 6.5 depending on soil type and pH screening results) in accordance with Sections 7 or 8. Any materials with a field pH of less than 5.5 are not suitable for disposal as untreated PASS and must be treated on-site in accordance with Sections 7 or 8;
- Any leachate / runoff water potentially impacted by ASS requires management in accordance with Section 9;
- All PASS must be kept wet during excavation and transport. Materials should be sprayed with water as required to keep them wet;

[1] All imported materials, including recycled aggregate require an appropriate exemption under the POEO Act

- PASS must be transported to the receiving facility with minimal delay. All PASS must arrive at the receiving facility no more than 16 hours after excavation, but preferably immediately following excavation to reduce the potential for the material to dry out and oxidise, thus reducing the pH;
- Full-time inspection of excavation and truck loading procedures by either a dedicated site engineer or an environmental consultant to confirm the works are carried out according to general good works practice, and with the intention to minimise the aeration (i.e., oxidation) of the PASS;
- Documentation is to be sent with each truckload detailing the soil's excavation, transport and handling procedures and timing, as well as the field pH recorded on site and the time the truck left the site. A copy of this documentation will also be kept on-site. The documentation is to show that the PASS management has been done in general accordance with this ASSMP and EPA (2014) and has appropriately mitigated oxidation of the PASS. This documentation is to be provided to the receiving facility in accordance with the requirements of EPA (2014) along with any other documentation required by the Receiving Facility;
- Transport must be conducted in a sealed / lined truck to prevent water leaking from the truck during transport. Given the material will be wet, it will be heavy (estimated to be approximately 2 t/m^3), and this should be taken into account in loading of trucks to ensure they are not overweight;
- Direct transport routes should be used to minimise transport times; and
- Once the PASS has been accepted by the receiving facility they are required to manage it in accordance with their licence conditions. It is not the role of this document to discuss management of material once they have been accepted by the receiving facility.

7. On-Site Treatment and Disposal of ASS

7.1 Overview

On-site neutralisation, management, monitoring and validation of ASS treatment, followed by off-site disposal to a licenced landfill facility, should be undertaken as required using the methodology given below. This methodology can be applied to all ASS materials (including ASS with contamination and PASS).

7.2 Construction of Treatment Area, Stockpiling Area and Leachate Collection

Prior to commencement of excavation of ASS or soils considered to be potentially ASS, an area (or areas) will need to be prepared for the management of the ASS materials. As a minimum, the management area will need to incorporate an ASS treatment area(s) and a leachate collection and treatment system.

If required, an ASS stockpiling area(s) can also be prepared. The need for a separate stockpiling area will depend on the expected volume of ASS, and the time and space available for on-site treatment. All ASS or soils considered to be potentially ASS must be kept in either an appropriately prepared treatment or stockpiling area at all times, until they have been validated as either not ASS, or that they have been successfully treated.

The area(s) where ASS is to be treated, and stockpiled prior to treatment, needs to be managed so as to prevent any runoff (leachate) from the materials either leaving the site, or entering groundwater, surface water bodies or the local stormwater system.

The treatment / stockpiling area(s) should be constructed as follows:

- Locate the treatment / stockpiling area(s) on relatively level ground to minimise any potential risk of leachate run-off. If appropriate, the division of the treatment area into cells may expedite the treatment process, as material can be allocated to different cells as works progress, resulting in a staged treatment process;
- Construct bunding / drainage to divert any overland flow around the treatment / stockpiling area;
- Excavate a lined perimeter drain to collect any leachate from the treatment and stockpiling area(s) and direct leachate to a lined collection pond. The lining should be impervious, such as using HDPE sheeting. Any leachate generated during the treatment operations must be directed to the collection pond. Water is to be managed as outlined in Section 9. Water can either be stored and treated in the pond, or pumped into a holding / treatment tank. Sufficient on-site storage for water should be available to accommodate the leachate / water that would be generated by rainfall over at least a three-day period. This is to account for rainfall / surface water runoff which may occur during a non-work period (i.e., long weekend);
- Provide suitable bunding along the perimeter of the treatment pad and stockpiling area(s), to prevent leachate overflowing from the treatment area in foreseeable rainfall conditions;
- Place an impervious membrane such as HDPE sheeting over the treatment and stockpiling area(s), and anchor into the surrounding soils to keep in place; and
- Compact a layer of agricultural lime (ag-lime) to a minimum thickness of 300 mm across the treatment and stockpiling area(s). The drain and inner bund slopes should be hand-broadcast with ag-lime at a rate of approximately 1 kg/m^2. These are precautionary measures to counteract potential acidic leachate migration prior to treatment.

An example cross-section of a treatment pad is shown in Figure 1, below.

It is noted that the fastest turnaround of results for chromium reducible sulfur (Scr) full suite testing is three days from receipt of the sample to the laboratory (with the timing generally commencing from the morning after the samples are received by the laboratory), and this timing may not always be available from the laboratory. This should be taken into account to ensure adequate on-site storage is available for treated and untreated ASS.

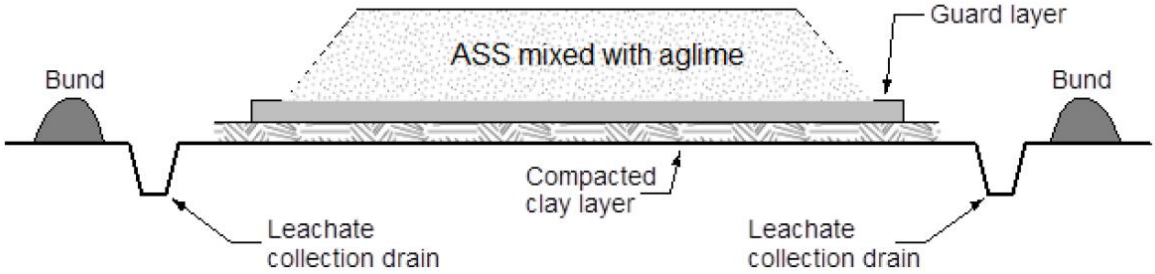

Figure 1: ASS Treatment Pad[2]

7.3 Management Process

- Excavation and disposal of any non-ASS overburden from areas of bulk excavation containing ASS;
- Any ASS material requiring transport to the treatment area should be loaded directly into sealed trucks and immediately transferred. The volume of ASS placed in the truck should be limited as required to prevent spillage;
- If required, the ASS can be placed in the ASS stockpiling area awaiting treatment. Materials to be stockpiled overnight need to be covered to minimise leachate production from rainfall and to prevent dust generation;
- The excavated soil should be spread onto the treatment pad in 300 mm thick layers, leaving a 0.5 m flat / vacant area between the toe of the stockpiled soil and the containment bund or drain. When spreading the first soil layer, care should be taken to not churn up the lime pad;
- If required, allow the soil to dry out to a moisture level which facilitates mixing. If the soil is too wet, then adequate / thorough mixing of the neutralising product can be difficult;
- Selection of a suitable neutralisation product, as further discussed in Section 7.4. This ASSMP is written on the basis of fine ag-lime being used, however, an alternative product can be used subject to prior approval by the environmental consultant, and if necessary, modification of this ASSMP;
- Apply ag-lime to the stockpiled soil at the calculated liming rate (refer to Section 7.5) over each spread layer, and mix thoroughly prior to spreading the next layer. As a precautionary measure, treatment works involving ag-lime should not be conducted during windy conditions, unless the material can be appropriately conditioned to prevent dust generation. The ASS should be covered / moistened as required during stockpiling/ treatment to prevent dust generation during windy conditions;
- If wet weather prevails, cover the stockpiled material with plastic sheeting to reduce the formation of leachate;
- Continue the spreading/ liming / mixing cycle until the mixing is complete;
- Undertake pH screening in accordance with Section 7.6 and compare with the thresholds given in Section 7.7;

[2] Sourced from Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M., 2014. *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines*. Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government.

- If the pH screening meets the criteria given in Section 7.7, undertake laboratory validation testing in accordance with Section 7.6 and compare with the criteria given in Section 7.7;
- If the pH screening or laboratory testing indicate that the materials are not suitably neutralised, undertake further mixing, and if considered necessary addition of extra lime, until the required results are achieved;
- When pH testing and laboratory validation testing indicates that neutralisation is complete (by compliance with the criteria given in Section 7.7), then the stockpiled material may be removed from the liming pad (if required), and the next batch of soils can be added to the liming pad for treatment;
- Prior to undertaking further treatment on the treatment pad, check the depth / condition of the ag-lime base layer and add additional ag-lime to meet the requirements of Section 7.2 as required; and
- Waste classification and off-site disposal of the treated ASS in accordance with Section 7.8.

It should be noted that standard turnaround times for the laboratory verification testing are five to seven working days, with a minimum time frame of approximately 3 days.

7.4 Neutralising Materials

Agricultural lime (ag-lime) with a particle size of less than 1 mm should be used as the preferred neutralisation material for the management of ASS, as it is usually the cheapest and most readily available product for soil neutralisation. The material is mildly alkaline (pH of 8.5 to 9), of low solubility, and does not present significant handling problems. The ag-lime comprises calcium carbonate typically made from limestone that has been finely ground and sieved to a fine powder.

The ag-lime purity should preferably be 95% or greater (*i.e.,* NV> 95%, where NV is the neutralising value, a term used to rate the neutralising power of different forms of materials relative to pure, fine calcium carbonate which is designated NV=100). Ag-lime is typically sold at a NV of 95% to 98%. The effective neutralising value (ENV) is dependent on the NV and the fineness of the material, and should be requested from the supplier. Individual lime dosing rates should be increased by a factor of 100/ENV. A typical fine ground (<1 mm) ag-lime with a 98% NV may have an ENV in the order of 60%.

Coarse-grained calcite is not recommended, as one of the products of the neutralisation reaction is gypsum ($CaSO_4.2H_2O$) which has a relatively low solubility and tends to coat the reacting calcite grain, forming a partial barrier against further reaction.

Gypsum may also give off hydrogen sulphide if in reaction with acidic conditions and can itself result in the generation of sulphuric acid.

Dolomitic ag-lime, or magnesium-blend ag-lime, should not be used as these materials impose environmental risks from overdosing, with the potential to damage estuarine ecosystems.

An alternate neutralising material can be used subject to prior approval by a suitably qualified scientist or engineer.

7.5 Minimum Lime Dosing Rates

The minimum liming dosing rate will depend on the Net Acidity (excluding acid neutralising capacity (ANC)) recorded from the laboratory testing, the adopted factor of safety, and the ENV of the neutralising material (refer to Section 7.4). These parameters should be obtained as follows:

- The Net Acidity (excluding ANC) should be obtained from the laboratory results. The equations below use the Net Acidity reported as % S. The highest applicable laboratory result should be adopted, unless sufficient analytical results are available to allow statistical analysis for a specific material type. For the results provided in Appendix C, the applicable **Net Acidity is 0.087% S**;
- The Factor of Safety allows for variability in mixing, low solubility and coating grains. A minimum value of 1.5 needs to be adopted, although values of up to 2 can be suitable. A **FOS of 1.5** is adopted herein; and
- The Effective Neutralising Value (ENV) of the neutralising material is based on the neutralising value (NV), solubility and fineness. The ENV should be obtained from the supplier or assessed for proposed materials in accordance with ASSMAC (1998). For the current purposes and **ENV of 60%** is assumed.

The liming rate can be calculated from the below equations, or from the liming rate calculator available at: *https://www.der.wa.gov.au/your-environment/acid-sulfate-soils/67-lime-rate-calculations-for-neutralising-acid-sulfate-soils*

Alkali Material Required (kg)

$$\textit{per unit mass of soil} = \left(\frac{\%\ S \times 623.7}{19.98}\right) \times \frac{100}{ENV\ (\%)} \times FOS$$

Alkali Material Required (kg)

$$\textit{per unit volume of soil } (m^3) = \left(\frac{\%\ S \times 623.7}{19.98}\right) \times \frac{100}{ENV\ (\%)} \times D \times FOS$$

Where:

%S = net acidity (% S units). This value is obtained from the SPOCAS / chromium suite analytical results and should be the "worst case" result of the acid or sulfur trails of all samples;

623.7 converts % S to mol H^+/t;

19.98 converts mol H^+/t to kg $CaCO_3$/t;

D = Bulk density of soil (as measured, or else assume 2 t/m^3);

FOS (factor of safety) = a minimum value of 1.5 needs to be adopted, although values of up to 2 can be suitable;

ENV = Effective Neutralising Value

Based on the laboratory results provided in Appendix C, a FOS of 1.5 and an ENV of 60%, the recommended initial ag-lime dosing rates for the ASS is **6.8 kg $CaCO_3$ per tonne of ASS**. Prior to the commencement of works, the lime dosing rate should be finalised following review of the ENV of the selected ag-lime.

It is noted that the acid production will vary both horizontally and vertically through the ASS profile, due to the variability of natural systems. The liming rate to be calculated from the analytical results should therefore be considered as a "starting point", and pH monitoring should be conducted during treatment to assess the progress of the neutralisation, and need for additional mixing and/ or addition of ag-lime. Material will only be considered to have been successfully treated when all soil complies with the criteria given in Section 7.7.

