Douglas PARTNERS

GROUNDED EXPERTISE

Acid Sulfate Soil Management Plan

Proposed Mixed Use Development

79-81 Queens Road and 2-8 Spencer Street, Five Dock NSW

Prepared for DPG Project 37 Pty Ltd

Project 224583.03

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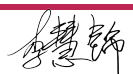
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Douglas Partners acknowledges Australia's First Peoples as the Traditional Owners of the Land and Sea on which we operate. We pay our respects to Elders past and present and to all Aboriginal and Torres Strait Islander peoples across the many communities in which we live, visit and work. We recognise and respect their ongoing cultural and spiritual connection to Country.

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Acid Sulfate Soil Management Plan
Proposed Mixed Use Development
79-81 Queens Road and 2-8 Spencer Street, Five Dock NSW

1. Introduction

Douglas Partners Pty Ltd (Douglas) has been engaged by DPG Project 37 Pty Ltd to prepare this acid sulfate soil management plan (ASSMP) for a proposed mixed use development at 79-81 Queens Road and 2-8 Spencer Street, Five Dock NSW (the site). The site is shown on Drawing 1, Appendix A.

The ASSMP was prepared in accordance with Douglas' proposal 224583.02.P.003.Rev0 dated 16 May 2025.

The objective of this ASSMP is to provide management methods and procedures to minimise environmental impacts resulting from the disturbance of acid sulfate soils (ASS) during the construction of the proposed development. This ASSMP provides a summary of previous ASS test results, neutralisation and treatment methods, verification testing and monitoring requirements, emergency response procedures, groundwater / leachate management procedures and contingency measures.

It is understood that the report will be used to support a Stage Significant Development (SSD-78287462) Application. Specifically, this report has been prepared to response to the SEARs requirements issued below.

Table 1: Planning Secretary's Environmental Assessment Requirements

Secretary's Environmental Assessment Requirements	Response
13. Ground and Groundwater Conditions If the proposed development is on land identified as having high salinity or acid sulfate soil potential in an EPI provide a Salinity Management Plan or Acid Sulfate Soil Management Plan that includes appropriate management measures and strategies. Supporting Documentation (if required): • Acid Sulfate Soils Management Plan	This Acid Sulfate Soils Management Plan report in its entirity.

This ASSMP is devised on the basis of the guidelines and reference documents endorsed by NSW EPA and with reference to other national guidelines where considered appropriate and includes the following key guidelines:

- Acid Sulfate Soil Management Advisory Committee (ASSMAC), Acid Sulfate Soil Manual 1998 (Stone, Ahern, & Blunden, 1998).

- QLD Department of Resources, QLD Department of Environment and Science, Acid Sulfate Soil Technical Manual: Soil Management Guidelines, Version 5.1 (Dear, et al., 2024).
- Department of Agriculture and Water Resources (DAWR), National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual (Sullivan, et al, 2018a).
- DAWR, National Acid Sulfate Soils guidance: National acid sulfate soils sampling and identification methods manual (Sullivan, et al, 2018b).

This report must be read in conjunction with all appendices, including the notes provided in Appendix B.

2. Site information and environmental setting

Site address	79-81 Queens Road Five Dock NSW; and 2-8 Spencer Street, Five Dock NSW.
Legal description	Lot 17, and Lot 20- 22 of Deposited Plan (DP) 1117; Lot 18 of DP 651570; and Lot 1 of DP 540151.
Area	3,200 m^2
Zoning	Majority of the site is mapped as MU1- Mixed use; and The eastern boundary of the site is mapped as RE1 - Public Recreation.
Local Council Area	City of Canada Bay Council
Current use	The site is currently used for light industrial activities including a second-hand car dealership, vehicle workshops and warehouses across most of the site, with on-grade pavements elsewhere.
Surrounding uses	North – Queens Road, followed by Five Dock Leisure Centre and Charles Heath Reserve East – William Street followed by industrial properties South – Spencer Street, followed by industrial properties including car mechanics West – Industrial properties including car mechanic and micro-brewery
Topography	The regional topography falls generally to north towards Parramatta River which is located approximately 500 m north of the site. The site is located in the valley floor with the surrounding land rising to the east, south and west. Based on the supplied detailed survey plans prepared by C&A Surveyors NSW Pty Ltd (Ref: 30163-23 DET, Rev1, dated 24 August 2023), ground surface levels across the site range between RL 1.9 m Australian Height Datum (AHD) and RL 2.3 m AHD.

Geology	Reference to the Sydney 1:100 000 Series Seamless Geology Geological Sheet indicates that the site is underlain by Quaternary Anthropogenic deposits described as deposits varying from large man-made clasts (concrete blocks to building demolition rubble) to quarried natural boulders, with interstitial sand-sized to clay matrix, silty to peaty quartz sand, silt, and clay; overlying Ashfield Shale of the Wianamatta Group described as black to dark-grey shale and laminite. Quaternary deposits are mapped about 115 m to the north of the site and are associated with a buried channel connected to the connected to Kings Bay to the north. Large man-made clasts and quarried building rubble were not observed on the site during the geotechnical investigation.
Soil landscape	Refer to Sydney 1:100 000 Soils Landscape Sheet indicates that majority of the site is underlain by disturbed terrain landscape which is typically extensively disturbed by human activity, including complete disturbance, removal or burial of soil. Fill type typically includes soil, rock, building and waste material. A small south portion of the site is underlain by the residual Blacktown soil landscape comprising gently undulating rises on Wianamatta Group Shales and Hawkesbury shale, local relief to 30 m, slops are usually < 5%. A corner of east potion of the site is underlain by erosional Gymea soil landscape comprising undulating to rolling rises and low hills on Hawkesbury Sandstone.
Groundwater and Surface Water	Surface water is anticipated to drain to the local stormwater system and follow the general regional topography. An unnamed canal is present 90 m north of the site which drains towards Parramatta River. Surface water and stormwater likely discharge to this canal. Likewise, groundwater is also anticipated flow towards the north to the Parramatta River which is located about 500 m north of the site. Groundwater details from previous Douglas investigations are summarised in Section 5.2.
Acid sulfate soil risk	Reference to the published national ASS mapping, indicates that the majority of the site is mapped as an area with extremely low probability of occurrence of ASS, while the area near the northern boundary is mapped as an area with low probability of occurrence of ASS. Reference to regional ASS Risk map indicates that the northern boundary of the site is located within an area mapped as disturbed terrain. Reference to Acid Sulfate Soils Map – Sheet ASS_005 of Canada Bay Local Environmental Plan (LEP) 2013 indicates that the northern boundary of the site is mapped as Class 2 while the remaining area is mapped as Class 5. The map is included in Appendix B1.

According to LEP 2013, for class 2 land, development consent is required for the carrying out of works below the natural ground surface and for works by which the water table is likely to be lowered. For class 5 land, development consent is required for works within 500 m of adjacent class 1, 2, 3, or 4 land that is below 5 m AHD and by which the water table is likely to be lowered below 1 m AHD on adjacent 1, 2, 3 or 4 land.

Based on the above, ASS assessment was conducted to assess the presence / absence of ASS, and confirmed the presence of ASS (refer to Section 5).



Figure 1. Acid sulfate soil mapping with approximate site location

- High probability of ASS occurrence
- Low probability of ASS occurrence
- No known ASS occurrence
- Beach
- Disturbed Terrain

The site boundary is shown on Figure 2.



Figure 2. Site boundary (red outline, refer to Drawing 1 for full legend)

3. Background on acid sulfate soils and risk categories

ASS are naturally occurring sediments that contain reduced inorganic sulfur (RIS), including iron sulfides, (primarily pyrite), commonly deposited in estuarine environments.

Further details on the formation of ASS is in Appendix C and the relevant guidelines are cited in Section 1. ASS can either be classified as 'actual acid sulfate soils' (AASS) which are soils that have already reacted with oxygen to produce acid, or 'potential acid sulfate soils' (PASS) and are often found in the same soil profile, with AASS overlying PASS. PASS are soils containing iron sulfide that have not been exposed to oxygen (e.g. soils below the water table). PASS therefore have not produced sulfuric acid but have the potential to do so if exposure to oxygen occurs.

ASS field and laboratory-based criteria for assessing whether soils are classified as PASS/AASS and/or, exceed the action criteria for management if disturbed, are provided in Appendix C.

Dear, et al. (2024) relates environmental risk from ASS to the treatment level and volume of disturbance of ASS. Based on the tonnage of ASS to be disturbed and the average net acidity, the proposed disturbance of the site soils is categorised as one of the following:

- Low level of treatment: Category L;

- Medium level of treatment: Category M;
- High level of treatment: Category H;
- Very High level of treatment: Category VH; and
- Extra High level of treatment: Category XH.

The assessment of risk categorisation for this ASSMP is provided in Section 7.2.

4. Proposed development

It is understood that the proposed development comprises the following:

- Site preparation works, including demolition and excavation;
- Construction of 2 x shop top housing buildings, including a 5-storey building along Queens Road, and a 26-storey building along William Street, comprising a shared single storey non-residential podium, with 134 dwellings above;
- Construction of a shared basement carpark accessed from Spencer Street;
- Public domain and landscaping upgrades, including landscaped street setbacks to all boundaries, and the provision of part of a shared through site link connecting Queens Road to Spencer Street; and
- Associated infrastructure upgrades and diversions.

5. Review of previous investigations

5.1 Previous investigations

The following previous reports are relevant to the current investigation:

- Report on Acid Sulfate Soil Assessment, Proposed Mixed Use Development, 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW, Prepared for DPG Project 37 Pty Ltd, Project 224583.01.R.002.Rev1 dated February 2026 (ASSA) (Douglas, 2026a); and
- Dewatering Management Plan, Proposed Mixed Use Development,79-81 Queens Rd & 2-8 Spencer St, Five Dock NSW, Prepared for DPG Project 37 Pty Ltd, Project 224583.01.R.003.Rev1 dated February 2026 (DMP) (Douglas, 2026b).

5.2 Douglas (2024a) ASSA

Douglas has previously undertaken an acid sulfate soil assessment at the site in conjunction with geotechnical and contamination assessment. The investigations identified the following general sub-soil profile. The borehole logs are presented in Appendix B.

CONCRETE	- Concrete slab at the start of BH101 and BH104 to BH112. The concrete was measured to be between 150 mm and 160 mm at all locations. The concrete slab was absent at locations BH102 and BH103.

	-	A recycled aggregate (crushed concrete and brick) was present on the surface in 79 Queen Street in the outdoor car storage area (at BH102 and BH103).
FILL	-	Typically, sandy clay with various proportions of gravel within the shallow depths of the boreholes, with variable thickness in a range of 0.6 m to 1.0 m.
ALLUVIAL SOIL	-	Comprising medium plasticity, soft, organic peaty clay varying in thickness between 0.2 m and 0.5 m, overlying fine to medium grained loose silty sand to depths ranging from 1.2 m to 2.2 m. The peaty clay was absent from boreholes BH105, BH109, BH110, and BH112.
RESIDUAL SOIL	-	Medium to high plasticity clay to depths ranging from 5.6 m to 7.1 m. The consistency of the soil was assessed to range from firm to hard but was typically stiff to very stiff.
SHALE and LAMINITE BEDROCK	-	Generally low to medium strength, moderately weathered to fresh, dark grey and grey shale and laminite (Mittagong Formation) encountered in boreholes BH105, BH106, and BH107 to depths between 7.4 m and 7.7 m. The Shale and laminite was absent with other boreholes.
SANDSTONE BEDROCK	-	Generally medium to high strength, slightly weathered to fresh, pale grey to grey, medium to coarse grained sandstone (Hawkesbury Sandstone) to the termination depth of boreholes. Low strength sandstone was encountered within BH107 at a depth between 9.5 m and 11.5 m.
SILTSTONE BEDS	-	Siltstone interbeds within the sandstone bedrock in boreholes encountered at varying depths of between 11.1 m and 12.2 m with an average thickness of about 500 mm. The siltstone beds were generally medium to high strength.

Groundwater was encountered at depths of between 1.2 m and 1.5 m during the augering of boreholes. The use of water as a drilling fluid during diamond coring precluded measurement of the groundwater level during coring.

Groundwater levels were gauged on 11 June 2024 (BH103, BH103s) and 7 June 2024 (BH105, BH107, BH107s) using an electronic oil / water interface meter prior to sampling. The measured water levels prior to sampling are shown in Table 1. It should be noted that groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

In addition to the groundwater levels measured in the monitoring wells groundwater seepage was observed in all boreholes during drilling, generally at the interface of fill and underlying clay soils between a depth of 0.6 to 1.3 m bgl.

Table 2: Summary of groundwater level measurements

Well ID	Location of monitoring well	Ground level * m (AHD)	SWL m (bgl)	SWL m (AHD)
BH103	down-gradient	1.9	1.07	0.83
BH103s	down-gradient	1.9	1.1	0.8
BH105	up-gradient	2.0	10.16	-8.16
BH107	up-gradient	2.1	10.10	-8
BH107s	up-gradient	2.1	Dry	-

Notes:
*Surveyed by dGPS
AHD – Australian Height Datum
SWL – standing water level
bgl – below ground level
^Down-gradient of diesel UST
S screened in soil. Other wells screened in rock

Based on the groundwater level measurements, groundwater is interpreted to be flowing to the north towards Parramatta River. This was expected given the topography and the location of the down-gradient discharge point (i.e. the Parramatta River).

Acid sulfate soil field screening results recorded the following:

- pH_F was recorded between 5.2 to 8.2 pH units, indicating that AASS was not present (<4 pH units is indicative of actual ASS);
- pH_{FOX} was recorded between 3.2 to 8.3 pH units with the exception of BH103/1.5-1.6 (2.5 pH units). Result <3 pH units can be indicative of PASS); and
- Most samples recorded a drop in pH_F of >1 pH units (results ranging from 0.7 to 4.5 pH units), which can be indicative of PASS.

Three samples were tested for SPOCAS and chromium reducible sulphur. The results are summarised below. The net acidity exceeded the action criterion in the three samples tested. Testing of soils confirmed the presence of ASS triggering the need for management under this ASSMP.

Table 3: Summary of Laboratory Testing

Sample ID	Soil Type	Spos (%S)	Scr (%S)	Net Acidity
BH102/3-3.1	Clay (residual)	0.07	0.02	0.09
BH103/1.5-1.6	Clayey Sand (alluvial)	0.05	0.04	0.05
BH107/1.5-1.6	Peaty Clay (alluvial)	0.07	0.05	0.07
Criterion				0.03

The full results of the previous ASS testing are summarised in Table B1, Appendix B.

The action criteria adopted for this ASSMP for determination of when management of ASS is required are provided in Appendix C.

Taking into consideration the ASS results and cross-referencing of borehole logs, the SPOCAS results suggest that PASS:

- Is present in alluvial soils beneath the water table, likely from depths of between 0.5 and 3.0 m bgl to depths up to and 4.5 m bgl (depth of testing) and is likely to be associated with the alluvial deposits across the site.
- Was recorded in one sample of material logged as residual soil. Based on the limited tested the significance of this result is not clear, including the potential implications for ASS in the underlying residual soils to the top of bedrock (encountered up to a depth of up to 7.1 m bgl).

Therefore, it is recommended that data gap assessment be undertaken to provide further vertical profiling of the PASS/ASS to confirm the liming rates and extent of alluvial soils and if the underlying residual soils are PASS/ASS.

5.3 Douglas (2024b) DMP

Douglas (2026b) provides the dewatering management plan (DMP) for the site. The predicted inflow rates from the DMP are provided in the following tables. Reference should be made to DMP for the assumptions and limitations of the model.