7.6 Verification Testing

Verification of works should be conducted as follows:

- Following initial neutralisation, the soils will require pH screening to confirm that the appropriate quantities of lime have been added and the soils have been suitably mixed / blended prior to disposal. The pH testing should be undertaken on the treated material at the following frequency:
  - One sample per 100 m^3 of treated soil or a minimum of 10 samples per treatment batch (for field and oxidised pH screening tests).
- Once the pH screening results all meet the criteria given in Section 7.7, laboratory verification testing will be required at the below rate, with each sample tested at the laboratory comprising either a composite sample with 5 to 10 sub-samples or the "worst case" sample:
  - <0.5% S-equivalent (<312 mol H^+/tonne) - one per 1,000 m^3 (appropriate sampling rate based on results in Appendix C);
  - 0.5% to 2% S-equivalent (312 to 1247 mol H^+/tonne) - one per 500 m^3; and
  - >2% S-equivalent (>1247 mol H^+/tonne) - one per 250 m^3.
- Compare the verification results with the acceptance criteria given in Section 7.7. If results meet the acceptance criteria, the ASS will be considered to have been successfully treated.

7.7 Verification Acceptance Criteria

7.7.1 Field Screening

Field screening results will be considered to be acceptable when the results are below the adopted criteria. When soils do meet the following criteria, confirmatory laboratory testing should be undertaken.

- Field pH is ≥ 5.5 (but ideally between pH 6.5 and 8.5); and
- pH_{fox} ≥ 6.5.

7.7.2 Laboratory Analysis

The laboratory (SPOCAS or chromium reducible sulfur (Scr) full suite) results must meet the following criteria:

SPOCAS Analysis

- pH_{KCL} is ≥ 6.5;
- TPA = 0;
- TAA = 0; and
- Net acidity ≤ 0 where net acidity is calculated as:

  Net Acidity = S_{POS} - [(S_{POS}+ (s-ANC_E post-treatment - s-ANC_E pre-treatment)) / fineness factor)].

Scr Full Suite Analysis (assuming no retained acidity such as jarosite before treatment):

- pH_{KCL} is ≥ 6.5;
- TAA = 0; and
- Net acidity ≤ 0, where net acidity is calculated as:

  Net Acidity = S_{cr} - (s-ANC_{BT} post-treatment - s-ANC_{BT} pre-treatment)) / fineness factor).

A fineness factor of 1.5 is appropriate for finely-ground ag-lime. If another neutralising material is used, a higher fineness factor may need to be applied.

Note, for both the SPOCAS and Scr full suite methods, an individual sample may have a net acidity of up to 18 mol H^+/tonne (0.03% S), as long as the average of any four spatially adjacent samples (including the exceeding sample) has an average net acidity of zero or less.

7.8 Waste Classification and Disposal of Treated ASS

Waste classification of treated ASS material to be disposed off-site is to be conducted in accordance with the EPA (2014) and the Protection of the Environment Operations (POEO) Act.

With regard to Acid Sulfate Soils, Part 4 (Acid Sulfate Soils) of EPA (2014) the guideline states that ASS must be treated (neutralised) prior to acceptance by a landfill operator (unless it is to be disposed of as "PASS" to an appropriately licenced landfill). After treatment, the soil should be chemically assessed in accordance with Step 5 in Part 1 of EPA (2014). This will determine whether any other contaminants are present in the material. When the classification has been established, the soil should be disposed to a landfill which can lawfully accept that class of waste. The treated ASS would (at a minimum) be classifiable as general solid waste (GSW), however, chemical testing will need to be carried out to confirm the classification prior to disposal: a higher, more stringent classification could apply.

Prior arrangements should be made with the operator of the landfill to ensure that it is licensed to accept the waste. The landfill should be informed that the ASS has been treated in accordance with the neutralising techniques outlined in an ASSMP produced in accordance with ASSMAC (1998) and that the waste has also been classified in accordance with EPA (2014).

8. Off-Site Treatment and Disposal of ASS

8.1 Overview

Off-site neutralisation, management, monitoring and validation of ASS treatment, followed by off-site disposal to a licenced landfill facility, should be undertaken as required using the methodology given below. This methodology can be applied to all ASS materials (including ASS with contamination and PASS).

There are a limited number of licenced treatment facilities in the Sydney area, and at the time of preparation of the ASSMP included one facility able to treat ASS with asbestos. Advice on appropriate facilities for treatment of ASS can be obtained from the EPA, or from the Environmental Consultant if this option is planned to be implemented.

8.2 Stockpiling Area and Leachate Collection

If stockpiling of ASS prior to loading into trucks is required, it should be conducted in accordance with Section 7.2.

Leachate produced from the ASS, or any other site water potentially impacted by the ASS, should be collected in accordance with Section 7.2 and managed and treated in accordance with Section 9.

8.3 Management Process

Sulfurous odours have previously been observed in the sediments from the site, and some odours may be observable from the materials to be excavated. This should be taken into account during treatment, and any odours should be managed in accordance with the EPL conditions of the relevant site.

The below works will be undertaken:

- Excavation of the ASS and loading into trucks and transport to the treatment facility;
- Transport must be conducted in a sealed / lined truck to prevent water leaking from the truck during transport. Given the material will be wet, it will be heavy (estimated to be approximately 2 t/m^3), and this should be taken into account in loading of trucks to ensure they are not overweight;
- Completion of site records of the above and all information required by the Treatment Facility, and provision of copies of these records to the Treatment Facility. This needs to include information on the required liming rate. The liming rate for use by the Treatment Facility can be calculated as detailed herein, based on the laboratory results summarised in Appendix C, or applicable laboratory results from additional testing, which should also be provided to the Receiving Site;
- Once the ASS has been accepted by the Treatment Facility they will treat and manage it in accordance with ASSMAC (1998) and their EPL conditions;
- Verification of the treatment of the ASS and classification of the soil in accordance with Sections 7.6 to 7.8; and
- Transport of the treated, classified ASS to an appropriately licenced landfill for final disposal.

9. Management and Treatment of Water Potentially Impacted by ASS

9.1 Disposal Options

In general, site water can be either disposed of on-site, through infiltration into the soil, or disposed off-site.

Water requiring off-site discharge should be disposed of in accordance with relevant guidelines and licences. Consent for discharge should be obtained from the relevant authorities, where appropriate. The approval body for discharge into the stormwater system is City of Sydney Council. Sydney Water is responsible for discharge into sewerage, and discharge can only be conducted in accordance with a Trade Waste Agreement. Sydney Water generally only accepts waters which have been contaminated by human activities, and it is the responsibility of the local government authority (City of Sydney) to accept water impacted only by ASS into the local stormwater system, subject to the water quality / disposal management meeting their requirements. Alternatively, water can be disposed to a licenced liquid waste facility, although this is generally an expensive option.

It is assumed herein that water will preferentially be disposed to stormwater in accordance with City of Sydney approval requirements. If the water is to be disposed on-site through infiltration into site soils the methodology described below will still apply, with the exception of the need to measure / treat for total suspended solids (TSS), which is not relevant for re-absorption. If the water is found not to be suitable for either of these disposal methods, then specific disposal requirements / approvals will need to be sought from Sydney Water or the receiving facility.

9.2 Management and Monitoring

Typically, ponded leachate from treated excavated ASS materials would be anticipated to have relatively low acidity (i.e., higher pH, as the management protocols are designed to minimise increases in acidity). However, unforeseen events such as heavy or sustained rainfall during excavation, especially over non-work periods, may produce leachate from excavated stockpiles which have unacceptable acidity (pH less than 6.5), as there has been insufficient time to contact and react with the ag-lime. Under such circumstances, the ponded leachate would need “finishing” prior to their final discharge.

The following procedure is recommended in order to minimise potential adverse impacts resulting from water / leachate from ASS:

- All water should be collected and stored in an appropriately lined and bunded holding pond and / or within a sealed holding tank for testing and treatment prior to disposal;
- Monitoring for a minimum of pH, total suspended solids (TSS), heavy metals, iron and oil and grease as per Table 2. In addition, any contaminants of concern identified for the site or specific analytes required by City of Sydney should also be assessed; and
- Treatment of water for any parameters which do not meet the target levels provided in Table 2 and / or any specific guidelines provided by City of Sydney. If water cannot be treated to meet these requirements, either further assessment of background water quality in the receiving system can be undertaken or an alternate disposal option could be implemented.

Table 2: Suggested Water Monitoring Frequencies and Target Levels for Disposal to Stormwater

Test	Frequency	Target Level for Disposal to Stormwater
pH	Field measurement: • During storage as required to allow timely treatment; • Immediately prior to disposal; and • Daily checks during discharge period.	• pH 6.5 – 8.5
Total Suspended Solids (TSS)	Field / Laboratory measurement: • Immediately prior to disposal; and • As required based on visual observations; and Visual assessment: • Daily during discharge period.	• Water observed to be clear; • ≤50 mg/L or equivalent turbidity measure (in NTU) where a statistical correlation between the TSS and turbidity has been determined.
Oil and Grease	Visual assessment: • Immediately prior to disposal; and • Daily checks during discharge period; and Laboratory analysis: • As required based on visual observations.	• None observable. • <10 mg/L.
Iron (total and soluble)	Laboratory analysis: • Immediately prior to disposal; and • Weekly checks during discharge period; and • As required based on visual observations; and Visual assessment: • Daily during discharge	• ≤ 0.3 mg/L filterable iron. • No obvious sign of iron staining / settlement.
Metals (aluminium, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, zinc)	Laboratory analysis: • One round of testing before first disposal; • If first round of testing exceeds target levels, then further testing prior to disposal is required	• ANZG (2018) Trigger Levels for 95% Level of Protection for marine ecosystems.

9.3 Treatment

9.3.1 General

Treatment of water from construction sites is commonly required for pH and TSS. Aeration / flocculation and removal of TSS also generally decreases metal concentrations in the water. Standard industry treatment methods and commercial treatment products are suitable for the site and are likely to provide the most efficient treatment, however, an alternate treatment method for pH is provided below.

If a suitable treatment method for man-made contaminants in the water (e.g., oil and grease or metals) cannot be implemented, an alternate disposal method may be required (e.g., to trucking off-site to a liquid waste disposal facility or disposal to sewer in accordance with a specific Trade Waste Agreement, to be obtained from Sydney Water).

9.3.2 Alternate pH Treatment Method

It is noted that ag-lime is generally not suitable for the treatment of leachate due to its low solubility in water. A commercial pH adjustment product can be used, or else 'slaked lime', as discussed below.

A calcium hydroxide solution (commonly called 'slaked' or 'hydrated lime') can be produced by stirring calcium oxide (commonly called 'quicklime') into water, in a container of sufficient volume (for example, a plastic 200 litre drum). The slurry should be allowed to settle, and the clear solution (which will be caustic, with a pH of approximately 12.5 to 13) can be pumped or sprayed into the standing water in small amounts, with some agitation and monitoring. This procedure should be continued until the pH is adjusted to acceptable levels. Great care should be taken not to overshoot the desired pH with calcium hydroxide.

It is recommended that the contractor have several large bags of quicklime readily available at all times, subject to site constraints, with necessary equipment to produce, transport and apply the hydroxide solution as required.

Quicklime is very reactive, and relatively corrosive (due to its caustic nature). When quicklime is mixed with water, the resulting reaction generates heat. Therefore, the material should be added in increments to a large amount of water to control the reaction. Slaked or quicklime should not be allowed to come into contact with the skin or be inhaled during use.

The amount of neutraliser required to be added to the discharged groundwater can be calculated from the equation below:

$$\textit{Alkali Material Required (kg)} = \frac{M_{Alkali} \times 10^{-pH\ initial}}{2 \times 10^{3}} \times V$$

Where: M_{Alkali} = *molecular weight of alkali material (g/mole)*
pH initial = initial pH of leachate
V = volume of leachate (litres)

Note: *molecular weight of slaked lime ($Ca(OH)_2$) = 74 g/mole.*

As a guide, the approximate quantities of slaked lime required to neutralise acidic water are provided in Table 3.

Table 3: Approximate Liming Rates for Water (Based on Slaked Lime (kg of Ca $(OH)_2$)

Water pH	Volume		
	1 m^3	5 m^3	10 m^3
2	0.37	1.85	3.7
3	0.037	0.185	0.37
4	0.0037	0.0185	0.037
5	0.00037	0.00185	0.0037
6	0.000037	0.000185	0.00037

10. Work Health and Safety and Emergency Response Procedures

10.1 Work Health and Safety Training

Prior to commencement of excavation all workers should be made aware through site training / induction of potential site hazards in accordance with the SafeWork NSW requirements. The training must be substantiated with training and attendance records of the workers.

10.2 Neutralisation Products

Ag-lime and slaked lime are caustic, and should be handled and stored in accordance with the product advice. Appropriate staff training should be provided, and the required personal protective equipment (PPE) should be made available and used during handling. Required PPE may include protective clothing, gloves and goggles.

Products should be stored on-site in a safe / locked area, and should be kept in appropriate, sealed containers with the product safety advice.

10.3 Emergency Response Procedures

Construction activities in ASS which may cause potential environmental threats are summarised in Table 4 on the following page, together with recommendations for “Emergency Response Procedures”.

For all construction incidents which pose a potential health or environmental threat, an incident report must be completed in order to:

- Determine the cause of the incident;
- Implement additional control measures as required; and
- Adequately modify work procedures to reduce the likelihood of the incident re-occurring.

Table 4: Emergency Response Procedures

Construction Activity	Potential Environmental or Health Threat	Emergency Response
All activities potentially generating airborne ASS dust or involving direct contact of workers with ASS	Potential eye or skin irritation in sensitive individuals, including dermatitis	• Rinse skin with clean water, rinse eyes with saline or clean water; • Control dust in accordance with site Construction Environmental Management Plan (CEMP), or equivalent; • Minimise exposure of sensitive individuals to ASS; • Ensure workers wearing long-sleeve shirts, long pants and gloves when in contact with ASS, and glasses if eye irritation experienced; and • Seek medical advice if required.
ASS field screening or water treatment	Potential burn / harmful inhalation or other exposure to chemical	• Follow MSDS requirements; and • Seek immediate medical advice.
	Spill of chemicals into the environment	• Inform site foreman and project environmental officer; • Estimate volume of chemical released; • Report incident in accordance with project requirements and requirements under the POEO Act (if applicable); • Conduct analysis for chemical in adjacent watercourses / drains / ponds (if potentially impacted); • Treat adjacent watercourses / drains / ponds (if impacted). The method of required treatment, if any, will be determined based on the chemical and degree of impact; and • Assess potential impacts on groundwater: this may be based on release volumes and surface water impacts only, or may require testing of groundwater in the potentially impacted area.
Stockpiling / Neutralisation	Breach in stockpile containment bund	• Inform site foreman and project environmental officer; • Repair the breach in bund; • Conduct pH analysis of adjacent watercourses / drains / ponds (if potentially impacted); • Correct pH in any adjacent watercourses / drains / ponds (if impacted); • Evaluate footprint of breach for any ASS which may have moved through the breach; and • Report incident in accordance with project requirements and requirements under the POEO Act (if applicable).

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Construction Activity	Potential Environmental or Health Threat	Emergency Response
Stockpiling / Neutralisation (continued)	Stockpiled material washes or slips outside bunded lime pad	• Inform site foreman and project environmental officer; • Estimate volume of material outside of bund; • Report incident in accordance with project requirements and requirements under the POEO Act (if applicable); • Remove ASS from outside the bund and place onto a bunded limed pad; • Over-excavate impacted area to 0.2 m depth, assess underlying materials for ASS using ASS screening (pH field and pH_{FOX}); • If assessment indicates ASS / ASS-impacted soils from the wash / slip remain outside bund, undertake further excavation until all impacted soils have been removed; and • Conduct pH analysis of adjacent watercourses / drains / ponds (if potentially impacted).
	Release of ag-lime into the environment	• Inform site foreman and project environmental officer; • Estimate volume of material released; • Report incident in accordance with project requirements and requirements under the POEO Act (if applicable); • Remove lime from outside the bund and place onto a bunded limed pad; • Over-excavate contaminated area to 0.1 m depth, assess underlying materials; • Conduct pH analysis of adjacent watercourses / drains / ponds (if potentially impacted); and • Assess the need for any further remedial works based on an assessment of the risks.
Water collection and treatment	Breach in water collection or storage bund or lining	• Inform site foreman and project environmental officer; • Repair the breach in bund; and • Undertake works detailed below if possible release of water is in a manner not meeting Licence conditions.

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Construction Activity	Potential Environmental or Health Threat	Emergency Response
Water collection and treatment (continued)	Release of water in manner not meeting EPL conditions	• Inform site foreman and project environmental officer; • Estimate volume of water released; • Report incident in accordance with project requirements and requirements under the POEO Act (if applicable); • Conduct pH analysis of adjacent watercourses / drains / ponds (if potentially impacted); • Correct pH in any adjacent watercourses / drains / ponds (if impacted); and • Assess potential impacts on groundwater, this may be based on release volumes and surface water impacts only, or may require testing of groundwater in the potentially impacted area.

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11. Reporting Requirements

11.1 Contractor Reporting Requirements

A record of management, treatment, monitoring, validation and disposal of ASS should be maintained by the contractor, and should include the following details:

- Date;
- Location / area and depth of excavated material;
- Time of excavation and time of leaving site (for disposal of untreated PASS only);
- Field pH of ASS prior to leaving site (for disposal of untreated PASS only);
- Neutralisation process undertaken;
- Liming material and rate utilised;
- Results of monitoring;
- Disposal location; and
- Tonnages of material treated/disposed and landfill dockets.

These records should be submitted to the environmental consultant following completion of the works.

11.2 Closure Report

Following completion of the works and receipt of the contractor's records, a close-out report should be prepared by the environmental consultant to demonstrate conformance to the management plan. The close-out report should include the following:

- Description of site works undertaken and methodologies;
- Volume of materials treated including quantity and nature of neutralising materials mixed;
- Acid sulfate soil management measures employed;
- Field screening and laboratory analytical results; and
- Discussion of soil monitoring programs and acceptance criteria.

12. Comments

This ASSMP describes the requirements to manage ASS during the proposed development works. It is considered that implementation of this ASSMP will appropriately manage the associated potential risk of harm to the surrounding water bodies, including the local groundwater.

13. References

- Ahern CR, McElnea AE, Sullivan LA (2004). *Acid Sulfate Soils Laboratory Methods Guidelines*. Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia (Ahern et al, 2004).
- DP *Report on Preliminary and Detailed Site (Contamination) Investigation, Proposed Mixed-Use Development, 31 Cowper Street and 2A-2D Wentworth Park Road, Glebe* (Report 99554.01.R.001.DftA dated February 2020) (the DSI).
- Government of Western Australia Department of Environmental Regulation (WA DER) *Treatment and management of soil and water in acid sulfate soil landscapes* June 2015.
- https://www.der.wa.gov.au/your-environment/acid-sulfate-soils/67-lime-rate-calculations-for-neutralising-acid-sulfate-soils.
- NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC), 1998. *Acid Sulfate Soil Manual* (ASSMAC, 1998).
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, *National Acid Sulfate Soils guidance: National acid sulfate soils sampling and identification methods manual*, Department of Agriculture and Water Resources, Canberra ACT. CC BY 4.0 (Sullivan et al, 2018a).
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, *National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual,* Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0 (Sullivan et al, 2018b).
- NSW Environment Protection Authority (EPA), 2014. *Waste Classification Guidelines* (EPA, 2014), Part 4: Acid Sulfate Soils.

14. Limitations

Douglas Partners (DP) has prepared this report for this project at 31 Cowper Street and 2A-2D Wentworth Park Road, Glebe, in accordance with DP's proposal SYD191235 dated 11 December 2019 and a 'Letter of Agreement to undertake LAHC 2019/608' dated 29 January 2020. The work was carried out under a modified New South Wales Land and Housing Corporation contract. This report is provided for the exclusive use of New South Wales Land and Housing Corporation 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 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.

DP's advice is based upon the conditions encountered during the previous DSI investigation as referenced herein. 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 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 (geotechnical / environmental / groundwater) 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

Notes About this Report

Drawings

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

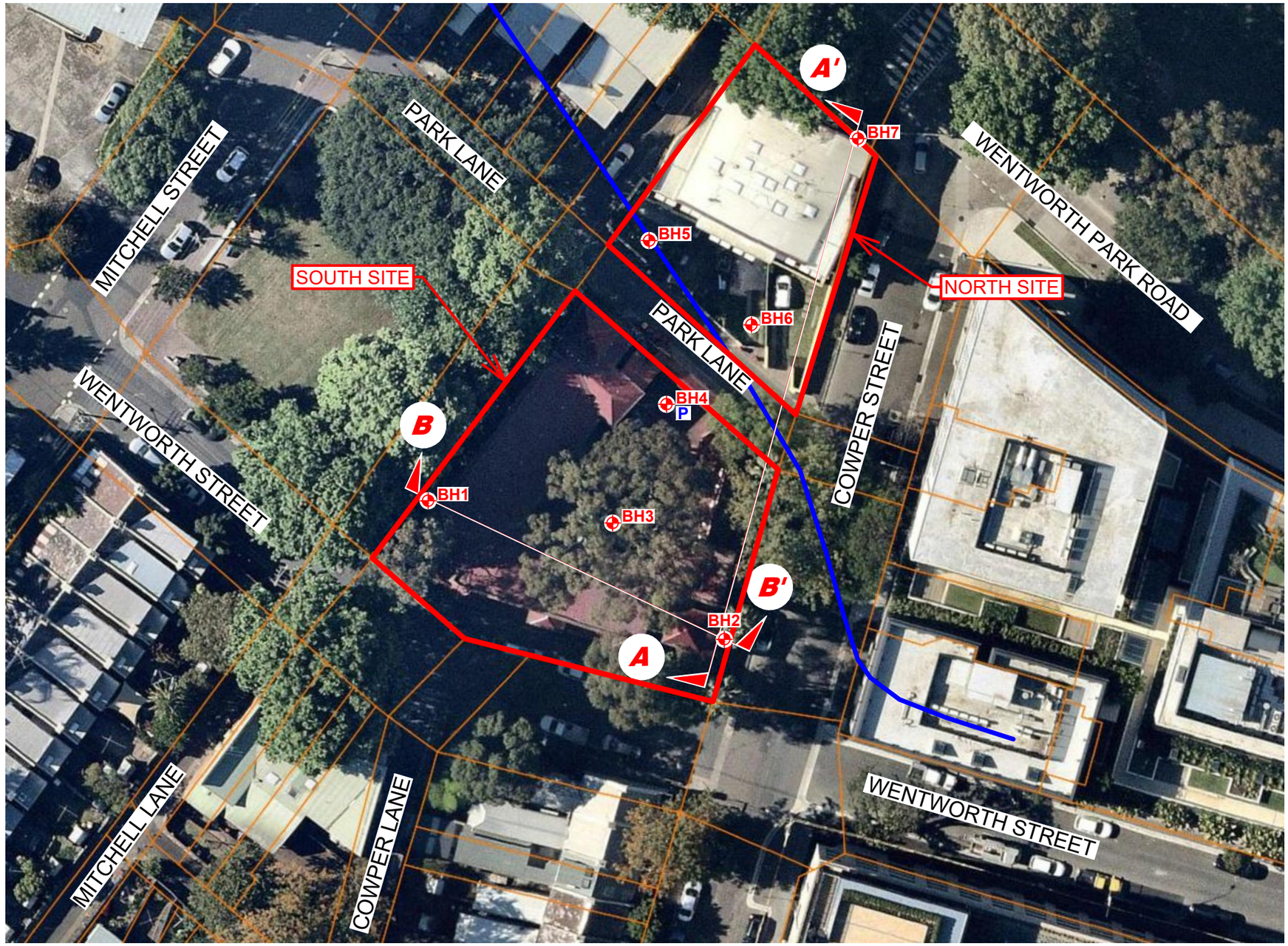
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later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

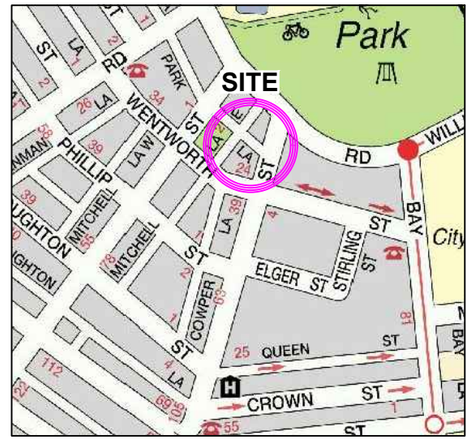
Site Inspection

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.