Table 4: Simulated Inflow Results from Baseline Model with k_v / k_h = 0.33

Time	Estimated Dewatering Flow Rate		
	L/sec	m³/day	ML/year
Transient (first year)	0.06 to 0.09	4.9 to 7.4	1.8
Long term (steady state)	0.06	4.9	1.8

Table 5: Simulated Inflow Results from Baseline Model with kv / kh = 0.66

Time	Estimated Dewatering Flow Rate		
	L/sec	m³/day	ML/year
Transient (first year)	0.10 to 0.14	9.2 to 11.8	3.4
Long term (steady state)	0.10	9.2	3.4

The estimated inflows from the sensitivity analyses are summarised in the following tables.

Table 6: Simulated Inflow Results from Sensitivity Model with kv / kh = 0.33

Time	Estimated Dewatering Flow Rate		
	L/sec	m³/day	ML/year
Transient (first year)	0.12 to 0.17	10.8 to 14.5	4.0
Long term (steady state)	0.12	10.8	3.9

Table 7: Simulated Inflow Results from Sensitivity Model with k_v / k_h = 0.66

Time	Estimated Dewatering Flow Rate		
	L/sec	m^3/day	ML/year
Transient (first year)	0.23 to 0.27	19.7 to 23.3	7.2
Long term (steady state)	0.23	19.7	7.2

The magnitudes of the potential changes to the groundwater levels resulting from the construction of a drained basement (drawdown) were estimated by subtracting the predicted long-term groundwater levels from the original groundwater levels. The maximum estimated drawdowns at various distances from the east and west excavation faces are summarised in Table 8.

Table 8: Estimated Drawdown from Eastern Excavation Face

Location	Original Water Level (m AHD)	Final Water Level (m AHD)	Drawdown (m)
Immediately adjacent to basement	-8.3	-14.0	5.7
20 m away from basement	-8.3	-10.9	2.6
50 m away from basement	-8.3	-9.7	1.4

The groundwater drawdown is expected to occur within the sandstone bedrock only as no drawdown was noted in the upper alluvial soils. As such, the drawdowns are not considered to present a risk of oxidising off-site ASS.

Settlements induced by drawdown in the bedrock are expected to be negligible.

6. Data gap assessment

Based on the previous investigation findings and proposed development, additional subsurface investigation is recommended prior to construction to provide:

- Delineation of vertical extent of alluvial soils and ASS;
- Confirmation of the lime treatment rates for each soil unit / depth; and
- Confirmation of the baseline groundwater and surface water conditions.

The scope of the data gap assessment includes:

- Measurement of the pH and electrical conductivity (EC) in, and collection of a water sample from, the Parramatta River, approximately 500 m to the north of the site, using a handheld calibrated meter;
- Drilling of four boreholes to a depth of 7.0 m below ground level using a Geoprobe push-tube drill rig and logging of the subsurface conditions;
- Collection of soil samples at every 0.25 m depth interval and at least one sample for every change in strata observed as per the methodology for Douglas (2026a);

- ASS (field) screening testing of all soil samples and net acidity (acid base accounting) testing of up to 30 soil samples;
- Sampling groundwater and analysis of pH, EC, major cations and anions, dissolved and total metals (including Al and Fe);
- Analysis of the surface water sample for pH, EC, major cations and anions, dissolved and total metals (including Al and Fe); and
- Preparation of a data gap assessment report and update of this ASSMP, if required.

7. Potential for oxidising acid sulfate soil and risk categorisation

7.1 Acid sulfate soil oxidation potential

Based on the results of previous investigations (refer to Section 5), any excavations which disturb or uncover natural alluvial soils in the site have the potential to oxidise PASS and/or disturb AASS. Based on the proposed development (refer to Section 4) this is expected to include:

- Bulk excavations for the proposed basement / site levelling. Excavation to depth of 16 m (RL - 14) are anticipated. Bedrock is present at a depth of approximately 7 m bgl;
- Drilling of piles through ASS and into rock; and
- Minor excavations for service installations of up to 3 m deep around the perimeter of the site or below the final basement RL.

The groundwater drawdown is expected to occur within the sandstone bedrock only as no drawdown was modelled to occur in the upper alluvial soils (refer to Section 5.3), based on the assumption that the basement shoring will comprise a relatively water-tight secant pile wall cutoff (or similar) at least 1 m into the sandstone around the basement perimeter.

It is understood that:

- A drained basement will be adopted from 1 m below the top of bedrock; and
- Any seepage / groundwater inflow into the excavation will be pumped out using pumps connected to spear-points within the excavation, sumps within the excavation, or a combination of the two.

At this stage the volume of ASS that will be disturbed is unknown. Further vertical profiling of ASS is required to confirm if and/or to what depth ASS extends into the residual soils. The volume of ASS present will be determined by the proposed data gap assessment.

Any disturbance (e.g. excavation or dewatering) of ASS must be undertaken in accordance with this ASSMP.

Dewatering is also anticipated during construction for a period of up to 12 months. Based on the DMP (refer to Section 5.3) groundwater drawdown is expected to occur within the sandstone bedrock only as no drawdown was noted in the upper alluvial soils. Therefore, no soils are expected to be impacted outside the basement footprint.

On the basis of the result of the ASSA (Douglas, 2026a), the following proposed construction activities are unlikely to require ASS management:

- Stripping / excavation of upper fill / topsoil above a depth of 0.5 m bgl; and
- Excavations below a depth of approximately 7.0 m (below the top of bedrock).

Further data gap assessment is required to determine if ASS management is required for the following:

- Excavation between 2.0 to 3.5 m bgl in transition between alluvial and residual soils. ASS Management is likely to be required between a depth of 2.0 to 3.5 m bgl at the transition of the alluvial to residual soils however further vertical delineation of ASS is required to confirm; and
- Residual soils between a depth of 3.5 m to 7.0 m bgl – Unknown: Further vertical delineation of ASS is required to confirm if the deeper residual soils require ASS Management.

7.2 Assigned risk categorisation

The risk categorisation and formulating this ASS management strategy considers:

- Proximity to the adjacent Parramatta River and associated ecosystem. The site is 500 m from Parramatta River and therefore very unlikely to impact upon this ecosystem;
- Temporary impacts of dewatering (i.e. temporary lowering of the water table[1]). Note as previously stated, modelling undertaken in DMP ((Douglas, 2026b)) indicated that groundwater drawdown (outside the basement excavation) would occur within the sandstone bedrock only as no drawdown was noted in the upper alluvial soils; and
- Previous ASS results and soil types.

Dear, et al. (2024) relates environmental risk from ASS to the treatment level and volume of disturbance of ASS. Based on the proposed development and subsequent tonnage of ASS to be disturbed (estimates to be within the range of 7,200 tonnes to 28,000 tonnes as per Section 7.1) and the maximum net acidity (0.09%w/w S as per Section 5.2 or average 0.07%w/w S), the proposed disturbance of the site soils is considered to be:

- Very high level of treatment (VH).

Douglas note that if the volume of ASS is at the higher end of the potential range than it may be possible that it would technical become an extra high (EH) treatment category site, noting it is considered unlikely that the volume of ASS will approach the upper limit of the estimates. However, the management methods provided herein are considered to be suitable for the higher end of the predicted volume of possible ASS on the basis that:

- The expected lower net acidity within the residual soils; and
- Dewatering activities are not anticipated to result in drawdown of the upper alluvial soils outside the basement.

[1] Dear et al., (2024) defines groundwater dewatering as the process of extracting water from a saturated soil or sediment that results in alteration of the water table level, however, does not include short-term pumping (<1 day duration) of saturated soils or sediments from small volume excavations

8. Acid sulfate soil management

8.1 Roles and responsibilities

The following key roles and responsibilities are relevant to this ASSMP:

- Contractor: the contractor with responsibility to implement this ASSMP during earthworks / dewatering etc.;
- Site Supervisor: head representative for the Contractor responsible for the day-to-day site operations including management of ASS; and
- Environmental Consultant: data collection / verification testing and documentation of the works, as per this ASSMP.

8.2 Management options

Stone, Ahern, & Blunden (1998) and Dear, et al. (2024) provides the following potential soil management options:

Option 1	Non-excavation or minimal earthworks (avoidance);
	On-site treatment (neutralisation) followed by: • Off-site disposal; and/or • On-site reuse; and/or • Off-site reuse under a specific resource recovery exemption.
Option 2	Off-site treatment and disposal.
Option 3	On-site reburial below the permanent water table without treatment (PASS only).
Option 4	Off-site reburial below the permanent water table without treatment (PASS only).
Option 5	Hydraulic separation of ASS fines.

Based on the proposed development and discussions with the client Option 2 – on-site treatment followed by off-site disposal (and/or on-site reuse) has been identified as the preferred management option, with reference to the relevant guidelines and reference materials. This option was preferred given that the proposed development will require bulk excavation across the site for construction of a basement.

It is the responsibility of the Contractor to manage ASS under this ASSMP and in accordance with relevant standards and statutory requirements. Verification sampling and testing must be undertaken by the Environmental Consultant.

8.3 Proposed management strategy for on-site treatment

8.3.1 General

The process for treatment of excavated ASS comprises:

- Preparation of a treatment pad as described in Section 8.3.2.

- Excavation and segregation / stockpiling and treatment of ASS:
  - For coarse soils (i.e. sands), treatment should occur within approximately 12 to 18 hours (or less) following excavation; and
  - For fine-grained soils (i.e. clays), treatment should occur within approximately 40 to 60 hours following excavation. Faster oxidation rates are possible, particularly in warm weather.
- Treatment via spreading the ASS over the guard layer in layers of up to 0.3 m thick, leaving a 1 m buffer between the toe of the spread soil and the containment bund or drain. When spreading the first soil layer, care should be taken not to churn up the guard layer;
- Application of aglime over the 0.3 m layer at the minimum lime dosing rate (refer to Section 8.3.3) and harrow / mix thoroughly. Use of rotary plough equipment (e.g. auger bucket) may be appropriate for cohesive soils, where adequate mixing is difficult to achieve. If ASS materials are too wet, adequate mixing of aglime cannot be achieved and soils may require a period of drying prior to mixing;
- Undertaking verification testing (as outlined in Section 10) to confirm that the ASS has been adequately neutralised in each layer prior to placement of the next layer to be treated. If verification testing indicates that additional neutralisation is required, add additional aglime (at an appropriate liming rate) and mix as described above;
- Continuing the spreading / liming / harrowing / verification cycle for each 0.3 m layer until excavation is finished;
- Verification testing to confirm that the ASS has been adequately neutralised. Upon confirmation, the soil should be removed from the treatment pad for beneficial re-use on site and/or or off-site disposal and/or re-use (subject to waste classification);
- Management of leachate and groundwater may also be required where leachate is produced and/or if groundwater is impacted by the works as outlined in Section 8.4.1; and
- Adding a layer of fine aglime at the base of excavations, where the based of the excavation is ASS (5 kg/m^3 is recommended) to neutralise downward seepage from exposed ASS, or to minimise acidification of groundwater following re-establishment of groundwater levels.

8.3.2 Preparation of treatment pads

The treatment pad should be located as far as practical from any ecological receptors (e.g. drainage lines which enter the stormwater system and nearby water bodies. The pad should be of an appropriate area to accommodate the volume of soil to be treated / stored and should be prepared on relatively level or gently sloping ground to minimise the risk of potential instability issues, with a fall to the local drainage sump.

Construction of the treatment pad involves:

- Lining the footprint of the pad with either:
  - Natural low permeability clay;
  - A compacted clay layer;
  - Geosynthetic liner (e.g. HDPE); and
  - Impervious barrier (e.g. concrete or bitumen hardstand).

- Placement of a guard layer of fine aglime at approximately 5 kg/m^2 per 300 mm layer of ASS proposed. The guard layer should be re-applied each time treated soils are removed, prior to placement of the next batch of un-treated ASS; and
- Construction of a perimeter clay bund (or equivalent) to collect any leachate runoff and to prevent surface water from entering the treatment pad.

A standard treatment pad is shown on in Figure 3, below.

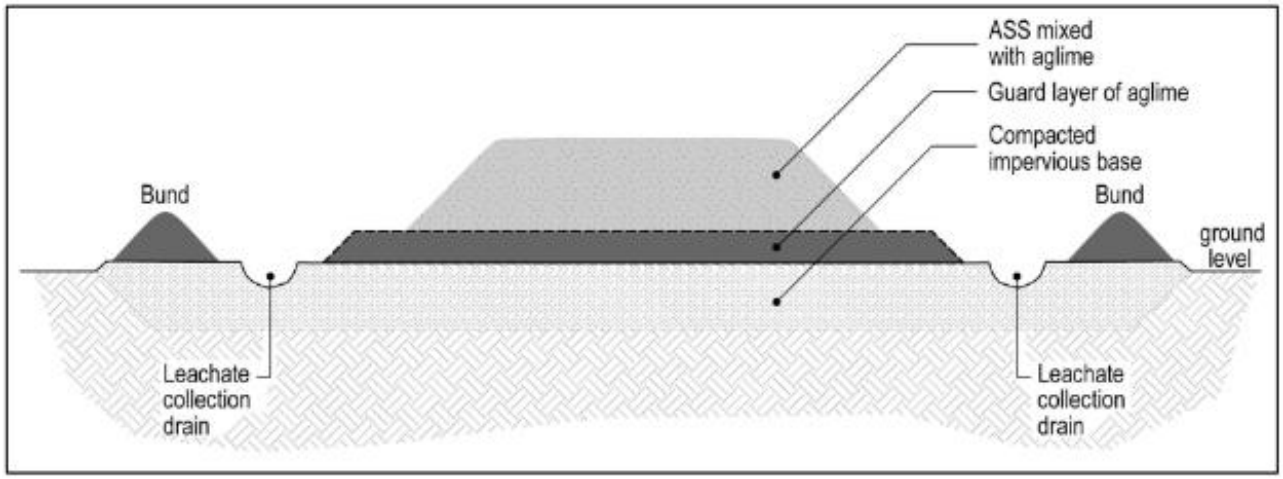


Figure 3. Schematic cross-section of a treatment pad, including compacted impervious base (clay layer), guard layer, leachate collection drains and bunding (source: Dear, et al. (2024))

Reapplication of the guard layer will be necessary under treatment pads if the treated soil is being removed as the guard layer could be removed with the treated soil. Guard layers may need to be applied between each placed ASS layer in situations where multiple layers of ASS are placed on the same treatment pad.

8.3.3 Neutralising materials and liming rate

Agricultural lime (aglime) is the preferred neutralisation material.

Refer to Appendix D for additional information on aglime and purity of specific aglime.

Based on the assessment results, natural soils that are to be disturbed during excavation are to be treated using aglime prior to reuse off-site or on-site or disposal. Table 9 provides indicative liming rates for neutralisation of the ASS likely to be disturbed.