0 5 10 15 20 30 40 50m

1:500 @ A3



Locality Plan

LEGEND

- Borehole Location
- P Standpipe Piezometer
- A A' Geotechnical Cross Section A-A'
- Historical High Water Mark and Inferred Southern Limit of Reclaimed Land (1890 Map from Parish of Petersham)
- Site Boundary

NOTE:
1: Base image from Nearmap.com (Dated 22.10.2019)

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Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: New South Wales Land and Housing Corporation	TITLE: **Site and Test Location Plan**	PROJECT No: 99554.01
	OFFICE: Sydney / DRAWN BY: IT/HDS	**Glebe Mid-Rise Project**	DRAWING No: 1
	SCALE: 1:500 @ A3 / DATE: 11.05.2020	**31 Cowper St and 2A-2D Wentworth Park Rd, Glebe**	REVISION: 1

A

A'

PROPERTY BOUNDARY

INTERSECTION CROSS-SECTION B-B'

PROPERTY BOUNDARY

PROPERTY BOUNDARY

PROPERTY BOUNDARY

GARDENS, FENCES AND AWNINGS

PARK LANE

GRASS AND DRIVEWAY

TWO-STOREY RESIDENTIAL BUILDING

FOOTPATH

BH2
Offset -0.6m

Rock Strength
EL VL L M H VH EH

BH4
Offset 12.5m

Rock Strength

BH6
Offset 5.8m

Rock Strength

BH7
Offset - 0.5m

FOOTPATH

WENTWORTH PARK ROAD

CONCRETE

FILL

N = 4

N = 5

N = 0

SANDY CLAY and CLAY ALLUVIUM (FIRM TO STIFF)

N = 3

N = 0

N = 8

N = 9

N = 2

N = 0

N = 8

N = 7

N = 8

refusal

FILL

CLAYEY SAND AND SANDY CLAY ALLUVIUM (VERY SOFT / LOOSE)

OUTLINE OF BASEMENT ENVELOPE (TO RL 0m)

VERY LOW TO LOW STRENGTH SANDSTONE

SANDY CLAY ALLUVIUM (VERY SOFT)

CLAYEY SAND RESIDUAL

SANDY CLAY and CLAY ALLUVIUM (FIRM TO STIFF)

MEDIUM OR HIGH STRENGTH SANDSTONE

PROJECTED OUTLINE OF BASEMENT ENVELOPE (TO RL-3m)

VERY LOW TO LOW STRENGTH SANDSTONE

CLAYEY SAND ALLUVIUM (FIRM TO STIFF)

MEDIUM OR HIGH STRENGTH SANDSTONE

Bottom Depth 14 m

Bottom Depth 13.8 m

Bottom Depth 15.38 m

Bottom Depth 1.3 m

ELEVATION (AHD)

6 4 2 0 -2 -4 -6 -8 -10 -12 -14

0 10 20 30 40 50 60 70

DISTANCE ALONG PROFILE (m)

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LEGEND

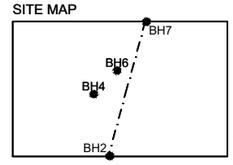
- Concrete
- Fill
- Fill / Topsoil
- Fill / Roadbase
- Clay
- Sandy Clay
- Clayey Sand
- Sandstone

NOTES:
1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs included only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

ROCK STRENGTH
- EL - Extremely low
- VL - Very low
- L - Low
- M - Medium
- H - High

TESTS / OTHER
- N - Standard penetration test value
- ▽ - Water level
- — ? — — - Inferred geotechnical boundary

SITE MAP



0 4
Horizontal Scale (metres)
Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: New South Wales Land and Housing Corporation		TITLE: **Inferred Geotechnical Cross-Section A-A'**	PROJECT No: 99554.00
OFFICE: Sydney	DRAWN BY: IT/HDS	**Glebe Mid-Rise Project**	DRAWING No: 2
SCALE: 1:200 (H) 1:100 (V) @ A3	DATE: 11.05.2020	**31 Cowper St and 2A-2D Wentworth Park Rd, Glebe**	REVISION: 1

B

B'

PROPERTY BOUNDARY

INTERSECTION CROSS-SECTION A-A'

PROPERTY BOUNDARY

TWO-STOREY RESIDENTIAL BUILDING

BH1
Offset 0.0m
Rock Strength
EL VL L M H VH EH

BH2
Offset -0.4m
Rock Strength
EL VL L M H VH EH

MITCHELL LANE

FOOTPATH

COWPER STREET

FILL

N = 3

N = 11

N = 4

N = 4

N = 5

N = 0

SANDY CLAY and CLAY ALLUVIUM (FIRM TO STIFF)

SANDY CLAY ALLUVIUM

VERY LOW TO LOW STRENGTH SANDSTONE

OUTLINE OF BASEMENT ENVELOPE (TO RL-3m)

MEDIUM OR HIGH STRENGTH SANDSTONE

SHALE

Bottom Depth 14.2 m

Bottom Depth 14 m

ELEVATION (AHD)

6 4 2 0 -2 -4 -6 -8 -10 -12 -14

-10 0 10 20 30 40 50

DISTANCE ALONG PROFILE (m)

1096

LEGEND

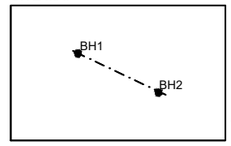
- Concrete
- Fill
- Clay
- Sandy Clay
- Shale
- Sandstone

NOTES:
1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs included only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

ROCK STRENGTH
EL - Extremely low
VL - Very low
L - Low
M - Medium
H - High

TESTS / OTHER
N - Standard penetration test value
- Water level
- Inferred geotechnical boundary

SITE MAP



0 4
Horizontal Scale (metres)
Vertical Exaggeration = 2.0

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CLIENT: New South Wales Land and Housing Corporation		TITLE: **Inferred Geotechnical Cross-Section B-B'**	PROJECT No: 99554.00
OFFICE: Sydney	DRAWN BY: IT/HDS	**Glebe Mid-Rise Project**	DRAWING No: 3
SCALE: 1:200 (H) 1:100 (V) @ A3	DATE: 11.05.2020	**31 Cowper St and 2A-2D Wentworth Park Rd, Glebe**	REVISION: 1

Appendix B

Previous Borehole Logs

BOREHOLE LOG

CLIENT: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 3.2 AHD
EASTING: 332849
NORTHING: 6249728
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 99554.00
DATE: 21/01/2020
SHEET 1 OF 3

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
3	0.0	FILL/SAND: fine to medium, dark grey, trace silt, organic debris, gravel and charcoal fragments, moist, appears generally in a loose condition							A/E			PID=3
	0.3	FILL/GRAVEL and SAND: medium to coarse gravel, angular to subangular and rectangular, flaky, mostly ripped sandstone gravel, fine to medium sand, with glass, ceramic tile and timber, trace ash, slag and charcoal, moist, appears generally in a loose condition							A/E*			PID=2
2	1								A/E			PID=4
									S			1,1,2 N = 3 PID=2
1	1.8	CLAY CH: high plasticity, mottled brown and pale grey, trace silt and ironstone gravel, w=PL, stiff, alluvial							A/E			PID=3
	2								S			5,6,5 N = 11 PID=2
0	3.0	Sandy CLAY CL: low plasticity, pale brown, 30% fine sand, w~PL, stiff, alluvial				21-01-20			A/E			PID=1
-1	4								S			2,2,2 N = 4 PID=1
	4.5	Sandy CLAY CL: low plasticity, pale grey and brown, fine to medium, 35% clay/silt, w>PL, stiff, alluvial										
	5.0											

RIG: XC100 **DRILLER:** FF **LOGGED:** SI **CASING:** HW to 5.5m

TYPE OF BORING: Solid flight auger (TC-bit) to 5.5m, NMLC to 14.2m

WATER OBSERVATIONS: Free groundwater at 3.0m whilst augering

REMARKS: *BD2 210120 replicate of sample 0.4-0.5m. Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinate obtained using Nearmap and site measurements.

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 3.2 AHD
EASTING: 332849
NORTHING: 6249728
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 99554.00
DATE: 21/01/2020
SHEET 2 OF 3

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
-2	5.2	Sandy CLAY CL: refer previous page										
		SANDSTONE: fine to medium grained, brown, very low strength, highly weathered, Hawkesbury Sandstone										
-3	6.22	SANDSTONE: medium grained, pale grey and brown, low to medium strength with very low strength bands, slightly then highly weathered, slightly fractured, Hawkesbury Sandstone						5.5 to 5.6m: fg, fe 5.7m: J45°, pl, ro, fe 6.0 & 6.2m: J(x2) 70°, pl, ro, cln	C	100	50	PL(A) = 0.1 PL(A) = 0.3
-4	7.05	SANDSTONE: medium to coarse grained, pale grey, thinly bedded and cross bedded (5° to 25°), high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone						6.7m: Ds, 200mm 6.95m: J50°, pl, ro, cly 7.05m: J45°, pl, ro, cly	C	100	68	PL(A) = 1.4
-5								7.95m: B0°, pln, ro, cly co, 2mm 8.1 & 8.35m: B(x2) 10°, pln, ro, cly co, 2mm	C	100	100	PL(A) = 1.7
-6		Below 9.3m, unbroken						8.92m: B0°, cly 5mm 8.93 to 9.3m: J70° to 90°, cu, he, cly 5mm	C	100	52	PL(A) = 1.2
	10.0											

RIG: XC100 **DRILLER:** FF **LOGGED:** SI **CASING:** HW to 5.5m

TYPE OF BORING: Solid flight auger (TC-bit) to 5.5m, NMLC to 14.2m

WATER OBSERVATIONS: Free groundwater at 3.0m whilst augering

REMARKS: *BD2 210120 replicate of sample 0.4-0.5m. Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinate obtained using Nearmap and site measurements.

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 3.2 AHD
EASTING: 332849
NORTHING: 6249728
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 99554.00
DATE: 21/01/2020
SHEET 3 OF 3

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
-7	10.08	SANDSTONE: refer previous page										
		CARBONACEOUS SHALE: dark grey, with irregular clayey zones, very low strength, highly to slightly weathered, highly fractured, Hawkesbury Shale						10.06m: J35°, un, ro, cly 10mm 10.2m: J45°, pl, sm, cly 10.4m: J45°, pl, sm, cln	C	100	52	PL(A) = 0.2
	10.7	SANDSTONE: medium grained, pale grey, thinly bedded and cross bedded (10°-20°) with carbonaceous flakes and laminations between 10.7-12.4m, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone										
-8	11							11.06m: B10°, cly co, 2mm 11.36m: J45°, pl, ro, cly 5mm	C	100	96	PL(A) = 2.6
-9	12							12.1m: J45°, pl, ro, cly 3mm				PL(A) = 1.1
-10	13							13.2m: J35°, pl, ro, cly 15mm 13.3m: J30°, pl, ro, cly 10mm 13.38m: B5°, cly 2mm	C	100	94	PL(A) = 0.7
								13.8m: B20°, pl, ro, cly vn 13.9m: J45°, pl, ro, cln				PL(A) = 1.6
-11	14											
	14.2	Bore discontinued at 14.2m - Target depth reached										

RIG: XC100 **DRILLER:** FF **LOGGED:** SI **CASING:** HW to 5.5m

TYPE OF BORING: Solid flight auger (TC-bit) to 5.5m, NMLC to 14.2m

WATER OBSERVATIONS: Free groundwater at 3.0m whilst augering

REMARKS: *BD2 210120 replicate of sample 0.4-0.5m. Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinate obtained using Nearmap and site measurements.

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)

BOREHOLE LOG

CLIENT: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 3.5 AHD
EASTING: 332882
NORTHING: 6249712
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 99554.00
DATE: 22/01/2020
SHEET 1 OF 3

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
		CONCRETE										
	0.3	FILL/Sandy CLAY: low plasticity, dark grey, fine to medium, with fine to coarse, angular to subangular igneous gravel and clay, trace ash, slag, glass, brick, rootlets, ripped sandstone gravel and wire, w~PL, appears generally in a loose condition							A/E			PID<1
									A/E			PID<1
									S			1,2,2 N = 4 PID<1
									A/E			PID<1
	2.4	Sandy CLAY CL: low plasticity, brown, fine to medium, w~PL, firm, alluvial							A/E			PID<1
									S			4,2,3 N = 5 PID<1
	3.1	CLAY CH: high plasticity, dark grey, trace fine to medium ironstone gravel and fine sand, w>PL, firm, alluvial				22-01-20			A/E			PID<1
	4.0	Sandy CLAY CL-CI: low to medium plasticity, grey-brown, fine to medium sand, w>PL, very soft, alluvial							A/E			PID<1
									S			1,0,0 N = 0 PID=2
	5.0								A/E			PID=3

RIG: XC100 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 5.5m

TYPE OF BORING: Diatube (250mm) to 0.3m, Solid flight auger (TC-bit) to 5.2m, NMLC coring to 14.0m

WATER OBSERVATIONS: Free groundwater observed at 3.2m whilst augering

REMARKS: Surface level obtained from Mepstead and Associates Pty Ltd, drawing 5743 dated 18/12/2018. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 3.5 AHD
EASTING: 332882
NORTHING: 6249712
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 99554.00
DATE: 22/01/2020
SHEET 2 OF 3

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)	Type	Core Rec. %	RQD %	Test Results & Comments
	5.1	Sandy CLAY CL-CI: as per previous page										
	5.3	SANDSTONE: fine to medium grained, pale grey, very low strength, highly weathered, Hawkesbury Sandstone						5.23m: Cs, 30mm				PL(A) = 1.4
-2		SANDSTONE: medium to coarse grained, orange-brown and pale grey, thinly bedded and cross bedded, high strength, moderately weathered, slightly fractured, Hawkesbury Sandstone						5.88m: B5°, un, ro, fe stn	C	100	96	
6												PL(A) = 2
-3								6.62m: B5°, pl, ro, fe stn 6.75m: B5°, pl, ro, cbs vn 6.85m: B0°, pl, sm, cly co				
		Below 6.85m, red-brown, highly weathered then slightly weathered, unbroken							C	100	100	PL(A) = 2.3
7												
-4												
8												
-5												PL(A) = 2.2
	8.64	SANDSTONE: medium to coarse grained, pale grey and orange-brown, thinly bedded and cross bedded, with carbonaceous flakes and laminations, medium to high then high strength, moderately weathered then slightly weathered, unbroken, Hawkesbury Sandstone						8.7m: B5°, un, ro, fe	C	100	100	
9												
-6												PL(A) = 0.9
									C	100	100	

RIG: XC100 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 5.5m

TYPE OF BORING: Diatube (250mm) to 0.3m, Solid flight auger (TC-bit) to 5.2m, NMLC coring to 14.0m

WATER OBSERVATIONS: Free groundwater observed at 3.2m whilst augering

REMARKS: Surface level obtained from Mepstead and Associates Pty Ltd, drawing 5743 dated 18/12/2018. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 3.5 AHD
EASTING: 332882
NORTHING: 6249712
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 99554.00
DATE: 22/01/2020
SHEET 3 OF 3

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
-7		SANDSTONE: medium to coarse grained, pale grey and orange-brown, thinly bedded and cross bedded, with carbonaceous flakes and laminations, medium to high then high strength, moderately weathered then slightly weathered, unbroken, Hawkesbury Sandstone *(continued)*						10.27m: B0-5°, pl, sm, cly co	C	100	100	PL(A) = 2.1
	11							11.1m: B0°, pl, sm, cly co				
-8		Below 11.5m, with occasional thin bands of fine gravel							C	100	100	PL(A) = 2.2
	12											
-9		Below 12.35m, fresh										PL(A) = 2.4
	13								C	100	100	PL(A) = 1.4
-10												
	14 14.0	Bore discontinued at 14.0m - Target depth reached										
-11												

RIG: XC100 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 5.5m

TYPE OF BORING: Diatube (250mm) to 0.3m, Solid flight auger (TC-bit) to 5.2m, NMLC coring to 14.0m

WATER OBSERVATIONS: Free groundwater observed at 3.2m whilst augering

REMARKS: Surface level obtained from Mepstead and Associates Pty Ltd, drawing 5743 dated 18/12/2018. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 3.5 AHD
EASTING: 332870
NORTHING: 6249725
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 99554.00
DATE: 20/01/2020
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)
		FILL/Silty SAND: find and medium, dark brown, trace gravel and fine roots, dry to moist, appears generally in a loose to very loose condition		A/E	0.0 0.1		PID<1		
	0.32	FILL/SAND: fine and medium, pale brown, trace gravel and silt, moist, appears generally in a loose condition		A/E*	0.4 0.5		PID<1		
	0.65 0.7	FILL/Gravelly SAND: fine to coarse sand, pale brown, dark brown and orange, medium to coarse gravel, trace brick fragments and plastic, moist, appears generally in a dense condition							
	1	Bore discontinued at 0.7m - Refusal on inferred tree root within fill							
	2								
	3								
	4								

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

RIG: Hand Tools **DRILLER:** HDS **LOGGED:** HDS **CASING:** Uncased

TYPE OF BORING: Hand Auger to 0.7m, within garden bed.

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *BDA 200120 replicate of sample 0.4-0.5m. Surface level obtained from Mepstead and Associates Pty Ltd, drawing 5743 dated 18/12/2018. Co-ordinates from Nearmap & site measurements

☐ 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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BOREHOLE LOG

CLIENT: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe
SURFACE LEVEL: 2.9 AHD
EASTING: 332875.4
NORTHING: 6249737.4
DIP/AZIMUTH: 90°/--
BORE No: BH4
PROJECT No: 99554.00
DATE: 20/01/2020
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Type	Core Rec. %	RQD %	Test Results & Comments
	0.09	CONCRETE: grey, fine and medium igneous aggregate, trace voids, 8mm diameter steel reinforcement at 0.05m				
	0.12		A/E			PID=3
	0.14	FILL/ROADBASE: Gravelly SAND, fine to medium, angular to subangular gravel, fine to coarse sand, moist to wet, appears well compacted	A/E			PID=1
	0.7	CONCRETE: grey				
2		FILL/SAND: fine to coarse, dark grey, with ash, trace gravel, slag, ceramic tiles, glass, timber, moist, appears generally in a loose condition	A/E*			PID=4
1	1.0	FILL/Clayey SAND: fine to medium, dark grey and brown, trace gravel, ash, slag and glass, moist, appears generally in a loose condition	S			1,1,2 N = 3
		FILL/SAND: fine to coarse, dark grey, with fine to coarse angular to sub-angular gravel and glass, trace silt, ash, slag, ceramic tile, and clay nodules, moist, appears generally in a loose condition				
1	1.9	CLAY CL: low plasticity, brown, trace sand and silt, w<PL, firm, alluvial (possible fill)	A/E			PID=1
2	2.2	Sandy CLAY CL: low plasticity, pale grey to grey, fine to medium, w=PL, very soft, alluvial	A/E			
			S			0,0,0 N = 0 PID=2
0						
3						
	3.5	Sandy CLAY Cl: medium plasticity, mottled brown and pale grey, 30% fine sand, 5% ironstone gravel, firm to stiff, w~PL, alluvial				
-1						
4			S			2,3,5 N = 8 PID=2
-2						

Water: 20-01-20, 29-01-20

Degree of Weathering: EW, HW, MW, SW, FS, FR
Graphic Log
Rock Strength: Ex Low, Very Low, Low, Medium, High, Very High, Ex High
Fracture Spacing (m): 0.01, 0.05, 0.10, 0.50, 1.00
Discontinuities: B - Bedding, J - Joint, S - Shear, F - Fault

RIG: XC100 **DRILLER:** FF **LOGGED:** SI **CASING:** HW to 6.32m

TYPE OF BORING: Diatube (250mm) to 0.09m, Solid flight auger (TC-bit) to 6.32m, NMLC Coring 6.32 to 13.8m

WATER OBSERVATIONS: Free groundwater at 2.2m whilst augering

REMARKS: *BD1 200120 replicate of sample 0.9-1.0m. Standpipe installed: Solid PVC to 0.1-1.5m, screened PVC 1.5-6.5m with end cap, backfill 0.2-0.5m, Bentonite 0.5-1.0m, gravel 1.0-6.5m, bentonite 6.5-7.0m, gravel backfill 7.0-13.8m, gatic cover at the surface.

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 2.9 AHD
EASTING: 332875.4
NORTHING: 6249737.4
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 99554.00
DATE: 20/01/2020
SHEET 2 OF 3

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)	Type	Core Rec. %	RQD %	Test Results & Comments
-3	6	Sandy CLAY CI: medium plasticity, mottled brown and pale grey, 30% fine sand, 5% ironstone gravel, firm to stiff, w~PL, alluvial *(continued)*							S			4,4,5 N = 9 PID=2
	6.0	Clayey SAND SC: fine to medium, pale grey-brown, 30% clay, apparently dense, wet, residual (possibly extremely weathered sandstone)										
	6.32	SANDSTONE: medium grained, pale grey, orange-brown and yellow-brown, thinly bedded and cross bedded with zones of iron cementation, medium then high strength, moderately then highly weathered, fractured to slightly fractured, Hawkesbury Sandstone						6.7m: Cs, 150mm	C	100	85	PL(A) = 0.9 PL(A) = 2
-4	7							7.5m: B20°, fe 7.55m: B25°, pl, ro, fe				
-5	8							7.85-7.88m: fg 7.9m: B25°, fe, he				
		Below 8.35m, moderately weathered, unbroken						8.35m: B10°, fe	C	100	100	PL(A) = 1.9
-6	9											
	9.1	SANDSTONE: medium to coarse grained, pale grey, thinly bedded and cross bedded, trace siltstone flakes, high strength, fresh, unbroken, Hawkesbury Sandstone						9.1m: B10°, fe	C	100	98	PL(A) = 1.6
-7												

RIG: XC100 **DRILLER:** FF **LOGGED:** SI **CASING:** HW to 6.32m

TYPE OF BORING: Diatube (250mm) to 0.09m, Solid flight auger (TC-bit) to 6.32m, NMLC Coring 6.32 to 13.8m

WATER OBSERVATIONS: Free groundwater at 2.2m whilst augering

REMARKS: *BD1 200120 replicate of sample 0.9-1.0m. Standpipe installed: Solid PVC to 0.1-1.5m, screened PVC 1.5-6.5m with end cap, backfill 0.2-0.5m, Bentonite 0.5-1.0m, gravel 1.0-6.5m, bentonite 6.5-7.0m, gravel backfill 7.0-13.8m, gatic cover at the surface.

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 2.9 AHD
EASTING: 332875.4
NORTHING: 6249737.4
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 99554.00
DATE: 20/01/2020
SHEET 3 OF 3

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
-8		SANDSTONE: medium to coarse grained, pale grey, thinly bedded and cross bedded, trace siltstone flakes, high strength, fresh, unbroken, Hawkesbury Sandstone *(continued)*						10.15m: B0°, cly, fg 10mm	C	100	98	PL(A) = 1.8
	11	Between 10.8-11.98m, high to very high strength							C	100	98	PL(A) = 3.1
-9	12							11.98m: Cs, 30mm				PL(A) = 1.9
-10	13								C	100	100	PL(A) = 1.6
-11	13.8	Bore discontinued at 13.8m - Target depth reached. Standpipe piezometer installed						13.75m: B5°, cly co 2mm				
-12	14											

RIG: XC100 **DRILLER:** FF **LOGGED:** SI **CASING:** HW to 6.32m

TYPE OF BORING: Diatube (250mm) to 0.09m, Solid flight auger (TC-bit) to 6.32m, NMLC Coring 6.32 to 13.8m

WATER OBSERVATIONS: Free groundwater at 2.2m whilst augering

REMARKS: *BD1 200120 replicate of sample 0.9-1.0m. Standpipe installed: Solid PVC to 0.1-1.5m, screened PVC 1.5-6.5m with end cap, backfill 0.2-0.5m, Bentonite 0.5-1.0m, gravel 1.0-6.5m, bentonite 6.5-7.0m, gravel backfill 7.0-13.8m, gatic cover at the surface.

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 2.7 AHD
EASTING: 332874
NORTHING: 6249756
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 99554.00
DATE: 23/01/2020
SHEET 1 OF 4

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
2	0.2	FILL/TOPSOIL: SAND, fine to medium, brown, with silt, trace ash, slag, gravel and rootlets, dry, appears generally in a loose condition							A/E			PID<1
		FILL/Sandy CLAY: low plasticity, dark grey, fine to medium sand, with fine to coarse, angular to subangular igneous gravel, trace ash, slag, glass, brick, rootlets, ripped sandstone gravel, w~PL, appears generally in a loose condition							A/E			PID<1
1									A/E			PID<1
									S			2,2,2 N = 4 PID<1
1	1.8	Clayey SAND SC: fine to coarse, orange-brown, moist, medium dense, alluvial							A/E*			PID<1
0	2.4	Sandy CLAY CL-CI: low to medium plasticity, dark grey and red-brown, fine to medium, w>PL, firm to stiff, alluvial				23-01-20			A/E			PID<1
									S			1,4,4 N = 8 PID<1
-1	3.0	CLAY CH: high plasticity, dark grey and red-brown, trace fine sand, w>PL, firm to stiff, alluvial							A/E			PID<1
									A/E			PID<1
									A/E			PID<1
									S			2,4,4 N = 8 PID<1
-2	4.6	Sandy CLAY CL: medium plasticity, pale grey and red-brown, fine to medium, w>PL, firm to stiff, alluvial							A/E			PID<1
	5.0											

RIG: Comacchio Geo 205 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 5.7m

TYPE OF BORING: Solid flight auger (TC-bit) to 5.5m, NMLC coring to 15.3m

WATER OBSERVATIONS: Free groundwater observed at 2.4m whilst augering

REMARKS: *BD3 230120 replicate of sample 1.9-2.0m. Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 2.7 AHD
EASTING: 332874
NORTHING: 6249756
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 99554.00
DATE: 23/01/2020
SHEET 2 OF 4

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
		Sandy CLAY CL: as per previous page										
	5.2	Clayey SAND SC: fine to coarse, pale grey, wet, dense, residual (possibly extremely weathered sandstone)							A/E			PID<1
-3									S			4,5,2/100 refusal PID<1
	6 6.0	SANDSTONE: medium to coarse grained, orange-brown and red-brown, thinly bedded and cross bedded, high strength, moderately weathered then slightly weathered, slightly fractured to unbroken, Hawkesbury Sandstone						6.32m: B10°, pl, ro, fe	C	100	93	PL(A) = 1.1
-4	7											PL(A) = 1.4
-5								7.48m: B10°, pl, ro, fe, cly co				
	8							8.12m: B5°, pl, ro, fe				
-6	8.52	SANDSTONE: medium to coarse grained, pale grey, cross bedded, high strength, fresh, unbroken, Hawkesbury Sandstone							C	100	98	PL(A) = 1.7
	9											
-7												PL(A) = 1.4

RIG: Comacchio Geo 205 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 5.7m