Table 9: Indicative liming rate for soil

Material description	Net Acidity (%S) max. [a](range) [c]	Aglime application rate [b] (kg/tonne)
ALLUVIAL SOIL - Comprising medium plasticity, soft, organic peaty clay varying in thickness between 0.2 m and 0.5 m, overlying fine to medium grained loose silty sand to depths ranging from 1.2 m to 2.2 m and shallow residual soils at transition between alluvial and residual layer to a depth of 3.5 m bgl (refer to below description). **Note: further testing required to confirm if the residual soils require treatment and to what depth. Initially up to 3.5 m bgl.**	0.09 (0.05-0.09) Average	4.4 kg/tonne (6.7 kg/m^3) Average 3.5 kg/tonne (5.2 kg/m^3)
RESIDUAL SOIL - Medium to high plasticity clay, orange, red, brown and grey, to below a depth of 3.5 m and up to depths ranging from 5.6 m to 7.1 m.	TBC	TBC

Notes:
a Maximum net acidity for soil unit / type. Net acidity to be calculated based on the equation provided in Appendix C.
b Lime application rate calculated using maximum net acidity for soil unit / type using the equation in Appendix D. Lime rate calculated based on an ENV of 95% for aglime, a factor of safety (FOS) of 1.5 and a bulk density of 1.5 t/m^3 for clay / silt
c Net acidity range for soil unit/type
TBC. To be confirmed by data gap testing if a) residual soils require management and b) if management required what the appropriate liming rates are

Depending upon the source of the aglime and ultimately the representative effective neutralising value (ENV) of the aglime selected, the minimum lime dosing rate may be increased or decreased. Prior to the commencement of works, the minimum lime dosing rate should be finalised based on the results of the DGI and review of the ENV of the selected aglime.

8.4 Alternative strategy or contingency plan

Where the proposed primary management option is not possible, or practical, alternative or contingency strategies, with reference to the applicable guidelines, may be considered and following a 'fit for purpose' assessment. These contingency options are outlined in Appendix E.

8.4.1 Trenching works

For trenching works (i.e. service installation) which cannot be rerouted or modified to ensure the invert depth of the trench is above ASS and where trenchless tunnelling technologies cannot be used to minimise disturbance, the following process is recommended with reference to Dear, et al., (2024), for excavated trench spoil:

- Non-ASS surface soils should be removed and segregated from ASS. Soil horizons should be replaced back in the trench in the same order they were removed (after ASS has been neutralised), and subject to geotechnical considerations;
- The trench excavation should be staged, such that ASS soils are excavated, treated and backfilled within 24 hrs (typically within an 8-hour working day); and

- Where the ASS risk assessment shows the risk is high (refer to Section 7.2), the trench is located in a sensitive environment and/or where dewatering is required, ASS should be removed from the trench and neutralised on a fully contained treatment pad (refer to above) and neutralisation performance criteria (refer to Section 10).
- Where the ASS risk assessment shows the risk is not high, the trench is not located in a sensitive environment and no dewatering is required the following management strategy could be adopted in lieu of a treatment pad:
    - A guard layer of aglime (refer to above for application rates) should be applied to the ground surface alongside the trench;
    - Excavated soil from the trench should be placed on the guard layer;
    - Aglime should be applied to the surface of the excavated soil at double (FOS of three) the application rate provided in Section 8.3.3. Verification testing is not required for this methodology;
    - A layer of aglime should be placed over the base of the excavation. A lime application rate of 5 kg/m^2 is recommended;
    - The excavated treated soil should be backfilled into the trench; and
    - Segregated non-ASS overlying ASS should be re-instated on top of the treated ASS, minimising any aglime at the ground surface.

9. Leachate and groundwater management

Potential leachate and groundwater management strategies are provided in Appendix F.

10. Verification testing of treated soils and water

Verification testing to assess whether ASS has been adequately neutralised will be undertaken by means of:

- Screening tests (pH_F and pH_{FOX}) at the frequencies in Table 10; and
- Acid base accounting (e.g. using the chromium suite) testing at the frequencies in Table 10.

Based on a 'Category VH' treatment level, verification testing of the ASS and leachate (if present) is required after the addition of lime to test whether the soil / water has been adequately neutralised, whether or not adequate mixing of the ASS has been achieved, and to reduce the risk of acidic water being returned to the environment (including watercourses). The verification testing frequency for ASS is in Table 10.

Table 10: Verification testing frequency for treated acid sulfate soils

Test	Frequency
Field test: pH_F and pH_{Fox} screening	One sample / soil type AND Sampling to meet the following minimum requirements: • One sample / 100 m^3 of treated soil; AND • At least three to six samples / 200 mm to 300 mm deep soil treatment layer
Net acidity (acid base accounting)	One sample / soil type AND Sampling to meet the following minimum requirements: • Volumes of <250 m^3 = two samples OR • Volumes 251–500 m^3 = three samples OR • Volumes >500 m^3 and ≤2 %S = three samples, plus one sample per additional 500 m^3 OR • Volumes of >500 m^3 and >2 %S = three samples, plus one sample per additional 250 m^3 AND • At least one sample / 200 mm to 300 mm deep soil treatment layer

Note:
Verification testing frequencies should be adjusted (either increased or decreased) depending on net acidity value, performance, material quantities and purpose/reuse, and may be subject to change by the appropriate regulatory authority in the event of a review.
Laboratory analysis on untreated soils for each treatment layer should be considered where heterogenous materials are present and initial ASS investigations indicate the presence of existing ANC (unverified).

In addition, the pH of all ponded leachate around the confines of the treatment bunds and adjacent surface waters should be measured on a regular basis and results assessed against the criteria provided in Table 11 and against background (pre-construction) levels. The soil and water contained within the bunded treatment area should not be removed until the target values in Table 11, below, have been achieved.

Table 11: Target levels of neutralised soil and water

Test	Component	Target level
Monitoring of water (leachate, and surface water)	pH	pH 6.5 < pH < 8.5, or one pH unit from background levels.
	Turbidity	To comply with either values determined in consultation with the Authority or less than local background levels (baseline monitoring required).
	Aluminium (Al) and iron (Fe)	Establish local water quality data prior to site disturbance for comparison.
	Dissolved oxygen (DO)	To comply with either values determined in consultation with the Authority or less than local background levels established by baseline monitoring.

Test	Component	Target level
	Electrical conductivity (EC)	To comply with either values determined in consultation with the Authority or less than local background levels established by baseline monitoring.
Field screening of soil [a]	pH_F	$6.5 \leq pH_F \leq 8.5$
	pH_{FOX}	$6.5 \leq pH_{FOX} \leq 8.5$
Acid base accounting (including chromium reducible sulfur (Scr) method)	Net acidity [b]	Zero or negative
	pH_{KCL}	$6.5 \leq pH_{KCL} \leq 10$

Notes:
a used as a guide only to assess when adequate neutralisation and soil mixing has been achieved.
b determined using the equation in Appendix C

It should be noted that laboratory tests for soil verification will require at least four days turnaround, possibly longer, and hence sufficient time should be allowed in the treatment program for such verification testing. Only appropriately skilled staff should collect and test verification samples.

11. General monitoring requirements

11.1 General monitoring requirements

It is recommended that prior to commencement of works, a construction environmental management plan (CEMP) should be developed by the lead Contractor. The CEMP should also include a program for general site monitoring pertinent to the ASS. A typical monitoring program is provided below and should be implemented by the responsible parties.

Table 12: General monitoring requirements

Task	Frequency	Standard	Reporting / record keeping	Responsibility
Inception Meeting	Pre-start	ASSMP	Minutes	Contractor / Site Supervisor, Environmental Consultant
Site inspection	Daily	Visual / olfactory signs of ASS	File note	Site Supervisor
Site inspection	Monthly	Visual / olfactory signs of ASS	File Note	Environmental Consultant

Task	Frequency	Standard	Reporting / record keeping	Responsibility
Monitoring of disturbed excavations that are in ASS	Daily	Visual until backfilled	File note	Site Supervisor
Monitoring of ASS treatment area/s	Daily	Visual Daily pH testing until results show ASS or leachate has been neutralised (refer Section 10 for criteria and testing requirements)	File note and results of pH testing to be recorded in field sheets	Site Supervisor
Dewatering excavation in ASS	Prior to planned discharge	Treated and tested to demonstrate compliance with DMP and ASSMP guidance or regulatory requirements prior to discharge	Field sheets and permit to discharge	Site Supervisor, Environmental Consultant

11.2 Groundwater monitoring requirements

The DMP (Douglas, 2026b) recommends that three groundwater monitoring wells be established outside of the proposed basement excavation and provides the following general groundwater monitoring requirements (Table 13). In addition to general monitoring requirements Table 14 provides additional groundwater monitoring requirements for ASS management.

Table 13: General Groundwater Monitoring Requirements from DMP

Item	Monitoring	Monitoring Frequency	Reporting
Assess effect of excavation on groundwater	Monitoring of groundwater levels in three monitoring wells outside the excavation footprint, during and following completion of construction. The locations will be subject to access and approvals and will be determined prior to construction. Existing wells could be used where possible.	Daily for the first two weeks then weekly. This can be relaxed to monthly once steady groundwater levels are established, during construction	Weekly then monthly during construction

Item	Monitoring	Monitoring Frequency	Reporting
Groundwater Quality Sampling and Testing	Sampling and testing of water from wells and the excavation, or at the point of discharge. Contaminant and physical properties tested to be nominated by the authority accepting water but to include: • Heavy Metals • TRH / BTEX; • Phenols; • VOC; and • PFAS • PAH; and • OCP/OPP/PCB; • pH & conductivity • Suspended Solids • Dissolved Oxygen Levels • Turbidity	pH and turbidity to be measured daily for the first week and then weekly. Two rounds of groundwater sampling and testing initially. Subject to relatively uniform results groundwater testing to be carried out fortnightly or as otherwise agreed with the authority accepting the water.	
Groundwater inflow rates	Groundwater inflow to be measured in collection tanks, of a pre-determined size or using a calibrated flow meter connected to the dewatering system.	Twice daily, or once collection point is filled (whichever is more frequent), for the first two weeks. After steady groundwater inflow rates are established then daily.	Weekly
Quantity of water disposed off-site (includes rainwater)	Calibrated Flowmeter connected to any pump-out system.	Automatically	Weekly

Table 14: Additional ASS Groundwater Monitoring Requirements

Item	Monitoring	Standard	Action (in event of non-compliance)
Groundwater Level	Groundwater level monitoring per Table 6	The groundwater level should not be reduced by more than 1 m from the seasonally lowest water table level.	Further groundwater management contingencies should be considered in consultation with the dewatering contractor to reduce drawdown.
Groundwater Quality Monitoring	Conduct monitoring round prior to commencement of dewatering to establish background.		Further groundwater management contingencies should

Item	Monitoring	Standard	Action (in event of non-compliance)
	Two rounds of groundwater sampling and testing initially. Subject to relatively uniform results groundwater testing to be carried out fortnightly or as otherwise agreed with the authority accepting the water.		be considered in consultation with the dewatering contractor
	pH	pH 6.5 < pH < 8.5, or one pH unit from background levels.	
	Aluminium (Al) and iron (Fe)	Establish local water quality data prior to site disturbance for comparison.	
	Dissolved oxygen (DO)	To comply with either values determined in consultation with the Authority or less than local background levels established by baseline monitoring.	
	Electrical conductivity (EC)	To comply with either values determined in consultation with the Authority or less than local background levels established by baseline monitoring.	

12. Emergency incident response plan

Construction activities which may cause potential environmental impacts with respect to ASS are summarised in the table below together with recommendations for emergency response procedures.

Table 15: Emergency response procedures

Activity	Environmental threat	Emergency response
Excavations	Flooding of open excavation causing adjacent groundwater levels to rise, leading to potential acid leachate once the excavation is drained.	Inform site foreman and project manager / environmental officer. Determine pH of groundwater / floodwater in excavation. Correct groundwater / floodwater pH by application of slaked lime (hydrated lime) to bring pH in range of 6.5 to 8.5 or to pre-construction background levels.

Activity	Environmental threat	Emergency response
		Drain pit to tanks / ponds for water quality assessment prior to discharge.
Treatment / neutralisation	Soil washes or slips outside of bunded treatment area	Inform site foreman and project manager / environmental officer. Estimate volume of material breaching bund. Remove escaped soil into a bunded treatment area. Over-excavate impacted area to 0.2 m depth, apply and mix lime at rate as for guard layers (5 kg to 10 kg lime per m^2 of surface).
	Breach in containment bund	Inform site foreman and project manager / environmental officer. Close breach in bund.
	Extracted untreated groundwater, surface water or leachate is exiting the site in an uncontrolled manner.	Inform site foreman and project manager / environmental officer. Restrict / stop source of water. Conduct pH analysis of potential receiving water bodies (if any).

For all construction activity incidents which pose a potential environmental impact, an incident report must be completed in order that:

- The cause of the incident may be determined;
- Additional control measures may be implemented; and
- Work procedures may be modified to reduce the likelihood of the incident re-occurring.

13. Reporting and record keeping

With reference to Dear, et al. (2024), it is good practice for the Contractor to maintain a record of treatment of ASS. Such records should include the following details:

- Date;
- Location / area / treatment pad;
- Time of excavation; and
- Neutralisation process undertaken.
- Lime rate used including:
    - Records which demonstrate a safety factor of 1.5 has been applied in calculating liming rates;
    - Receipts showing quantities of aglime purchased;
    - Evidence of composition, purity, particle size and ENV of the aglime used;
    - Record of aglime use (e.g. per treatment pad, use in guard layers etc); and
    - Photographic evidence of incorporation of neutralising agent (aglime).

- Results of monitoring;
- Disposal and/or reuse location; and
- Tonnages and disposal / transfer dockets (if applicable).

A record should also be maintained confirming contingency measures and additional treatment if undertaken. A final report should be issued upon completion of the works presenting the monitoring regime and results and confirming that appropriate management of ASS has occurred during the works.

14. Conclusions and recommendations

This ASSMP provides the ASS management procedures to be enacted to minimise the impact of ASS disturbance on the environment during the proposed works.

If ASS are encountered, then the ASS management procedures provided herein will be enacted to minimise the impact of ASS disturbance on the environment.

Given the potential volumes of PASS that may be present which may require treatment Douglas would recommend that consideration be given to the application of Resource Recovery Order under Section 286A of the Protection of the Environment Operations Act 1997. The acid sulfate soil (ASS) order 2025 or a 'specific exemption' for treated PASS be sought from NSW EPA under relevant waste regulations for beneficial reuse on a defined receiving site willing to accept the material. The ASS order has specific requirements including the review and endorsement of the ASSMP by someone that holds certification from Soil Science Australia (SSA) Registered Soils Practitioner in Acid Sulfate Soils (ASS) (RSP-ASS) and proof of performance trials (during construction phase). The application can take some time to process and therefore requires appropriate pre-planning.

15. References

Dear, et al. (2024). *Queensland acid sulfate soil technical manual : soil management guidelines version 5.1.* Dear, S E; Williams, K M; McElnea, A E; Ahern, C R; Dobos, S K; Moore, N G; O'Brien, L E; Department of Environment, Science and Innovation.

Dear, S. E., Williams, K. M., McElnea, A. E., Ahern, C. R., Dobos, S. K., Moore, N. G., & O'Brien, L. E. (2024). *Queensland acid sulfate soil technical manual : soil management guidelines version 5.1.* Department of Environment, Science and Innovation.

Douglas. (2026a). *Report on Acid Sulfate Soil Assessment, Proposed Mixed Use Development, 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW.* Project 224583.01.R.002.Rev1 dated February 2026.

Douglas. (2026b). *Dewatering Management Plan, Proposed Mixed Use Development, 79-81 Queens Rd & 2-8 Spencer St, Five Dock NSW.* Project 224583.01.R.003.Rev1 dated February 2026.

NSW EPA. (2014a). *Waste Classification Guidelines, Part 1: Classifying Waste*. NSW Environment Protection Authority.

NSW EPA. (2014b). *Waste Classification Guidelines, Part 4: Acid Sulfate Soils*. NSW Environment Protection Authority.

Stone, Y., Ahern, C. R., & Blunden, B. (1998). *Acid Sulfate Soils Manual*. Wollongbar, NSW, Australia: Acid Sulfate Soil Management Advisory Committee.

Sullivan, et al. (2018a). *National Acid Sulfate Soils Guidance: National Acid Sulfate Soils Identification and Laboratory Methods Manual*. Canberra ACT CC BY 4.0: Sullivan, L; Ward, N; Toppler, N; Lancaster, G, Department of Agriculture and Water Resources.

Sullivan, et al. (2018b). *National Acid Sulfate Soils Guidance: National Acid Sulfate Soils Sampling and Identification Methods Manual*. Canberra ACT CC BY 4.0: Sullivan, L; Ward, N; Toppler, N; Lancaster, G, Department of Agriculture and Water Resources.

16. **Limitations**

Douglas Partners Pty Ltd (Douglas) has prepared this report (or services) for this project at 79-81 Queens Road and 2-8 Spencer Street, Five Dock NSW in line with Douglas' proposal dated 16 May 2025 and acceptance received from Alexander Lekovski of DPG Project 37 Pty Ltd dated 28 May 2025 The work was carried out under Douglas' Engagement Terms. This report is provided for the exclusive use of DPG Project 37 Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after Douglas' field testing has been completed.

Douglas' advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by Douglas 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.

The assessment of atypical safety hazards arising from this advice is restricted to the environmental components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. Douglas 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 Douglas. This is because this report has been written as advice and opinion rather than instructions for construction.

Appendix A

Drawings



REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	INITIAL ISSUE	03.06.2025	CL

SCALE: 0 5 10 15 20 m
1:400 @ A3

Douglas PARTNERS
OFFICE: SYDNEY
96-98 Hermitage Rd, West Ryde NSW 2114
(02)9809 0666

CLIENT:
Proposed Mixed Use Development

NOTE:
1: Basemap from Metromap (Dated 25.03.2024)

COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 56

PROJECT NAME:
DPG Project 37 Pty Ltd

PROJECT ADRESS:
79-81 Queens Road and 2-8 Spencer Street, Five Dock

DRAWING TITLE:
TEST LOCATION PLAN

PROJECT NO: **224583.02**
DRAWING NO: **1**
REVISION: **0**

Appendix B

Notes About This Report

Previous Results

Borehole Logs

About this Report

November 2023

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

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

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.

continued next page

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.

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Acid Sulfate Soil Test Results v1.2

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TableB1 Summary of results - acid sulfate soils

Project No: 224583.03

Project Name: Proposed Mixed Use Development

Location: 79-85 Queens Road and 2-8 Spencer Street, Five Dock

Sample Information						Screening Test Results				Laboratory Analysis Results (Acid Base Accounting)										
Location ID	Depth from (m)	Depth to (m)	Reduced level (AHD)	Sample Description	Adopted Texture	pH_F (pH units)	pH_{FOX} (pH units)	Reaction Strength	pH change (pH units)	pH_{KCl} (pH units)	S_{KCl} (%S)	S_{HCl} (%S)	SPOS (%S)	Scr (%S)	TAA (%S)	S_{NAS} (%S)	ANC_{BT} (%S)	ANC Corroborated (Y/N)	Net Acidity (%S)
				Assessment Criteria (pH units)		**<4**	**<3**	-	**1.0**	Action Criteria (%S)		Coarse texture: sands to loamy sands and peats								0.03
BH101	**0.90**	**1.00**	1.00 to 0.90		C	7.8	3.3		**4.5**											
BH101	**2.90**	**3.00**	-1.00 to -1.10		C	8.0	3.5		**4.5**											
BH102	0.50	0.60	1.60 to 1.50		C	8.2	6.8		**1.4**											
BH102	**3.00**	**1.60**	-0.90 to 0.50		C	5.2	3.3		**1.9**	4.8	0.040	NT	0.070	0.020	0.020	NT	NT	N	0.090
BH103	0.50	**1.10**	1.40 to 0.80		C	7.8	5.6		**2.2**											
BH103	**1.50**	**1.60**	0.40 to 0.30		C	6.5	**2.5**		**4.0**	6.5	0.020	NT	0.050	0.040	<0.01	NT	NT	N	0.050
BH111	**1.00**	**1.10**	0.80 to 0.70		C	7.3	4.0		**3.3**											
BH111	**2.50**	**2.60**	-0.70 to -0.80		C	8.1	5.1		**3.0**											
BH104	**1.50**	**1.60**	0.50 to 0.40		C	6.3	3.2		**3.1**											
BH105	**0.90**	**1.00**	1.10 to 1.00		C	7.3	3.7		**3.6**											
BH105	**4.40**	**4.50**	-2.40 to -2.50		C	7.6	8.3		**-**											
BH106	0.90	1.00	1.20 to 1.10		C	7.2	4.0		**3.2**											
BH106	**2.90**	**3.00**	-0.80 to -0.90		C	6.8	4.5		**2.3**											
BH107	**1.50**	**1.60**	0.60 to 0.50		C	7.3	3.3		**4.0**	5.8	0.010	NT	0.070	0.050	<0.01	NT	NT	N	0.070
BH107	**4.40**	**4.50**	-2.30 to -2.40		C	7.0	5.0		**2.0**											
BH104	**2.90**	**3.00**	-0.90 to -1.00		C	6.0	4.5		**1.5**											
			-																	
			-																	
			-																	
			-																	
			-																	
			-																	
			-																	

Notes:
Adopted texutre - C = coarse, M = medium, F = fine
pH_F - Soil pH in water
pH_{FOX} - Soil pH in peroxide
Reaction strength: L - Low , M - Medium, H - High, X - Extreme, V - Volcanic, F - Frothing (indicative of organic material)
pH change = pH_F - pH_{FOX}
pH_{KCL} - KCl extractable pH
S_{KCl} - KCl extractable sulfur
S_{HCl} - HCl extractable sulfur
S_{cr} - potential sulfidic acidity
TAA - titratable actual acidity (reported if pH_{KCL}<6.5)
S_{NAS} – retained acidity (reported if pHKCl < 4.5)
ANC_{BT} – acid neutralising capacity (reported if pH_{KCl} ≥ 6.5)
NT - Not tested
Blue depths indicate where samples have been collected at or below the groundwater table
Bold results are indicators of ASS conditions, noting:
- Assessment criteria are considered a reasonable initial screening for AASS or PASS
- pH_F<4 is indicative of the presence of Actual ASS (AASS), although it is not conclusive of ASS on its own as naturally occurring non ASS soils can have pH_F<5
- pH_{FOX}<3 or pH Change ≥1 may indicate potential ASS (PASS), although exception apply. Laboratory testing required to confirm presence of Reduced Inorganic Sulfur (RIS)
- Refer to Table 5.1, A2, A3 of Sullivan,L. et al (2018) for further details
Shaded results trigger action (i.e. equal to or exceed the action criteria). Criteria is specific for soil texture and anticpated tonnage of soil disturbed.
Net Acidity can only include the measured ANC where the ANC has been corroborated by other data (for example slab incubation data) that demonstrates the soil material does not experience acidification during complete oxidation under field conditions.
a - Action criterion for disturbance of 1-1000 tonnes of material
b - Action criterion for disturbance of more than 1000 tonnes of material
The action criteria apply only to ASS materials and not to other acidic soils such as acidic peatlands and coastal heaths.

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325978.4, N:6250752.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH101
PROJECT No: 224583.01
DATE: 01/05/24 - 02/05/24
SHEET: 1 of 3

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] / DENSITY.[*]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
		0.15	CONCRETE 150MM THICK			ND	ND						
seepage 01/05/24			FILL / Sandy CLAY: orange and brown; medium to high plasticity; fine to medium sand.		FILL	(S)	w>PL		A/ES		0.20 0.30		
									A/ES		0.50 0.60		
	1	0.90	Peaty CLAY (OH): dark grey and grey; medium plasticity.		ALV	VS to S		PFAS	A/ES		0.90 1.00	SPT	1,0,0 N=0
seepage 01/05/24		1.40	Clayey SAND (SC): red orange brown; fine to medium.		ALV	L	M		ES		1.40 1.50		
	0	2.00	CLAY (CI-CH): orange yellow brown mottled red; medium to high plasticity.			F to St					2	SPT	3,4,6 N=10
	-1	3	From 3.00m: pale grey orange mottled red; with ironstone bands		RS	VSt	w<PL		ES		2.90 3.00		
	-2	4									4	SPT	5,12,14 N=26
	-3	5	From 5.00m: orange-yellow; extremely weathered material						ES		4.40 4.50		
	-4	5.70 5.90	SANDSTONE: orange-brown, pale grey; inferred medium strength Continued as rock log			ND			ES		5.65 5.75	SPT	24,25/100mm
	-5	7									7		
	-6	8									8		
	-7	9									9		
	-8	10									10		
	-9	11									11		

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

PLANT: Comacchio 305
METHOD: AD/T to 2.5m, WB to 5.9m, NMLC to 20.5m
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: HW to 2.5m, then HQ to 6m

Refer to explanatory notes for symbol and abbreviation definitions

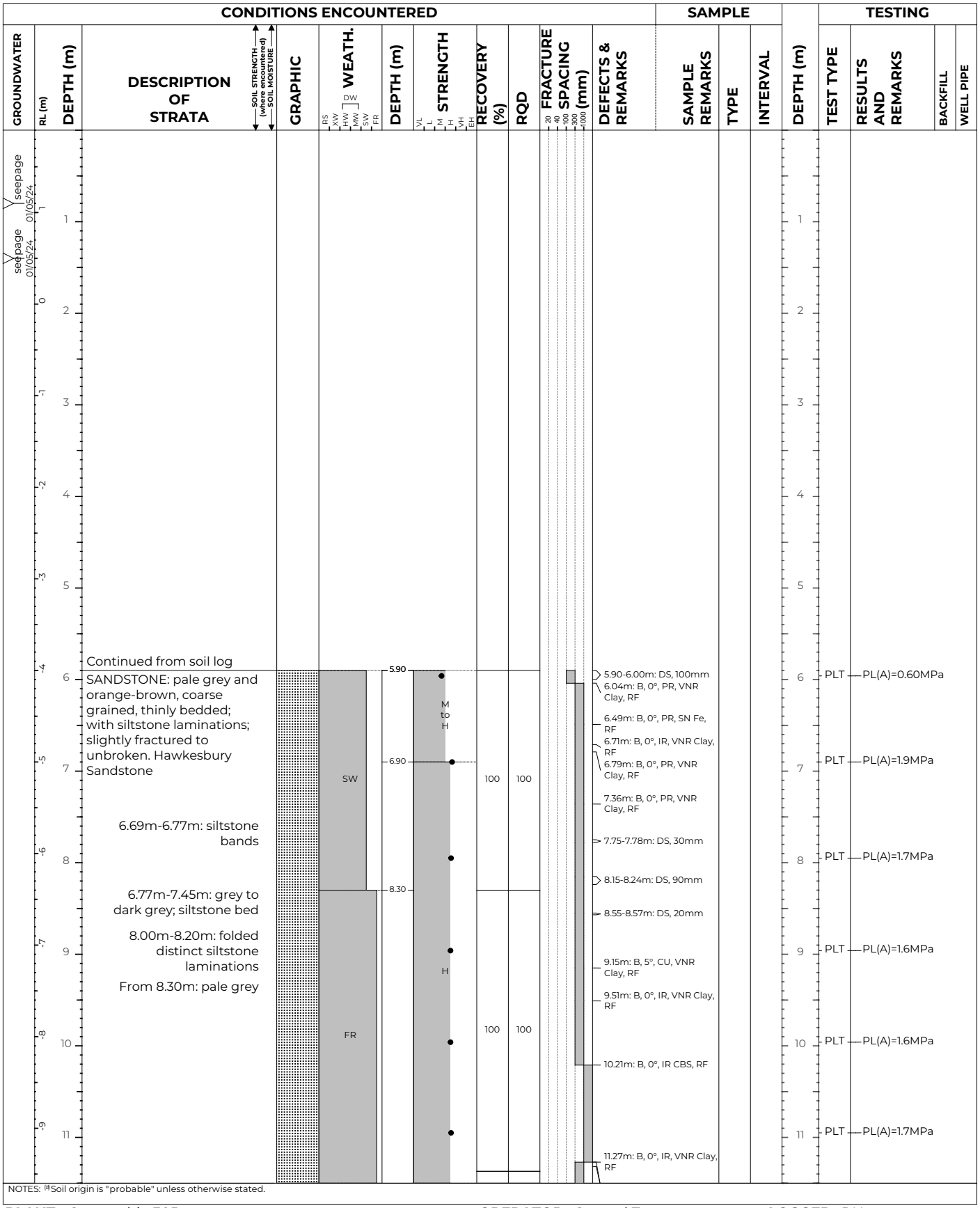
Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325978.4, N:6250752.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH101
PROJECT No: 224583.01
DATE: 01/05/24 - 02/05/24
SHEET: 2 of 3



NOTES: [a] Soil origin is "probable" unless otherwise stated.

Generated with CORE-GS by Geroc - Split Soil-Rock Log

PLANT: Comacchio 305
METHOD: AD/T to 2.5m, WB to 5.9m, NMLC to 20.5m
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: HW to 2.5m, then HQ to 6m

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325978.4, N:6250752.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH101
PROJECT No: 224583.01
DATE: 01/05/24 - 02/05/24
SHEET: 3 of 3

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (mm)	DEFECTS & REMARKS	SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
	-10	12	[CONT] SANDSTONE: pale grey and orange-brown, coarse grained, thinly bedded; with siltstone laminations; slightly fractured to unbroken. Hawkesbury Sandstone								11.27-11.32m: JT, 80°, UN, CN, RF				12	PLT	PL(A)=2.0MPa		
	-11	13	11.71m-11.84m: siltstone bands					100	100		11.80m: B, 0°, PR, VNR Clay, RF 12.43m: B, 5°, IR, VNR Clay, RF 13.04m: B, 5°, IR, VNR Clay, RF				13	PLT	PL(A)=1.8MPa		
	-12	14					H								14	PLT	PL(A)=2.4MPa		
	-13	15	Borehole discontinued at 20.50m depth. Target depth reached.												15				
	-14	16			FR	15.95	H to VH	100	100						16	PLT	PL(A)=3.3MPa		
	-15	17				16.95					17.20m: B, 5°, PR, VNR Clay, RF				17	PLT	PL(A)=2.6MPa		
	-16	18													18	PLT	PL(A)=2.9MPa		
	-17	19	19.48m-19.50m: siltstone bands From 19.55m: 30% siltstone laminations				H	100	100		18.68m: B, 0°, PR, VNR Clay, RF 18.87m: B, 5°, CU, VNR Clay, RF 19.47m: B, 0°, PR, VNR Clay, RF				19	PLT	PL(A)=2.7MPa		
	-18	20									20.23m: B, 0°, PR, SN Fe, RF				20	PLT	PL(A)=2.0MPa		
	-19	21														PLT	PL(A)=2.0MPa		
	-20	22																	
	-21																		

NOTES: [#] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 305
METHOD: AD/T to 2.5m, WB to 5.9m, NMLC to 20.5m
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: HW to 2.5m, then HQ to 6m