TYPE OF BORING: Solid flight auger (TC-bit) to 5.5m, NMLC coring to 15.3m

WATER OBSERVATIONS: Free groundwater observed at 2.4m whilst augering

REMARKS: *BD3 230120 replicate of sample 1.9-2.0m. Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe
SURFACE LEVEL: 2.7 AHD
EASTING: 332874
NORTHING: 6249756
DIP/AZIMUTH: 90°/--
BORE No: BH5
PROJECT No: 99554.00
DATE: 23/01/2020
SHEET 3 OF 4

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
		SANDSTONE: medium to coarse grained, pale grey, cross bedded, high strength, fresh, unbroken, Hawkesbury Sandstone *(continued)*							C	100	98	
	10.4							10.3m: fg, 50mm 10.35m: CORE LOSS: 50mm 10.4m: fg, 50mm				
-8												PL(A) = 1.9
	11											
-9									C	98	95	PL(A) = 1.7
	12							12.04m: fg, 20mm, cly vn				
-10								12.77m: B0°, pl, sm, cly co 12.81m: B0°, pl, ro, cly vn				PL(A) = 1.7
	13											
-11												PL(A) = 1.5
	14								C	100	99	
-12												PL(A) = 1
	14.79	SANDSTONE: refer following page						14.77m: fg, 20mm, cly co				
	15.0											

RIG: Comacchio Geo 205 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 5.7m

TYPE OF BORING: Solid flight auger (TC-bit) to 5.5m, NMLC coring to 15.3m

WATER OBSERVATIONS: Free groundwater observed at 2.4m whilst augering

REMARKS: *BD3 230120 replicate of sample 1.9-2.0m. Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 2.7 AHD
EASTING: 332874
NORTHING: 6249756
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 99554.00
DATE: 23/01/2020
SHEET 4 OF 4

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
		SANDSTONE: fine to medium grained, grey, massive, medium strength, fresh, unbroken, Hawkesbury Sandstone							C	100	99	PL(A) = 0.9
	15.3	Bore discontinued at 15.3m - Target depth reached										

RIG: Comacchio Geo 205 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 5.7m

TYPE OF BORING: Solid flight auger (TC-bit) to 5.5m, NMLC coring to 15.3m

WATER OBSERVATIONS: Free groundwater observed at 2.4m whilst augering

REMARKS: *BD3 230120 replicate of sample 1.9-2.0m. Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 2.7 AHD
EASTING: 332885
NORTHING: 6249747
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 99554.00
DATE: 24/01/2020
SHEET 1 OF 4

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
		FILL/TOPSOIL: SAND, fine to medium, dark brown, trace silt, gravel, brick, clay nodules, charcoal, ash, slag and rootlets, moist, appears generally in a loose condition										
	0.2								A/E			PID<1
		FILL/Sandy CLAY: low plasticity, dark grey, fine to medium, with clay and fine to coarse, angular to subangular igneous gravel, trace ash, slag, glass, brick, rootlets, ripped sandstone gravel, w~PL, appears generally in a loose condition							A/E			PID<1
									A/E			PID<1
									S			2,1,1 N = 2 PID<1
	1.9	Clayey SAND SC: fine to medium, orange-brown, moist, loose, alluvial							A/E			PID<1
	2.4	Sandy CLAY CL-CI: low to medium plasticity, grey, fine to medium sand, w>PL, very soft, alluvial				24-01-20			A/E			PID<1
	2.5	CLAY CI-CH: medium to high plasticity, grey and red-brown, trace fine to medium sand, w>PL, very soft, alluvial							S			0,0,0 N = 0 PID<1
									A/E			PID<1
									A/E			PID<1
									A/E			PID<1
	4.0	Sandy CLAY CL-CI: low to medium plasticity, red-brown and pale grey, fine to coarse, w>PL, firm, alluvial							S			2,3,5 N = 8 PID<1
									A/E			PID<1

RIG: Comacchio Geo 205 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 8.4m

TYPE OF BORING: Solid flight auger (TC-bit) to 8.1m; NMLC coring to 15.38m

WATER OBSERVATIONS: Free groundwater observed at 2.4m whilst augering

REMARKS: Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 2.7 AHD
EASTING: 332885
NORTHING: 6249747
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 99554.00
DATE: 24/01/2020
SHEET 2 OF 4

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
		Sandy CLAY CL-CI: low to medium plasticity, red-brown and pale grey, fine to coarse, w>PL, firm, alluvial *(continued)*										
									A/E			PID<1
									S			3,4,3 N = 7 PID<1
									A/E			PID<1
	7.1	Clayey SAND SC: fine to coarse, red-brown, wet, loose, alluvial							S			2,4,4 N = 8 PID<1
	8.0	SANDSTONE: fine to medium grained, red-brown, very low to low strength, highly weathered, Hawkesbury Sandstone							S			10/20,B refusal
	8.16	SANDSTONE: medium to coarse grained, red-brown and orange-brown, thinly bedded and cross bedded, high strength, highly weathered, slightly fractured, Hawkesbury Sandstone						8.16m: B5°, pl, ro, cly vn, fe stn 8.53m: B0°, pl, sm, cly co				PID<1 PL(A) = 1.1
								9.27-9.3m: J45°, pl, ro, cly vn	C	100	96	
	9.49	SANDSTONE: medium to coarse grained, pale grey, thinly bedded and cross bedded, with carbonaceous flakes and laminations, high strength, moderately weathered to fresh, slightly fractured						9.86m: Cs, 20mm				PL(A) = 1.4
	10.0											

RIG: Comacchio Geo 205 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 8.4m

TYPE OF BORING: Solid flight auger (TC-bit) to 8.1m; NMLC coring to 15.38m

WATER OBSERVATIONS: Free groundwater observed at 2.4m whilst augering

REMARKS: Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 2.7 AHD
EASTING: 332885
NORTHING: 6249747
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 99554.00
DATE: 24/01/2020
SHEET 3 OF 4

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
		SANDSTONE: medium to coarse grained, pale grey, thinly bedded and cross bedded, with carbonaceous flakes and laminations, high strength, moderately weathered to fresh, slightly fractured, Hawkesbury Sandstone						10.05m: B0°, pl, ro, cly vn	C	100	96	
-8												PL(A) = 1.1
								10.62-10.7m: J60°, pl, ro, cly vn 10.7m: B5°, un, sm, cbs co				
	11	Below 10.95m, unbroken						10.95m: B0-10°, un, sm, cly co				
												PL(A) = 2
-9									C	100	97	
	12											
												PL(A) = 2.5
-10												
								12.87m: B0°, pl, sm, cly co				
	13							13.05m: fg, 10mm, cly co 13.17m: B0°, pl, sm, cly co				
												PL(A) = 1.2
-11												
	14								C	100	100	
												PL(A) = 1.6
-12												
	15.0											

RIG: Comacchio Geo 205 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 8.4m

TYPE OF BORING: Solid flight auger (TC-bit) to 8.1m; NMLC coring to 15.38m

WATER OBSERVATIONS: Free groundwater observed at 2.4m whilst augering

REMARKS: Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 2.7 AHD
EASTING: 332885
NORTHING: 6249747
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 99554.00
DATE: 24/01/2020
SHEET 4 OF 4

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
		SANDSTONE: refer previous page							C	100	100	PL(A) = 1.3
-13	15.38	Bore discontinued at 15.38m - Target depth reached										
	16											
-14												
	17											
-15												
	18											
-16												
	19											
-17												

RIG: Comacchio Geo 205 **DRILLER:** Terratest **LOGGED:** IT **CASING:** HW to 8.4m

TYPE OF BORING: Solid flight auger (TC-bit) to 8.1m; NMLC coring to 15.38m

WATER OBSERVATIONS: Free groundwater observed at 2.4m whilst augering

REMARKS: Surface level obtained from Veris Australia Pty Ltd, drawing number 201704 dated 15/08/2019. Co-ordinates obtained using Nearmap & site measurements

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: New South Wales Land and Housing Corporation
PROJECT: Glebe Mid-Rise Project
LOCATION: 31 Cowper St and 2A-2D Wentworth Park Rd, Glebe

SURFACE LEVEL: 3.5 AHD
EASTING: 332897
NORTHING: 6249767
DIP/AZIMUTH: 90°/--

BORE No: BH7
PROJECT No: 99554.00
DATE: 20/01/2020
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	FILL/SAND: fine and medium, dark brown, trace silt, brick fragments and gravel, moist to wet, appears generally in a loose to medium dense condition		A/E	0.0 - 0.2		PID<1		
	0.2	FILL/Gravelly SAND: fine and medium, dark brown and brown, fine and medium gravel (brick, sandstone), trace ash, plastic, charcoal, glass and tile, moist, appears generally in a medium dense condition		A/E	0.2 - 0.3		PID<1		
		At 0.54 m, layer of white fabric and green glass		A/E	0.5 - 0.6		PID<1		
				A/E	0.8 - 0.9		PID<1		
	1.0	FILL/Sandy CLAY: low plasticity, pale brown to brown, fine and medium, trace rusted metal objects, silt, ash and charcoal, w<PL, appears generally in a stiff condition		A/E	1.0 - 1.1		PID<1		
	1.3	Bore discontinued at 1.3m - Refusal in fill on coarse gravel		A/E	1.2 - 1.3		PID<1		

RIG: Hand Tools **DRILLER:** HDS **LOGGED:** HDS **CASING:** Uncased

TYPE OF BORING: Hand Auger to 1.3m

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Within garden box, 0.65 m above street level and 0.52m back from the inside face of the brick retaining wall.

☐ 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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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).

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it 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 Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

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

* 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
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured , usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

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 occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

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

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

where 'sound' rock is assessed to be rock of low strength or stronger. 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

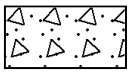
Symbols & Abbreviations

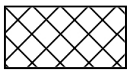
Graphic Symbols for Soil and Rock

General

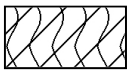

Asphalt

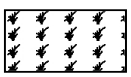

Road base

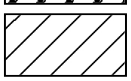

Concrete


Filling

Soils


Topsoil

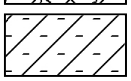

Peat


Clay


Silty clay

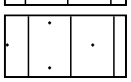

Sandy clay

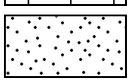

Gravelly clay

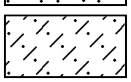

Shaly clay

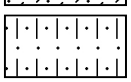

Silt


Clayey silt


Sandy silt

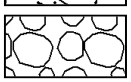

Sand


Clayey sand


Silty sand


Gravel

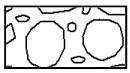

Sandy gravel


Cobbles, boulders

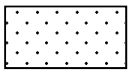

Talus

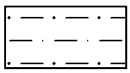
Sedimentary Rocks

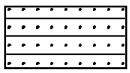

Boulder conglomerate

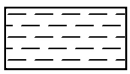

Conglomerate


Conglomeratic sandstone

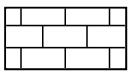

Sandstone


Siltstone

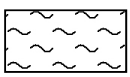

Laminite

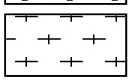

Mudstone, claystone, shale

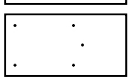

Coal


Limestone

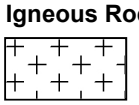
Metamorphic Rocks

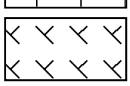

Slate, phyllite, schist

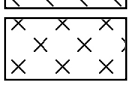

Gneiss

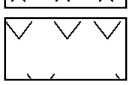

Quartzite

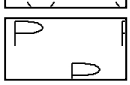
Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Appendix C