Refer to explanatory notes for symbol and abbreviation definitions

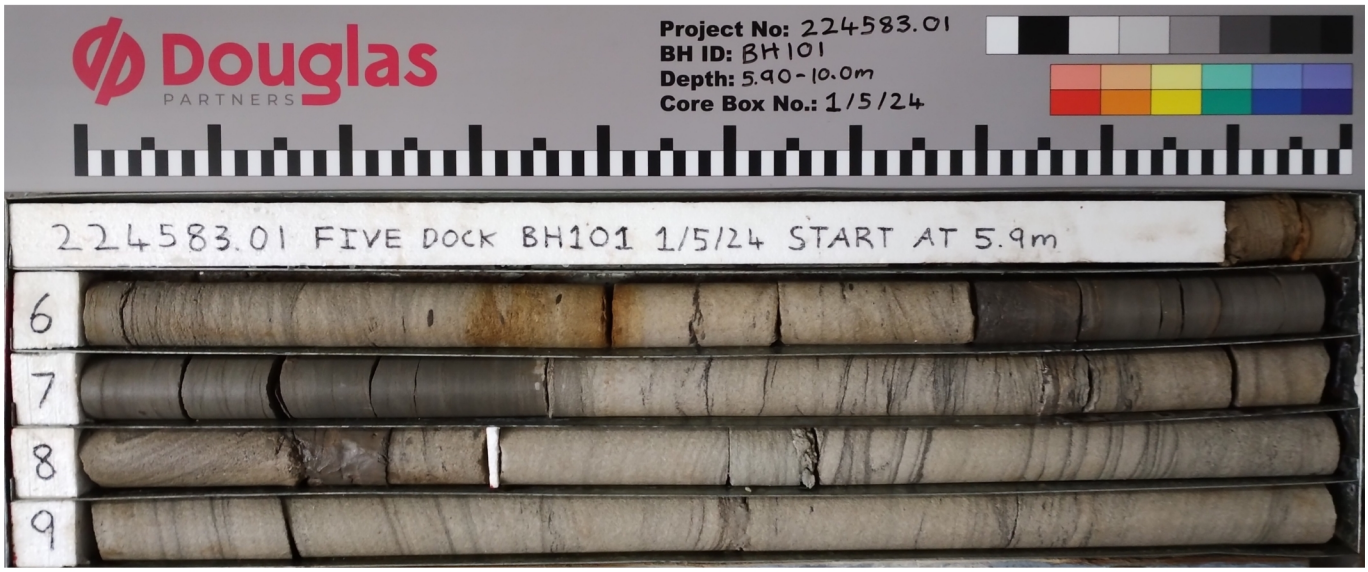
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CORE PHOTO LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325978.4, N:6250752.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH101
PROJECT No: 224583.01
DATE: 01/05/24 - 02/05/24
SHEET: 1 of 2



5.90-10.00 m depth



10.00-15.00 m depth

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CORE PHOTO LOG

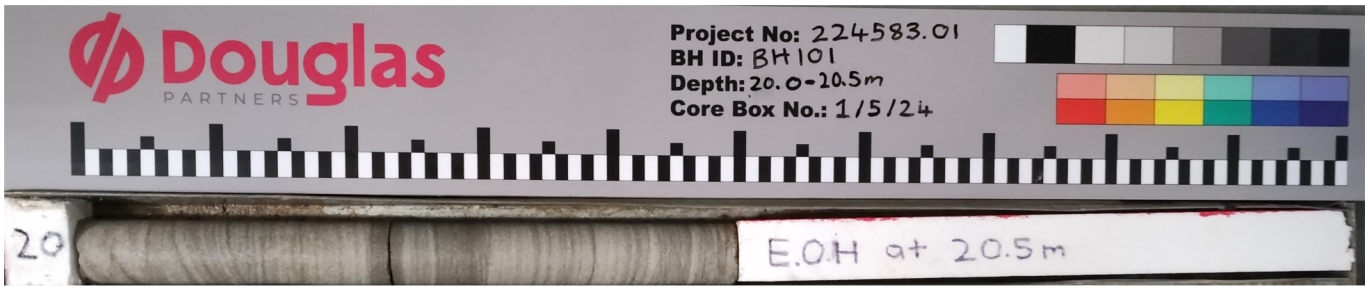
CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325978.4, N:6250752.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH101
PROJECT No: 224583.01
DATE: 01/05/24 - 02/05/24
SHEET: 2 of 2



15.00-20.00 m depth



20.00-20.50 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325955.7, N:6250733.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH102
PROJECT No: 224583.01
DATE: 29/04/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
	2	0.15	CONCRETE 150mm thick			ND	ND		A/ES		0.10 0.20		
seepage 29/04/24			FILL / Sandy CLAY: brown, orange and red; medium plasticity.		FILL	(S)	w>PL	PFAS	A/ES		0.50 0.60		
	1	1.10	Peaty CLAY (CI): grey and dark grey; medium plasticity.		ALV	S			A/ES		1.00 1.10	SPT	0,1,0 N=1
01/05/24		1.50	Silty SAND (SM): grey-brown; fine to medium.		ALV	L	W		ES		1.50 1.60		
	0	2.10	CLAY (CI-CH): orange, brown and red; medium to high plasticity. From 2.50m: pale grey; with ironstone bands		RS	St	w<PL		ES		3.00 3.10	SPT	3,5,6 N=11
	-1	3											
	-2	4									4	SPT	9,19,22 N=41
	-3	5				H			ES		4.50 4.60		
	-4	6									5	SPT	8,12,25 N=37
									ES		6.00 6.10		
			Borehole discontinued at 6.25m depth. Refusal on inferred medium strength sandstone.						ES		6.25		
	-5	7											
	-6	8											
	-7	9											
	-8	10											
	-9	11											

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

PLANT: Comacchio 305
METHOD: AD/T to 6.25m
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: HW to 2.5m, then HQ to 5.9m

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

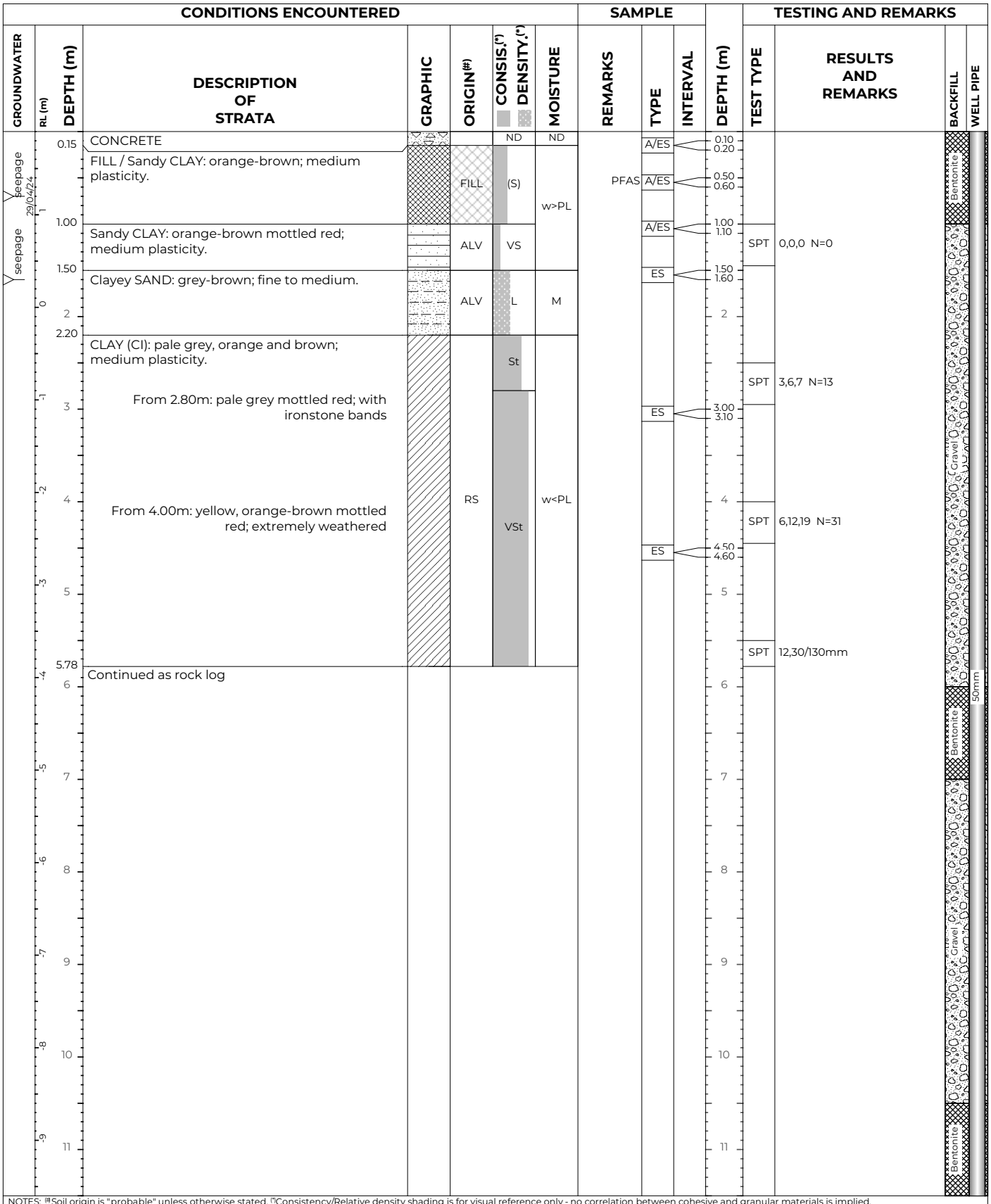
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BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325956.0, N:6250755.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH103
PROJECT No: 224583.01
DATE: 29/04/24 - 30/04/24
SHEET: 1 of 4



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

PLANT: Comacchio 305
METHOD: AD/T to 2.5m, WB to 5.9m, NMLC to 30.24M
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: HW to 4m, then HQ to 5.9m

Generated with CORE-GS by Geroc - Split Soil-Rock Log

Refer to explanatory notes for symbol and abbreviation definitions

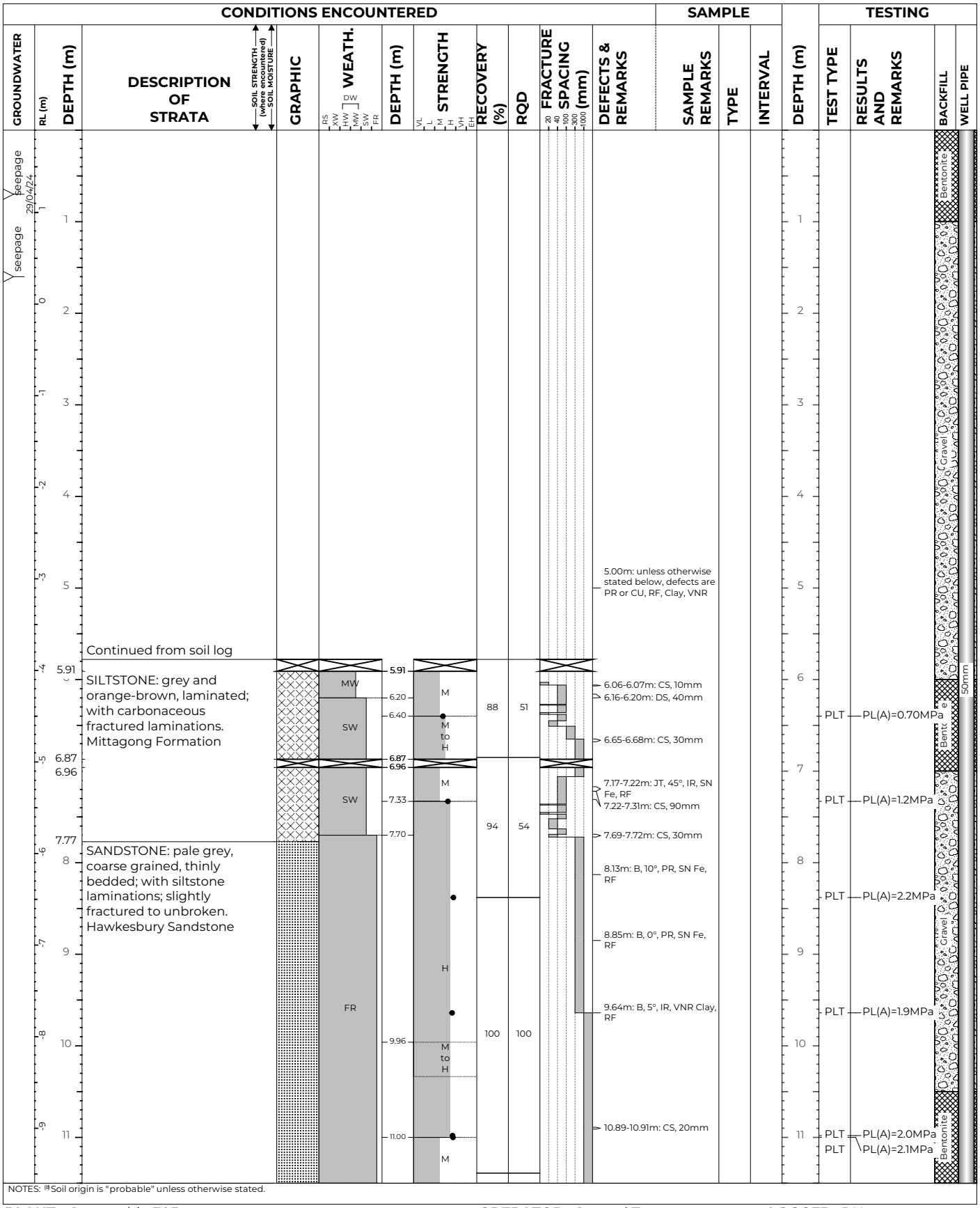
Douglas PARTNERS

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325956.0, N:6250755.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH103
PROJECT No: 224583.01
DATE: 29/04/24 - 30/04/24
SHEET: 2 of 4



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NOTES: [a] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 305
METHOD: AD/T to 2.5m, WB to 5.9m, NMLC to 30.24M
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: HW to 4m, then HQ to 5.9m

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325956.0, N:6250755.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH103
PROJECT No: 224583.01
DATE: 29/04/24 - 30/04/24
SHEET: 3 of 4

CONDITIONS ENCOUNTERED | **SAMPLE** | **TESTING**

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA (SOIL STRENGTH (where encountered) / SOIL MOISTURE)	GRAPHIC	WEATH. (PS, XW, DW [HW, MW, SW], FR)	DEPTH (m)	STRENGTH (VL, L, M, H, VH, EH)	RECOVERY (%)	RQD	FRACTURE SPACING (mm) (20, 60, 100, 300, 1000)	DEFECTS & REMARKS	SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
	-10 to -22	12 to 22	[CONT] SANDSTONE: pale grey, coarse grained, thinly bedded; with siltstone laminations; slightly fractured to unbroken. Hawkesbury Sandstone 11.40m-12.00m: dark grey siltstone bed 12.55m-13.00m: dark grey siltstone bed		FR	13.07 18.00	M H to VH H	100 100 100 100	91 99 100 98		11.98m: B, 0°, PR, VNR Clay, RF 12.04m: B, 10°, IR, SN Fe, RF 12.22m: B, 5°, IR, SN Fe, RF 12.56-12.60m: DS, 40mm 12.64m: B, 0°, IR, VNR Clay, RF 12.73-12.78m: B x5, 0°, PR CBS, RF 13.10-13.82m: B x5, 5-10°, CU, SN Fe, RF 14.38m: JT, 80°, IR, CN, RF 15.15m: B, 10°, PR, SN Fe, RF 16.04-16.05m: B x2, 0°, PR, VNR Clay, RF 17.21m: B, 0°, PR, CN, RF 19.64m: B, 5°, PR, VNR Clay, RF 20.15m: B, 15°, PR, VNR Clay, RF 20.63-20.68m: B x2, 5°, IR, CBS, RF 21.70-21.86m: B x2, 5°, IR, VNR Clay, RF 22.80m: B, 15°, PR, SN Fe, RF				12 to 22	PLT	PL(A)=0.80MPa PL(A)=0.70MPa PL(A)=2.5MPa PL(A)=1.6MPa PL(A)=3.1MPa PL(A)=2.2MPa PL(A)=3.3MPa PL(A)=2.7MPa PL(A)=1.7MPa PL(A)=2.7MPa PL(A)=2.1MPa	Gravel	50mm

NOTES: [a] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 305
METHOD: AD/T to 2.5m, WB to 5.9m, NMLC to 30.24M
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: HW to 4m, then HQ to 5.9m

Generated with CORE-GS by Geroc - Split Soil-Rock Log

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325956.0, N:6250755.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH103
PROJECT No: 224583.01
DATE: 29/04/24 - 30/04/24
SHEET: 4 of 4

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (mm)	DEFECTS & REMARKS	SAMPLE REMARKS	SAMPLE TYPE	SAMPLE INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
	-22	24	[CONT] SANDSTONE: pale grey, coarse grained, thinly bedded; with siltstone laminations; slightly fractured to unbroken. Hawkesbury Sandstone					100	98						24	PLT	PL(A)=1.7MPa		
	-23	25						100	100		24.78m: B, 0°, PR, SN Fe, RF				25	PLT	PL(A)=2.1MPa		
	-24	26			FR		H								26	PLT	PL(A)=2.4MPa		
	-25	27													27	PLT	PL(A)=1.6MPa	Gravel	
	-26	28						100	100		27.50m: B, 10°, IR, VNR Clay, RF				28	PLT	PL(A)=1.2MPa		
	-27	29	28.61m-28.67m: dark grey siltstone bed 28.81m-28.98m: dark grey siltstone bed												29	PLT	PL(A)=2.4MPa		
	-28	30						100	100						30	PLT	PL(A)=2.4MPa		
	-29	31	Borehole discontinued at 30.24m depth. Target depth reached.																
	-30	32																	
	-31	33																	
	-32	34																	

NOTES: [a] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 305
METHOD: AD/T to 2.5m, WB to 5.9m, NMLC to 30.24M
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: HW to 4m, then HQ to 5.9m

Refer to explanatory notes for symbol and abbreviation definitions

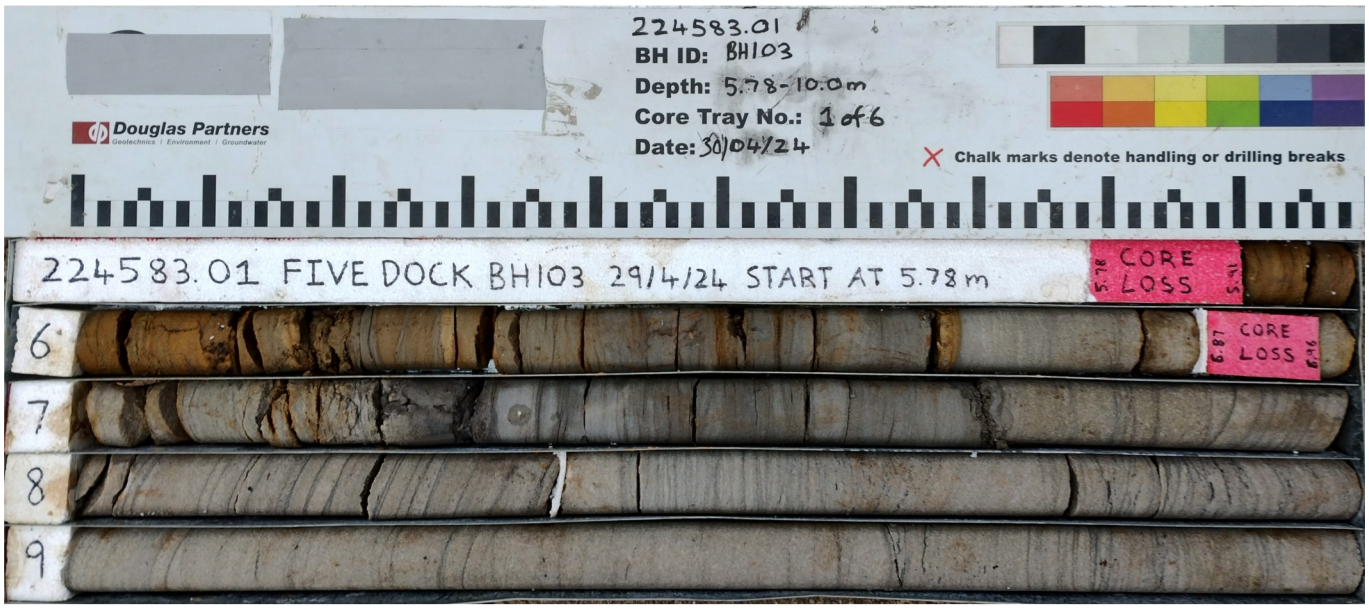
Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325956.0, N:6250755.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH103
PROJECT No: 224583.01
DATE: 29/04/24 - 30/04/24
SHEET: 1 of 3



5.78-10.00 m depth



10.00-15.00 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325956.0, N:6250755.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH103
PROJECT No: 224583.01
DATE: 29/04/24 - 30/04/24
SHEET: 2 of 3



15.00-20.00 m depth



20.00-25.00 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

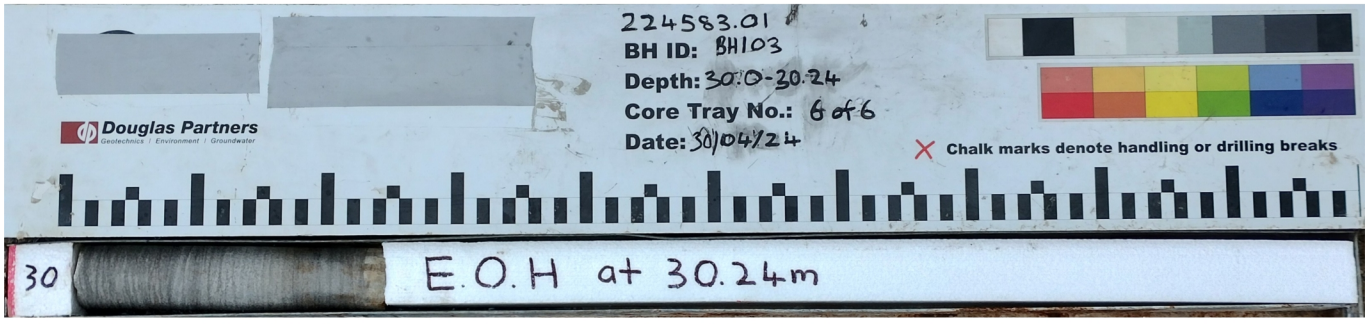
CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325956.0, N:6250755.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH103
PROJECT No: 224583.01
DATE: 29/04/24 - 30/04/24
SHEET: 3 of 3



25.00-30.00 m depth



30.00-30.24 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.0 AHD
COORDINATE: E:325968.2, N:6250732.6
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH104
PROJECT No: 224583.01
DATE: 29/04/24
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*)	DENSITY.(*)	MOISTURE	REMARKS	SAMPLE TYPE	SAMPLE INTERVAL	DEPTH (m)	TESTING AND REMARKS: TEST TYPE	TESTING AND REMARKS: RESULTS AND REMARKS
		0.15	CONCRETE.			ND		ND						
Seepage 29/04/24	1	1.10	FILL / Sandy CLAY: orange, grey-brown; low to medium plasticity; fine to coarse sand.		FILL	MC		w<PL		A/ES	0.20–0.30	0.20	DCP9/150	5 10 15 23
										A/ES	0.50–0.60	0.50		
										A/ES	0.90–1.00	0.90		
Seepage 29/04/24		1.60	Silty CLAY (OH): orange, grey-brown; medium to high plasticity.		ALV	F		w>PL		A/ES	1.50–1.60	1.50		
	0	2	Silty SAND (SC): grey brown; fine to medium.		ALV	L		M				2		
		2.20	CLAY (CI-CH): orange, red, brown; medium to high plasticity.							A/ES	2.90–3.00	2.90		
	-1	3										3		
	-2	4										4		
			From 4.50m: orange yellow brown		RS	St to VSt		w>PL		A/ES	4.40–4.50	4.40		
	-3	5										5		
	-4	6								A/ES	5.90–6.00	5.90		
	-5	7	From 6.80m: extremely weathered sandstone									6		
										A/ES	7.00–7.10	7.00		
	-6	8	Borehole discontinued at 7.10m depth. TC bit refusal on inferred medium strength sandstone.									7.10		
	-7	9												
	-8	10												
	-9	11												

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

PLANT: Comacchio 205
METHOD: Diatube to 0.15m, AD/T to 7.1m
REMARKS:

OPERATOR: Ground Test (Jack)

LOGGED: JAL
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

Generated with CORE-GS by Geroc - Soil Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.0 AHD
COORDINATE: E:325961.7, N:6250700.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH105
PROJECT No: 224583.01
DATE: 14/05/24
SHEET: 1 of 3

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
		0.15	CONCRETE			ND	ND		A/ES	0.20 0.30					
Seepage 14/05/24	1	1.00	FILL / Sandy CLAY: grey, orange-brown; medium plasticity. From 0.60m: saturated		FILL	PC			A/ES	0.50 0.60					
									* A/ES	0.90 1.00					
	0	2	Sandy CLAY (CI): grey, orange-brown; medium plasticity.		ALV	F	w>LL		A/ES	1.50 1.60	2	DCP9/150	5 10 15		
		2.10	CLAY (CI-CH): grey mottled, orange-red; medium to high plasticity.												
	-1	3						PFAS	A/ES	2.90 3.00					
	-2	4			RS	VSt to St	w<PL				4			Backfill	
									A/ES	4.40 4.50					50mm
	-3	5	From 5.50m: extremely weathered sandstone						A/ES	5.50 5.60					
		5.75	Continued as rock log												
	-4	6									6				
	-5	7									7				
	-6	8									8				
MW3 31/05/24	-7	9									9				
	-8	10									10			Bentonite	
	-9	11									11				

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

PLANT: Comacchio 205
OPERATOR: Ground Test (Jack)
LOGGED: JAL

METHOD: Diatube to 0.15m, AD/T to 2.5m, WB to 5.75m, NMLC to 19.17m
CASING: HW to 2.5m, then HQ to 5.8m

REMARKS: *Field replicate BD1/20240514 taken from 0.9-1.0m.
Per- and polyfluoroalkyl substances

Refer to explanatory notes for symbol and abbreviation definitions

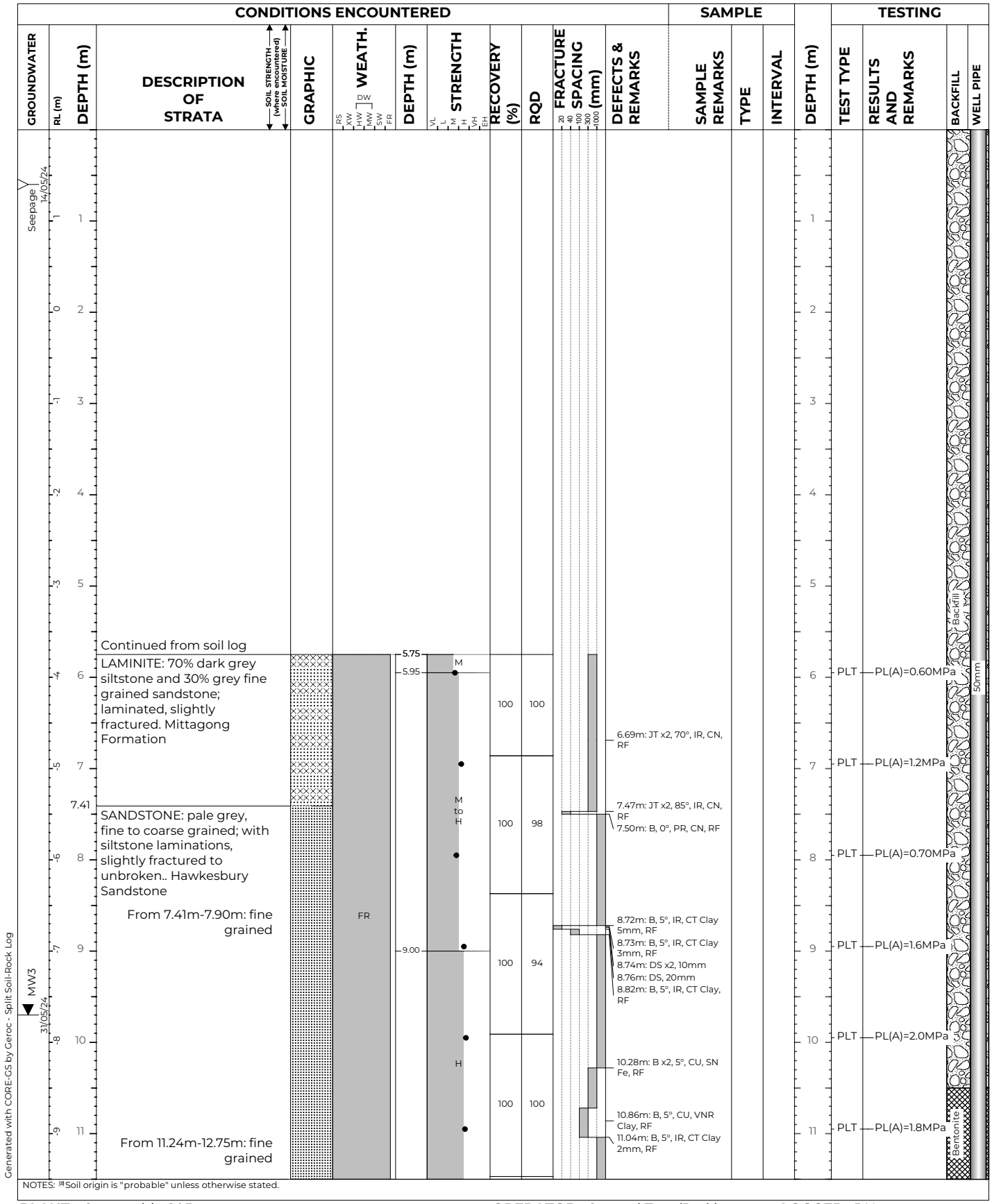
Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.0 AHD
COORDINATE: E:325961.7, N:6250700.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH105
PROJECT No: 224583.01
DATE: 14/05/24
SHEET: 2 of 3



NOTES: [#] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 205
OPERATOR: Ground Test (Jack)
LOGGED: JAL

METHOD: Diatube to 0.15m, AD/T to 2.5m, WB to 5.75m, NMLC to 19.17m
CASING: HW to 2.5m, then HQ to 5.8m

REMARKS: *Field replicate BD1/20240514 taken from 0.9-1.0m.
Per- and polyfluoroalkyl substances

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.0 AHD
COORDINATE: E:325961.7, N:6250700.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH105
PROJECT No: 224583.01
DATE: 14/05/24
SHEET: 3 of 3