Summary of Previous Laboratory Results

Previous Laboratory Reports

Table J3: Summary of Laboratory Results for Acid Sulfate Soil

Sample				Screening Tests				S_{Cr} Suite Laboratory Results								
Location	Depth		Date Sampled	pH_F	pH_{FOX}	pH_{FOX} minus pH_F	Reaction	pH_{KCl}	Chromium Reducible Sulphur (S_{Cr})	Total Actual Acidity (s-TAA)	Net Acid Soluble Sulfur ($s\text{-}S_{NAS}$)	Acid Neutralising Capacity ($s\text{-}ANC_{BT}$)	Net Acidity (excluding ANC)	Net Acidity (excluding ANC)	Liming Rate (excluding ANC)	Soil Description
	(m)			pH units			-	pH units	(%w/w S)					moles H+/T	kg CaCO3/T	
Investigation Levels																
ASSMAC (1998)																
Screening Indicators					<3.5	≤ -1										
Threshold, >1,000 tonnes, Any Texture									0.03	0.03			0.03	18		
EPA (2014)																
PASS Requirement				≥5.5												
Test Results																
1	/	2.5-2.95	21/01/20	6.4	4.5	**-1.9**	M									CLAY, brown and pale grey, ironstone gravel
1	/	3.0-3.5	21/01/20	6.7	5.1	**-1.6**	M	6.3	<0.005	<0.01	NT	<0.05	<0.005	<5	<0.75	Sandy CLAY, pale brown
1	/	4.0-4.45	21/01/20	6.1	5.4	-0.7	X									
1	/	5.5-5.95	21/01/20	5.6	4.6	**-1**	H									Sandstone, brown
4	/	1.5-1.6	20/01/20	6.6	**3**	**-3.6**	X									FILL/ Sand, dark grey
4	/	2.5-2.95	20/01/20	7.1	**3.5**	**-3.6**	H	5	**0.04**	**0.02**	<0.005	<0.05	**0.053**	**33**	2.5	*Sandy CLAY, pale grey to grey*
4	/	4.0-4.45	20/01/20	7.1	4.7	**-2.4**	H	5.3	**0.006**	<0.01	NT	<0.05	0.012	7.2	<0.75	*Sandy CLAY, mottled brown and pale grey, ironstone gravel*
4	/	5.5-5.95	20/01/20	7	5.9	**-1.1**	H									
5	/	1-1.45	23/01/20	6.9	4.6	**-2.3**	H									Fill/ Sandy CLAY, dark grey
5	/	1.9-2.0	23/01/20	7.1	4.1	**-3**	X									Clayey SAND, orange-brown
5	/	2.5-2.95	23/01/20	6.5	5.9	-0.6	V	5.1	<0.005	**0.03**	NT	<0.05	0.026	16	1.2	Sandy CLAY, dark grey and red-brown
5	/	3.0-3.1	23/01/20	6.5	6.1	-0.4	V	4.9	**0.005**	**0.03**	<0.005	<0.05	**0.031**	**19**	1.4	CLAY, dark grey and red-brown
5	/	4.0-4.45	23/01/20	6.8	5.3	**-1.5**	H									
5	/	4.9-5.0	23/01/20	6.7	4.7	**-2**	H	5.1	<0.005	**0.01**	NT	<0.05	0.013	8.2	<0.75	*Sandy CLAY, pale grey and red-brown*
5	/	5.5-5.9	23/01/20	6.5	5.6	-0.9	X									Clayey SAND, pale grey (residual)
6	/	1.0-1.45	24/01/20	8	6.9	**-1.1**	X									FILL/ Sandy CLAY, dark grey
6	/	1.9-2.0	24/01/20	7.8	5.7	**-2.1**	H									Clayey SAND, orange brown
6	/	2.5-2.95	24/01/20	6.8	4.5	**-2.3**	H									*CLAY, grey and red-brown*
6	/	3.0-3.1	24/01/20	7.2	4.1	**-3.1**	H	7.1	**0.03**	<0.01	NT	0.21	**0.03**	**19**	1.4	
6	/	4.0-4.45	24/01/20	6.5	4.6	**-1.9**	H									
6	/	4.9-5.0	24/01/20	7.5	**3.1**	**-4.4**	H	5.3	**0.08**	**0.01**	<0.005	<0.05	**0.087**	**54**	4.1	*Sandy CLAY, red-brown and pale grey*
6	/	5.5-5.95	24/01/20	6.8	5.8	**-1**	H									
6	/	7-7.45	24/01/20	7.1	6.5	-0.6	H	5.9	<0.005	<0.01	NT	<0.05	0.008	<5	<0.75	Clayey SAND, red-brown

Notes:

Shaded	Exceedance of ASS threshold
Bold	Detectable Scr of TAA possibly from low levels of ASS
Red	Assume ASS requiring treatment
italics	Assume not VENM due to ASS
	Blue line - observed groundwater level during drilling

Reaction Description (after Sullivan et al, 2018)

L	Low reaction
M	Medium reaction
H	High reaction
X	Extreme reaction
V	'Volcanic' reaction
F	denotes frothy reaction (can be indicative of organics)

1126

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 235396

Client Details

Client	Douglas Partners Pty Ltd
Attention	Nerilee Edwards
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**99554.01, Glebe**
Number of Samples	23 Soil
Date samples received	28/01/2020
Date completed instructions received	28/01/2020

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	04/02/2020
Date of Issue	30/01/2020

This document shall not be reproduced except in full.

Results Approved By
Nick Sarlamis, Inorganics Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

sPOCAS field test						
Our Reference		235396-1	235396-2	235396-3	235396-4	235396-5
Your Reference	UNITS	1	1	1	1	4
Depth		2.5-2.95	3.0-3.5	4.0-4.45	5.5-5.95	1.5-1.6
Date Sampled		21/01/2020	21/01/2020	21/01/2020	21/01/2020	20/01/2020
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	29/01/2020	29/01/2020	29/01/2020	29/01/2020	29/01/2020
Date analysed	-	29/01/2020	29/01/2020	29/01/2020	29/01/2020	29/01/2020
pH_F (field pH test)*	pH Units	6.4	6.7	6.1	5.6	6.6
pH_{FOX} (field peroxide test)*	pH Units	4.5	5.1	5.4	4.6	3.0
Reaction Rate*	-	Medium reaction	Medium reaction	Extreme reaction	High reaction	Extreme reaction

sPOCAS field test						
Our Reference		235396-6	235396-7	235396-8	235396-9	235396-10
Your Reference	UNITS	4	4	4	5	5
Depth		2.5-2.95	4.0-4.45	5.5-5.95	1-1.45	1.9-2.0
Date Sampled		20/01/2020	20/01/2020	20/01/2020	23/01/2020	23/01/2020
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	29/01/2020	29/01/2020	29/01/2020	29/01/2020	29/01/2020
Date analysed	-	29/01/2020	29/01/2020	29/01/2020	29/01/2020	29/01/2020
pH_F (field pH test)*	pH Units	7.1	7.1	7.0	6.9	7.1
pH_{FOX} (field peroxide test)*	pH Units	3.5	4.7	5.9	4.6	4.1
Reaction Rate*	-	High reaction	High reaction	High reaction	High reaction	Extreme reaction

sPOCAS field test						
Our Reference		235396-11	235396-12	235396-13	235396-14	235396-15
Your Reference	UNITS	5	5	5	5	5
Depth		2.5-2.95	3.0-3.1	4.0-4.45	4.9-5.0	5.5-5.9
Date Sampled		23/01/2020	23/01/2020	23/01/2020	23/01/2020	23/01/2020
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	29/01/2020	29/01/2020	29/01/2020	29/01/2020	29/01/2020
Date analysed	-	29/01/2020	29/01/2020	29/01/2020	29/01/2020	29/01/2020
pH_F (field pH test)*	pH Units	6.5	6.5	6.8	6.7	6.5
pH_{FOX} (field peroxide test)*	pH Units	5.9	6.1	5.3	4.7	5.6
Reaction Rate*	-	Volcanic reaction	Volcanic reaction	High reaction	High reaction	Extreme reaction

sPOCAS field test						
Our Reference		235396-16	235396-17	235396-18	235396-19	235396-20
Your Reference	UNITS	6	6	6	6	6
Depth		1.0-1.45	1.9-2.0	2.5-2.95	3.0-3.1	4.0-4.45
Date Sampled		24/01/2020	24/01/2020	24/01/2020	24/01/2020	24/01/2020
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	29/01/2020	29/01/2020	29/01/2020	29/01/2020	29/01/2020
Date analysed	-	29/01/2020	29/01/2020	29/01/2020	29/01/2020	29/01/2020
pH_F (field pH test)*	pH Units	8.0	7.8	6.8	7.2	6.5
pH_{FOX} (field peroxide test)*	pH Units	6.9	5.7	4.5	4.1	4.6
Reaction Rate*	-	Extreme reaction	High reaction	High reaction	High reaction	High reaction

sPOCAS field test				
Our Reference		235396-21	235396-22	235396-23
Your Reference	UNITS	6	6	6
Depth		4.9-5.0	5.5-5.95	7-7.45
Date Sampled		24/01/2020	24/01/2020	24/01/2020
Type of sample		Soil	Soil	Soil
Date prepared	-	29/01/2020	29/01/2020	29/01/2020
Date analysed	-	29/01/2020	29/01/2020	29/01/2020
pH_F (field pH test)*	pH Units	7.5	6.8	7.1
pH_{FOX} (field peroxide test)*	pH Units	3.1	5.8	6.5
Reaction Rate*	-	High reaction	High reaction	High reaction

Method ID	Methodology Summary
Inorg-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions.

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 (not SPOCAS); 60-140% for organics/SPOCAS (+/-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.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

SPOCAS FIELD TEST has exceeded the recommended technical holding times, Envirolab Group form 347 "Recommended Preservation and Holding Times" can be provided on request (available on the Envirolab website)

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No:	99554.01	**Suburb:**	Glebe	**To:**	Envirolab Services
Project Name:		**Order Number**			12 Ashley St Chatswood 2067
Project Manager:	NLE	**Sampler:**	SI/IT	**Attn:**	Aileen Hie
Emails:	nerilee.edwards@douglaspartners.com.au			**Phone:**	(02) 9910 6200
Date Required:	Same day ☐ 24 hours ☐ 48 hours ☐ 72 hours ☐ Standard ☑			**Email:**	AHie@envirolab.com.au
Prior Storage:	☐ Esky ☑ Fridge ☐ Freezer	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)	Analytes: ASS screen (pHf, pHfox)	Scr full suite								Notes/preservation
1/2.5-2.95	1	21.01.20	S	P	×									
1/3-3.5	2	21.01.20	S	P	×									
1/4-4.45	3	21.01.20	S	P	×									
1/5.5-5.95	4	21.01.20	S	P	×									
4/1.5-1.6	5	20.01.20	S	P	×									
4/2.5-2.95	6	20.01.20	S	P	×									
4/4-4.45	7	20.01.20	S	P	×									
4/5.5-5.95	8	20.01.20	S	P	×									
5/1-1.45	9	23.01.20	S	P	×									
5/1.9-2	10	23.01.20	S	P	×									
5/2.5-2.95	11	23.01.20	S	P	×									
5/3-3.1	12	23.01.20	S	P	×									
5/4-4.45	13	23.01.20	S	P	×									
5/4.9-5	14	23.01.20	S	P	×									
5/5.5-5.9	15	23.01.20	S	P	×									
PQL (S) mg/kg													**ANZECC PQLs req'd for all water analytes** ☐	

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ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

~~Job No:~~ 235396
Date Received: 28.9.2020
Time Received: 12:28
Received by: TC
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: As, Cd, Cr, Cu, Pb, Hg, Ni, Zn, Fe

Lab Report/Reference No: 235396

Total number of samples in container: **Relinquished by:** NLE **Transported to laboratory by:** Hunter Express

Send Results to: Douglas Partners Pty Ltd **Address:** 96 Hermitage Road West Ryde NSW 2114 **Phone:** (02) 4271 1836 **Fax:** (02) 4271 1897

Signed: **Received by:** ES, Thursday Canberra **Date & Time:** 28·1·20

Douglas Partners
Geotechnics | Environment | Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No:	99554.01	**Suburb:**	Glebe	**To:**	Envirolab Services
Project Name:		**Order Number**			12 Ashley St Chatswood 2067
Project Manager:	NLE	**Sampler:**	SI/IT	**Attn:**	Aileen Hie
Emails:	nerilee.edwards@douglaspartners.com.au			**Phone:**	(02) 9910 6200
Date Required:	Same day ☐ 24 hours ☐ 48 hours ☐ 72 hours ☐ Standard ☑			**Email:**	AHie@envirolab.com.au
Prior Storage:	☐ Esky ☑ Fridge ☐ Freezer	Do samples contain 'potential' HBM?	Yes ☐ No ☐ (If YES, then handle, transport and store in accordance with FPM HAZID)		

Sample ID	Lab ID	Sampling Date	Sample Type (S - soil, W - water)	Container Type (G - glass, P - plastic)	Analytes: ASS screen (pHf, pHfox)	Analytes: Scr full suite	Analytes	Analytes	Analytes	Analytes	Analytes	Analytes	Analytes	Notes/preservation
6/1-1.45	16	24.01.20	S	P	×									
6/1.9-2	17	24.01.20	S	P	×									
6/2.5-2.95	18	24.01.20	S	P	×									
6/3-3.1	19	24.01.20	S	P	×									
6/4-4.45	20	24.01.20	S	P	×									
6/4.9-5	21	24.01.20	S	P	×									
6/5.5-5.95	22	24.01.20	S	P	×									
6/7-7.45	23	24.01.20	S	P	×									
PQL (S) mg/kg													**ANZECC PQLs req'd for all water analytes** ☐	

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

Metals to Analyse:

Lab Report/Reference No: 235396

Total number of samples in container: **Relinquished by:** NLE **Transported to laboratory by:** Hunter Express

Send Results to: Douglas Partners Pty Ltd **Address:** 96 Hermitage Road West Ryde NSW 2114 **Phone:** (02) 4271 1836 **Fax:** (02) 4271 1897

Signed: **Received by:** EAS, Thurdad Canoes **Date & Time:** 28-1-20

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No:	99554.00	**Suburb:**	GLEBE	**To:**	Envirolab Services
Project Name:	Mixed-Use Development	**Order Number**			12 Ashley Street, Chatswood 2067
Project Manager:	HDS	**Sampler:**	NLE/SI	**Attn:**	Aileen Hie
Emails:	huw.smith@douglaspartners.com.au			**Phone:**	02 9910 6200
Date Required:	Same day ☐ 24 hours ☐ 48 hours ☐ 72 hours ☐ Standard ☐			**Email:**	Ahie@envirolab.com.au
Prior Storage:	☐ Esky x Freezer ☐ 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)	Analytes: Aggressivity (pH, EC, SO4, Chloride)								Notes/preservation
1/2.5-2.95	1	21/01/20	S	G, P	X								Please analyse and report separately to contamination testing
PQL (S) mg/kg													ANZECC PQLs req'd for all water analytes ☐

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 235396-A
Date Received: 28.01.2020
Time Received: 12:28
Received by: TC.
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

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

Lab Report/Reference No: 235396-A.