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (mm)	DEFECTS & REMARKS	SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
	-10	12	[CONT] SANDSTONE: pale grey, fine to coarse grained; with siltstone laminations, slightly fractured to unbroken.. Hawkesbury Sandstone		FR		H	100	100		12.73m: B, 0°, PR, SN Fe, RF				12	PLT	PL(A)=1.9MPa		
	-11	13	From 12.27m-12.74m: siltstone band					100	98		13.39m: DS, 10mm 13.41m: B, 0°, PR, VNR Clay, RF 13.43m: B, 0°, PR, VNR Clay, RF				13	PLT	PL(A)=1.2MPa		
	-12	14													14	PLT	PL(A)=2.4MPa		
	-13	15						100	100						15	PLT	PL(A)=2.3MPa	Gravel	50mm
	-14	16													16	PLT	PL(A)=2.2MPa		
	-15	17						100	100						17	PLT	PL(A)=2.4MPa		
	-16	18						100	100		18.17m: B, 10°, CU, VNR Clay, RF 18.43m: B, 0°, IR, VNR Clay, RF				18	PLT	PL(A)=1.9MPa		
	-17	19						100	100		19.06m: B, 0°, IR, CT Clay 3mm, RF				19	PLT	PL(A)=2.0MPa		
	-18	20	Borehole discontinued at 19.17m depth.																
	-19	21																	
	-20	22																	

NOTES: [#] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 205
OPERATOR: Ground Test (Jack)
LOGGED: JAL
METHOD: Diatube to 0.15m, AD/T to 2.5m, WB to 5.75m, NMLC to 19.17m
CASING: HW to 2.5m, then HQ to 5.8m
REMARKS: *Field replicate BD1/20240514 taken from 0.9-1.0m.
Per- and polyfluoroalkyl substances

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.0 AHD
COORDINATE: E:325961.7, N:6250700.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH105
PROJECT No: 224583.01
DATE: 14/05/24
SHEET: 1 of 2



5.75-10.00 m depth



10.00-15.00 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.0 AHD
COORDINATE: E:325961.7, N:6250700.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH105
PROJECT No: 224583.01
DATE: 14/05/24
SHEET: 2 of 2



15.00-19.17 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325980.6, N:6250705.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH106
PROJECT No: 224583.01
DATE: 16/05/24
SHEET: 1 of 3

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
	2	0.15	CONCRETE				NA		A/ES		0.20		
			FILL / Sandy CLAY: orange-brown, mottled red; medium to high plasticity; trace gravel and bluestone.		FILL	MC	w<PL		A/ES		0.30 0.50		
		0.90									0.60		
	1		Silty CLAY (CI-CH): orange-brown, mottled red; medium to high plasticity.		ALV	St	w>PL		* A/ES		0.90		
		1.20							A/ES		1.00		
Seepage 16/05/24			Silty SAND (SC): orange-brown, mottled red; fine to medium.		ALV	L	W		A/ES		1.50	DCP9/150	5 10 15
		1.90									1.60		
	0		CLAY (CI-CH): pale grey mottled orange-red; medium to high plasticity.						A/ES		2		
	-1	3							A/ES		2.90 3.00		
			3.60m-5.00m: clay with ironstone						A/ES				
	-2	4			RS	St to VSt	w<PL				4		
									A/ES		4.40 4.50		
	-3	5									5		
	-4	6	From 6.00m: extremely weathered sandstone								6		
		6.30	Continued as rock log										
	-5	7									7		
	-6	8									8		
	-7	9									9		
	-8	10									10		
	-9	11									11		

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

PLANT: Comacchio 205
OPERATOR: Ground Test (Jack)
LOGGED: JAL
METHOD: Diatube to 0.15m, AD/T to 2.5m, WB to 6.3m, NMLC to 19.0m
CASING: HW to 2.5m, then HQ to 6.3m
REMARKS: *Field replicate BD2/20240516 taken at 0.9-1.0m

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

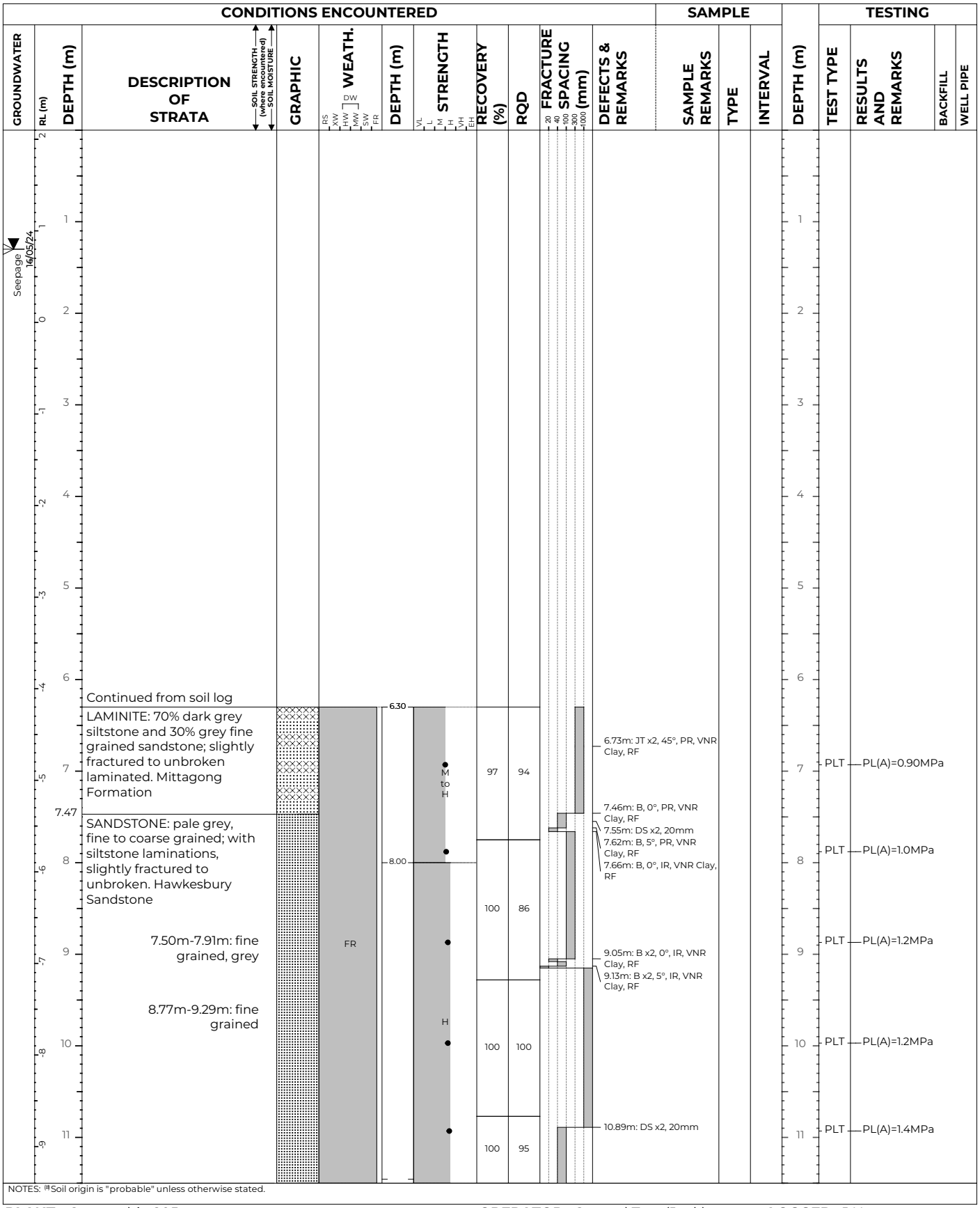
Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325980.6, N:6250705.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH106
PROJECT No: 224583.01
DATE: 16/05/24
SHEET: 2 of 3



NOTES: [a] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 205
OPERATOR: Ground Test (Jack)
LOGGED: JAL
METHOD: Diatube to 0.15m, AD/T to 2.5m, WB to 6.3m, NMLC to 19.0m
CASING: HW to 2.5m, then HQ to 6.3m
REMARKS: *Field replicate BD2/20240516 taken at 0.9-1.0m

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325980.6, N:6250705.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH106
PROJECT No: 224583.01
DATE: 16/05/24
SHEET: 3 of 3

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (mm)	DEFECTS & REMARKS	SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
	-10	12	[CONT] SANDSTONE: pale grey, fine to coarse grained; with siltstone laminations, slightly fractured to unbroken. Hawkesbury Sandstone		FR	11.50	M	100	95		11.97m: B, 0°, PR, SN Fe, RF				12	PLT	PL(A)=0.80MPa
	-11	13				12.50	H	100	100		13.37m: B, 5°, CU, VNR Clay, RF 13.65m: B, 10°, CU, VNR Clay, RF				13	PLT	PL(A)=1.1MPa
	-12	14						100	100		14.50m: B, 10°, CU, SN Fe, RF				14	PLT	PL(A)=1.7MPa
	-13	15				14.50	M								15	PLT	PL(A)=0.50MPa
	-14	16				15.50		93	100		15.67m: B, 5°, PR, CT Clay 2mm, RF 15.79m: B, 0°, IR, VNR Clay, RF				16	PLT	PL(A)=2.0MPa
	-15	17					H	100	100						17	PLT	PL(A)=1.7MPa
	-16	18						100	100		18.16m: B, 10°, CU, VNR Clay, RF				18	PLT	PL(A)=1.6MPa
	-17	19	Borehole discontinued at 19.00m depth.								18.95m: B, 0°, PR, VNR Clay, RF					PLT	PL(A)=1.2MPa
	-18	20															
	-19	21															
	-20	22															

NOTES: [a] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 205
METHOD: Diatube to 0.15m, AD/T to 2.5m, WB to 6.3m, NMLC to 19.0m
REMARKS: *Field replicate BD2/20240516 taken at 0.9-1.0m

OPERATOR: Ground Test (Jack)

LOGGED: JAL
CASING: HW to 2.5m, then HQ to 6.3m

Refer to explanatory notes for symbol and abbreviation definitions

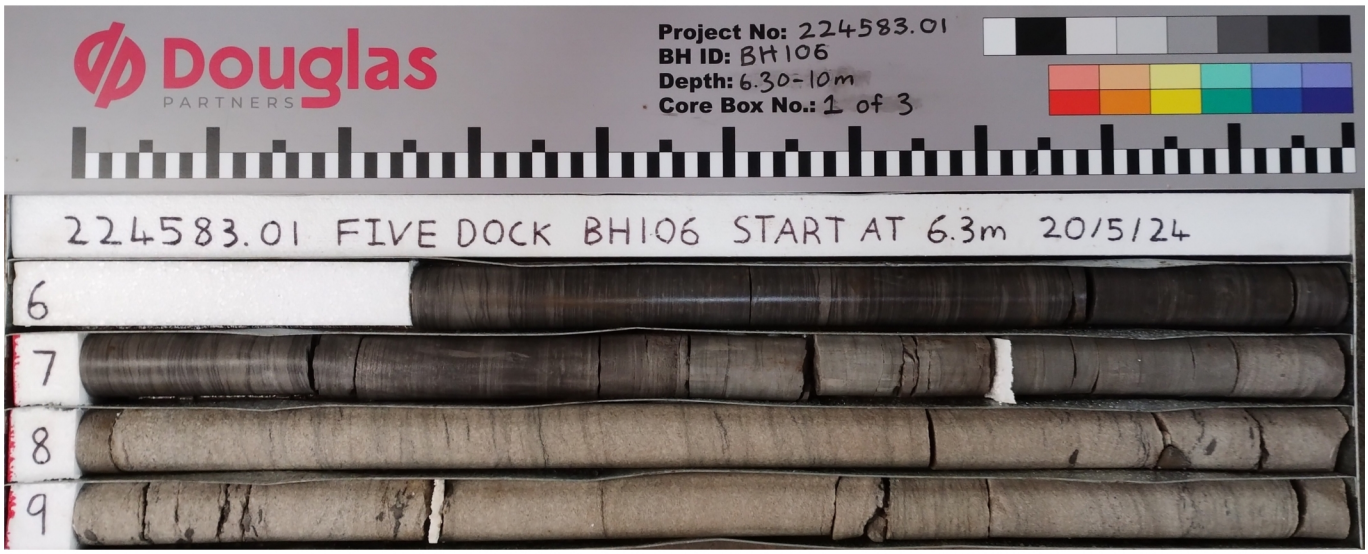
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CORE PHOTO LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325980.6, N:6250705.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH106
PROJECT No: 224583.01
DATE: 16/05/24
SHEET: 1 of 2



6.30-10.00 m depth



10.00-15.00 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325980.6, N:6250705.0
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH106
PROJECT No: 224583.01
DATE: 16/05/24
SHEET: 2 of 2



15.00-19.00 m depth

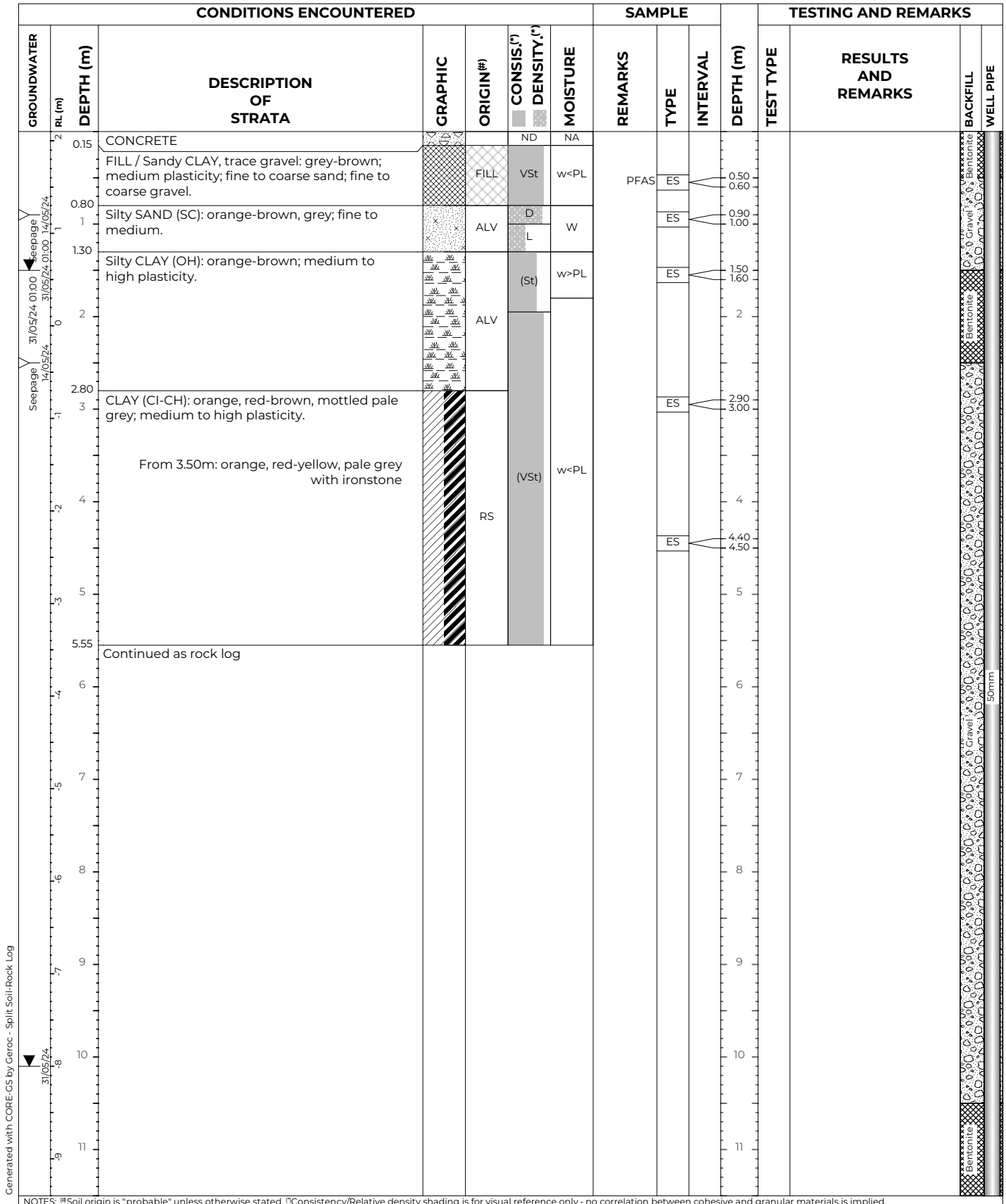
Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325989.6, N:6250729.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH107
PROJECT No: 224583.01
DATE: 22/05/24 - 23/05/24
SHEET: 1 of 3