Metals to Analyse: Nil

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

Send Results to: Douglas Partners Pty Ltd **Address:** 96 Hermitage Road, West Ryde **Phone:** 02 9809 0666 **Fax:**

Signed: [signature] **Received by:** ELS, Thurdead Gmalls. **Date & Time:** 28.1.20

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 235396-B

Client Details

Client	Douglas Partners Pty Ltd
Attention	Nerilee Edwards
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**99554.01, Glebe**
Number of Samples	23 Soil
Date samples received	28/01/2020
Date completed instructions received	31/01/2020

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	07/02/2020
Date of Issue	05/02/2020

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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

Nancy Zhang, Laboratory Manager

Chromium Suite				
Our Reference		235396-B-6	235396-B-12	235396-B-21
Your Reference	UNITS	4	5	6
Depth		2.5-2.95	3.0-3.1	4.9-5.0
Date Sampled		20/01/2020	23/01/2020	24/01/2020
Type of sample		Soil	Soil	Soil
Date prepared	-	03/02/2020	03/02/2020	03/02/2020
Date analysed	-	03/02/2020	03/02/2020	03/02/2020
pH $_{kcl}$	pH units	5.0	4.9	5.3
s-TAA pH 6.5	%w/w S	0.02	0.03	0.01
TAA pH 6.5	moles H^+ /t	11	16	6
Chromium Reducible Sulfur	%w/w	0.04	0.005	0.08
a-Chromium Reducible Sulfur	moles H^+ /t	22	<3	48
S_{HCl}	%w/w S	<0.005	<0.005	<0.005
S_{KCl}	%w/w S	0.007	0.015	0.018
S_{NAS}	%w/w S	<0.005	<0.005	<0.005
ANC_{BT}	% $CaCO_3$	<0.05	<0.05	<0.05
s-ANC_{BT}	%w/w S	<0.05	<0.05	<0.05
s-Net Acidity	%w/w S	0.053	0.031	0.087
a-Net Acidity	moles H^+ /t	33	19	54
Liming rate	kg $CaCO_3$ /t	2	1	4
a-Net Acidity without ANCE	moles H^+ /t	33	19	54
Liming rate without ANCE	kg $CaCO_3$ /t	2.5	1.4	4.1
s-Net Acidity without ANCE	%w/w S	0.053	0.031	0.087

Method ID	Methodology Summary
Inorg-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL: Chromium Suite						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			03/02/2020	21	03/02/2020	03/02/2020		03/02/2020	[NT]
Date analysed	-			03/02/2020	21	03/02/2020	03/02/2020		03/02/2020	[NT]
pH $_{kcl}$	pH units		Inorg-068	[NT]	21	5.3	5.3	0	93	[NT]
s-TAA pH 6.5	%w/w S	0.01	Inorg-068	<0.01	21	0.01	0.01	0	[NT]	[NT]
TAA pH 6.5	moles H^+ /t	5	Inorg-068	<5	21	6	6	0	95	[NT]
Chromium Reducible Sulfur	%w/w	0.005	Inorg-068	<0.005	21	0.08	0.08	0	[NT]	[NT]
a-Chromium Reducible Sulfur	moles H^+ /t	3	Inorg-068	<3	21	48	50	4	110	[NT]
S_{HCl}	%w/w S	0.005	Inorg-068	<0.005	21	<0.005	<0.005	0	[NT]	[NT]
S_{KCl}	%w/w S	0.005	Inorg-068	<0.005	21	0.018	0.017	6	[NT]	[NT]
S_{NAS}	%w/w S	0.005	Inorg-068	<0.005	21	<0.005	<0.005	0	[NT]	[NT]
ANC_{BT}	% $CaCO_3$	0.05	Inorg-068	<0.05	21	<0.05	<0.05	0	[NT]	[NT]
s-ANC_{BT}	%w/w S	0.05	Inorg-068	<0.05	21	<0.05	<0.05	0	[NT]	[NT]
s-Net Acidity	%w/w S	0.005	Inorg-068	<0.005	21	0.087	0.090	3	[NT]	[NT]
a-Net Acidity	moles H^+ /t	5	Inorg-068	<5	21	54	56	4	[NT]	[NT]
Liming rate	kg $CaCO_3$ /t	0.75	Inorg-068	<0.75	21	4	4	0	[NT]	[NT]
a-Net Acidity without ANCE	moles H^+ /t	5	Inorg-068	<5	21	54	56	4	[NT]	[NT]
Liming rate without ANCE	kg $CaCO_3$ /t	0.75	Inorg-068	<0.75	21	4.1	4.2	2	[NT]	[NT]
s-Net Acidity without ANCE	%w/w S	0.005	Inorg-068	<0.005	21	0.087	0.090	3	[NT]	[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.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

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 (not SPOCAS); 60-140% for organics/SPOCAS (+/-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.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

Samples were out of the recommended holding time for this analysis.

Aileen Hie

From: Nerilee Edwards <Nerilee.Edwards@douglaspartners.com.au>
Sent: Friday, 31 January 2020 7:56 AM
To: Aileen Hie
Cc: Ken Nguyen; Huw Smith
Subject: Additional Analysis FW: Results for Registration 235396 99554.01, Glebe

Hi Aileen,

Can you pls order ASS Scr full suite on the following samples,

Ref: 235396-B
TAT: 7/2/20
Due: std

Your Ref		Our Ref
235396	6	4/2.5-2.95
235396	12	5/3-3.1
235396	21	6/4.9-5

ta

Nerilee Edwards | Associate / Environmental Scientist
Douglas Partners Pty Ltd | ABN 75 053 980 117 | www.douglaspartners.com.au
96 Hermitage Road West Ryde NSW 2114 | PO Box 472 West Ryde NSW 1685
P: 02 9809 0666 | M: 0414 769 011 | E: Nerilee.Edwards@douglaspartners.com.au

From: Ken Nguyen <KNguyen@envirolab.com.au>
Sent: Thursday, 30 January 2020 7:02 PM
To: Nerilee Edwards <Nerilee.Edwards@douglaspartners.com.au>
Subject: Results for Registration 235396 99554.01, Glebe

Please refer to attached for:
a copy of the Certificate of Analysis
a copy of the COC/paperwork received from you
ESDAT Extracts
an Excel or .csv file containing the results

Please note that a hard copy will not be posted.

Enquiries should be made directly to:
customerservice@envirolab.com.au

How did we do? Send Feedback

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 235396-C

Client Details

Client	Douglas Partners Pty Ltd
Attention	Nerilee Edwards
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**99554.01, Glebe**
Number of Samples	23 Soil
Date samples received	28/01/2020
Date completed instructions received	13/02/2020

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	20/02/2020
Date of Issue	20/02/2020

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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

Nancy Zhang, Laboratory Manager

Chromium Suite						
Our Reference		235396-C-2	235396-C-7	235396-C-11	235396-C-14	235396-C-19
Your Reference	UNITS	1	4	5	5	6
Depth		3.0-3.5	4.0-4.45	2.5-2.95	4.9-5.0	3.0-3.1
Date Sampled		21/01/2020	20/01/2020	23/01/2020	23/01/2020	24/01/2020
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	16/02/2020	16/02/2020	16/02/2020	16/02/2020	16/02/2020
Date analysed	-	16/02/2020	16/02/2020	16/02/2020	16/02/2020	16/02/2020
pH $_{kcl}$	pH units	6.3	5.3	5.1	5.1	7.1
s-TAA pH 6.5	%w/w S	<0.01	<0.01	0.03	0.01	<0.01
TAA pH 6.5	moles H^+ /t	<5	<5	16	6	<5
Chromium Reducible Sulfur	%w/w	<0.005	0.006	<0.005	<0.005	0.03
a-Chromium Reducible Sulfur	moles H^+ /t	<3	4	<3	<3	19
S_{HCl}	%w/w S	NT	NT	NT	NT	NT
S_{KCl}	%w/w S	0.008	<0.005	0.023	0.012	0.010
S_{NAS}	%w/w S	NT	NT	NT	NT	NT
ANC_{BT}	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	0.65
s-ANC_{BT}	%w/w S	<0.05	<0.05	<0.05	<0.05	0.21
s-Net Acidity	%w/w S	<0.005	0.012	0.026	0.013	<0.005
a-Net Acidity	moles H^+ /t	<5	7.2	16	8.2	<5
Liming rate	kg $CaCO_3$ /t	<0.75	<0.75	1	<0.75	<0.75
a-Net Acidity without ANCE	moles H^+ /t	<5	7.2	16	8.2	19
Liming rate without ANCE	kg $CaCO_3$ /t	<0.75	<0.75	1.2	<0.75	1.4
s-Net Acidity without ANCE	%w/w S	<0.005	0.012	0.026	0.013	0.030

Chromium Suite		
Our Reference		235396-C-23
Your Reference	UNITS	6
Depth		7-7.45
Date Sampled		24/01/2020
Type of sample		Soil
Date prepared	-	16/02/2020
Date analysed	-	16/02/2020
pH $_{kcl}$	pH units	5.9
s-TAA pH 6.5	%w/w S	<0.01
TAA pH 6.5	moles H^+ /t	<5
Chromium Reducible Sulfur	%w/w	<0.005
a-Chromium Reducible Sulfur	moles H^+ /t	<3
S_{HCl}	%w/w S	NT
S_{KCl}	%w/w S	0.015
S_{NAS}	%w/w S	NT
ANC_{BT}	% $CaCO_3$	<0.05
s-ANC_{BT}	%w/w S	<0.05
s-Net Acidity	%w/w S	0.0080
a-Net Acidity	moles H^+ /t	<5
Liming rate	kg $CaCO_3$ /t	<0.75
a-Net Acidity without ANCE	moles H^+ /t	<5
Liming rate without ANCE	kg $CaCO_3$ /t	<0.75
s-Net Acidity without ANCE	%w/w S	0.0080

Method ID	Methodology Summary
Inorg-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL: Chromium Suite						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			16/02/2020	[NT]	[NT]	[NT]	[NT]	16/02/2020	[NT]
Date analysed	-			16/02/2020	[NT]	[NT]	[NT]	[NT]	16/02/2020	[NT]
pH $_{kcl}$	pH units		Inorg-068	[NT]	[NT]	[NT]	[NT]	[NT]	94	[NT]
s-TAA pH 6.5	%w/w S	0.01	Inorg-068	<0.01	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
TAA pH 6.5	moles H^+ /t	5	Inorg-068	<5	[NT]	[NT]	[NT]	[NT]	85	[NT]
Chromium Reducible Sulfur	%w/w	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-Chromium Reducible Sulfur	moles H^+ /t	3	Inorg-068	<3	[NT]	[NT]	[NT]	[NT]	116	[NT]
S_{HCl}	%w/w S	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
S_{KCl}	%w/w S	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
S_{NAS}	%w/w S	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
ANC_{BT}	% $CaCO_3$	0.05	Inorg-068	<0.05	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-ANC_{BT}	%w/w S	0.05	Inorg-068	<0.05	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-Net Acidity	%w/w S	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-Net Acidity	moles H^+ /t	5	Inorg-068	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Liming rate	kg $CaCO_3$ /t	0.75	Inorg-068	<0.75	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-Net Acidity without ANCE	moles H^+ /t	5	Inorg-068	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Liming rate without ANCE	kg $CaCO_3$ /t	0.75	Inorg-068	<0.75	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-Net Acidity without ANCE	%w/w S	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

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

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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.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

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 (not SPOCAS); 60-140% for organics/SPOCAS (+/-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.

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Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

Samples were out of the recommended holding time for this analysis.

Aileen Hie

From: Nerilee Edwards <Nerilee.Edwards@douglaspartners.com.au>
Sent: Thursday, 13 February 2020 4:06 PM
To: Aileen Hie
Cc: Huw Smith
Subject: Additional analysis - 235396-C - Glebe 99554.01

Hi Aileen,

235396-C.
Due: 20/2/20.
Std TAT.

Can you pls Scr full suite on:

1/3-3.5	2
4/4-4.45	7
5/2.5-2.95	11
5/4.9-5	14
6/3-3.1	19
6/7-7.45	23

ta

Nerilee Edwards | Associate / Environmental Scientist
Douglas Partners Pty Ltd | ABN 75 053 980 117 | www.douglaspartners.com.au
96 Hermitage Road West Ryde NSW 2114 | PO Box 472 West Ryde NSW 1685
P: 02 9809 0666 | M: 0414 769 011 | E: Nerilee.Edwards@douglaspartners.com.au