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

PLANT: Comacchio 205
METHOD: HA to 4.5m, WB to 5.5m, NMLC to 19.1
REMARKS:

OPERATOR: Ground Test (George)

LOGGED: JAL/JJ
CASING: HW to 2.5m, then HQ to 5.5m

Refer to explanatory notes for symbol and abbreviation definitions

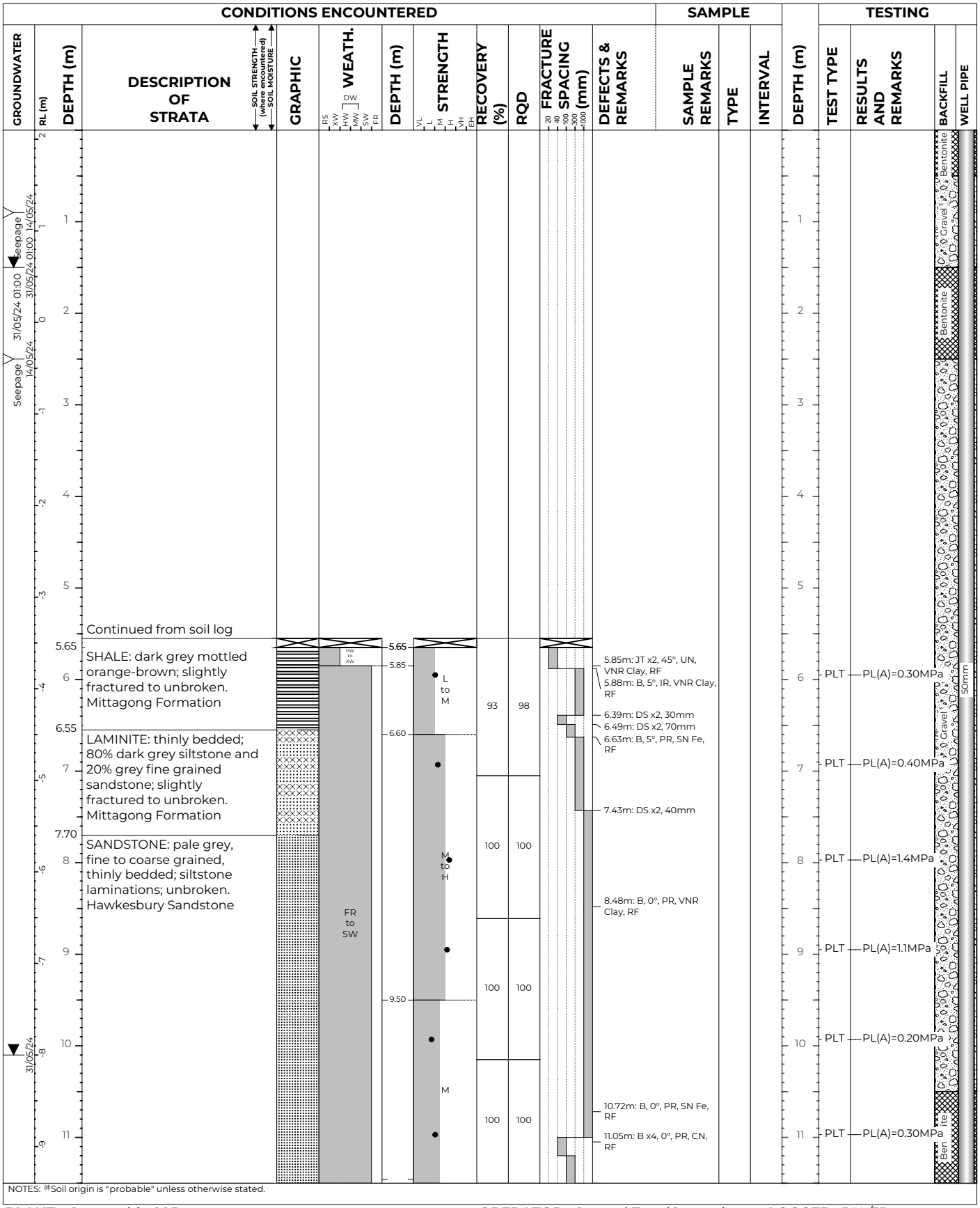
Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325989.6, N:6250729.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH107
PROJECT No: 224583.01
DATE: 22/05/24 - 23/05/24
SHEET: 2 of 3



Generated with CORE-GS by Geroc - Split Soil-Rock Log

NOTES: [a] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 205
METHOD: HA to 4.5m, WB to 5.5m, NMLC to 19.1
REMARKS:

OPERATOR: Ground Test (George)

LOGGED: JAL/JJ
CASING: HW to 2.5m, then HQ to 5.5m

Douglas PARTNERS

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325989.6, N:6250729.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH107
PROJECT No: 224583.01
DATE: 22/05/24 - 23/05/24
SHEET: 3 of 3

CONDITIONS ENCOUNTERED | **SAMPLE** | **TESTING**

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA (SOIL STRENGTH (where encountered) / SOIL MOISTURE)	GRAPHIC	WEATH. (PS, XW, DW, HW, MW, SW, FR)	DEPTH (m)	STRENGTH (VL, L, M, H, VH, EH)	RECOVERY (%)	RQD	FRACTURE SPACING (mm) (20, 40, 100, 300, 1000)	DEFECTS & REMARKS	SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
	-10	12	[CONT] SANDSTONE: pale grey, fine to coarse grained, thinly bedded; siltstone laminations; 12.05m: siltstone Hawkesbury Sandstone band 12.50m-13.00m: siltstone inclusions		FR to SW	11.50		100	100		11.50m: DB 11.63m: DB 11.94m: B, 5°, PR, CN 12.15m: DB 12.51m: B, 0°, UN, CN, RF 12.62m: B x2, 5°, UN, CN, RF 12.92m: B, 15°, PR, CN, RF 12.95m: B, 15°, PR, INF, RF, sand infill 13.00m: B, 15°, PR, CN, RF 13.60m: B, 5°, UN, CN, RF 13.80m: B, 10°, UN, CN, RF 14.24m: B, 5°, UN, CN, RF 14.65m: DB 14.70m: HB 14.74m: HB 14.84m: HB 15.25m: HB 16.20m: DB 17.00m: HB 17.70m: HB 17.80m: DB 18.00m: HB 19.00m: HB 19.10m: DB				12	PLT	PL(A)=1.4MPa	Gravel	
	-11	13.00	SANDSTONE: grey, fine to coarse grained, thinly laminated to thinly bedded; with dark grey laminations, unbronken. Hawkesbury Sandstone 14.60m-19.10m: unbroken			13.00		96	87							13	PLT	PL(A)=1.1MPa		
	-12	14					H	100	100							14	PLT	PL(A)=0.90MPa		
	-13	15						100	100							15	PLT	PL(A)=1.6MPa	50mm	
	-14	16			FR											16	PLT	PL(A)=1.4MPa		
	-15	17						100	100							17	PLT	PL(A)=1.4MPa		
	-16	18				17.50	M to H	100	100							18	PLT	PL(A)=0.40MPa		
	-17	19				18.50	H									19	PLT	PL(A)=1.0MPa		
	-18	20	Borehole discontinued at 19.10m depth. Target depth reached.																	
	-19	21																		
	-20	22																		

NOTES: [H] Soil origin is "probable" unless otherwise stated.

PLANT: Comacchio 205
METHOD: HA to 4.5m, WB to 5.5m, NMLC to 19.1
REMARKS:

OPERATOR: Ground Test (George)

LOGGED: JAL/JJ
CASING: HW to 2.5m, then HQ to 5.5m

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Split Soil-Rock Log

CORE PHOTO LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325989.6, N:6250729.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH107
PROJECT No: 224583.01
DATE: 22/05/24 - 23/05/24
SHEET: 1 of 2



5.55-10.00 m depth



10.00-14.00 m depth

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CORE PHOTO LOG

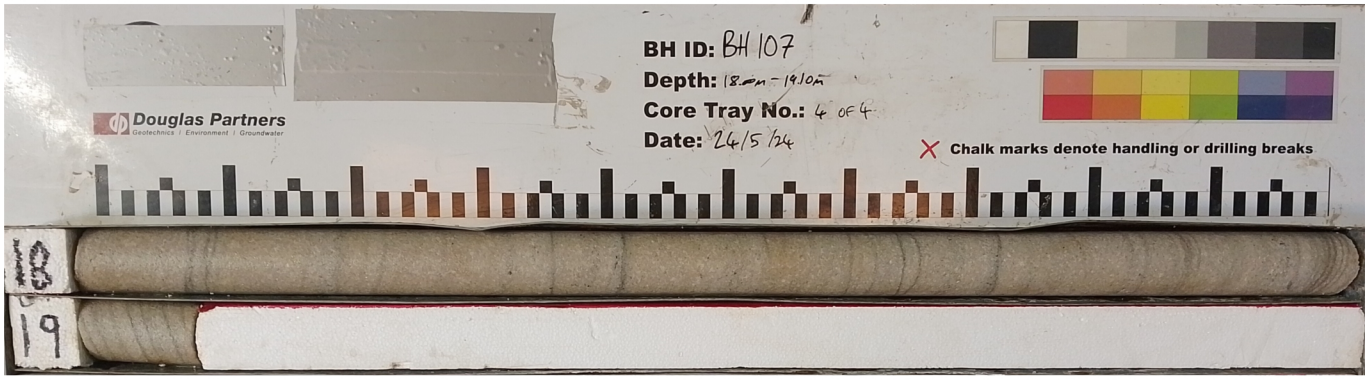
CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325989.6, N:6250729.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH107
PROJECT No: 224583.01
DATE: 22/05/24 - 23/05/24
SHEET: 2 of 2



14.00-18.00 m depth



18.00-19.10 m depth

Generated with CORE-GS by Geroc - Split Soil-Rock Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.0 AHD
COORDINATE: E:325963.7, N:6250709.8
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH109
PROJECT No: 224583.01
DATE: 24/04/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] / DENSITY.[*]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
	0.10	CONCRETE								0.10		
		FILL / Crushed SANDSTONE, with clay, with gravel: orange-brown; brown clay; angular to sub-angular, igneous gravel.		FILL	ND	M		A/ES		0.20		
24/04/24						W						
	1.00									1.00		
	1.10	FILL / Sandy CLAY: grey, orange-brown mottled red; medium plasticity; fine to medium sand.		FILL				A/ES		1.10		
		Sandy CLAY (CI): grey, orange-brown mottled red; medium plasticity.		ALV		w>LL						
							PFAS	A/ES		1.50		
										1.60		
		Borehole discontinued at 1.60m depth. Target depth reached.										

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

PLANT: Hand Tools
METHOD: HA to 1.6m
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.0 AHD
COORDINATE: E:325972.0, N:6250693.7
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH110
PROJECT No: 224583.01
DATE: 24/04/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
saturated from 0.5m 01/05/24	0.10	CONCRETE				ND						
		FILL / Sandy CLAY: grey, orange and brown; medium to high plasticity; suspected perched water in fill.		FILL	ND	w>LL		A/ES		0.10 – 0.20		
		0.40m-0.50m: layer of gravel (ash)						A/ES		0.40 – 0.50		
	1							A/ES		0.90 – 1.00		
	1.10	Sandy CLAY (CI): grey, orange-brown mottled red; medium plasticity.		ALV								
							PFAS	A/ES		1.40 – 1.50		
		Borehole discontinued at 1.50m depth. Target depth reached.										

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

PLANT: Hand Tools
METHOD: HA to 1.5m
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.8 AHD
COORDINATE: E:325968.0, N:6250749.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH111
PROJECT No: 224583.01
DATE: 24/04/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
	0.15	CONCRETE						A/ES		0.10 – 0.20		
		FILL / Sandy CLAY: pale grey and orange-yellow; medium plasticity; fine to medium sand.		FILL	ND	ND		A/ES		0.50 – 0.60		
	0.80	Peaty CLAY (CI): dark grey and pale grey; medium plasticity.		ALV		w>PL						
seepage 29/04/24	1.00	Clayey SAND: red, orange and brown; fine to medium.		ALV	(L)	M		A/ES		1.00 – 1.10		
	1.20	CLAY (CI): brown-grey; medium plasticity.		RS		w>PL						
	1.50	CLAY (CI-CH): pale grey and brown; medium to high plasticity.		RS	ND	w<PL		A/ES		1.50 – 1.60		
								A/ES		2.00 – 2.10		
							PFAS	A/ES		2.50 – 2.60		
	3	Borehole discontinued at 3.00m depth. Target depth reached.						A/ES		2.90 – 3.00		

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

PLANT: Comacchio 305
METHOD: AD/T to 3.0m
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

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BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.0 AHD
COORDINATE: E:325946.6, N:6250744.8
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH112
PROJECT No: 224583.01
DATE: 24/04/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
01/05/24 No free groundwater observed whilst augering	0.10	CONCRETE										
		FILL / SAND, with clay, with gravel; fine to medium; brown clay; (ash) gravel.		FILL	ND	M to W	PFAS	A		0.10		
								A		0.20	PID	<1ppm
								A		0.30	PID	<1ppm
								A		0.40	PID	<1ppm
	0.90	FILL / Sandy CLAY: grey; fine to medium sand; (possibly reworked natural).		FILL								
	1							A		1.00		
										1.10	PID	<1ppm
		Borehole discontinued at 1.50m depth. Target depth reached.										

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

PLANT: Hand Tools
METHOD: HA to 1.5m
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 1.9 AHD
COORDINATE: E:325956.0, N:6250755.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH103S
PROJECT No: 224583.01
DATE: 29/04/24 - 30/04/24
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	BACKFILL	WELL PIPE
		0.15	CONCRETE			ND	ND								
Seepage 29/04/24	1	1.00	FILL / Sandy CLAY: orange-brown; medium plasticity.		FILL	(S)	w>PL				1			Bentonite	50mm
		1.50	Sandy CLAY (CI): orange-brown mottled red; medium plasticity; fine to medium sand.		ALV	VS									
	0	2	Clayey SAND (SC): grey-brown; fine to medium.		ALV	L	M				2				
		2.20	CLAY (CI): pale grey, orange and brown; medium plasticity.			St									
▼ 31/05/24 01:00	-1	3	From 2.80m: pale grey mottled red; with ironstone bands								3				
	-2	4	From 4.00m: yellow, orange-brown mottled red; extremely weathered		RS	VSt	w<PL				4			Gravel	50mm
	-3	5									5				
	-4	6	Borehole discontinued at 6.00m depth. Target depth reached.												
	-5	7													
	-6	8													
	-7	9													
	-8	10													
	-9	11													

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

PLANT: Comacchio 305
METHOD: AD/T to 2.5m, WB to 5.9m, NMLC to 30.24M
REMARKS:

OPERATOR: Ground Test

LOGGED: JAL
CASING: HW to 4m, then HQ to 5.9m

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

BOREHOLE LOG

CLIENT: DPG Project 37 Pty Ltd
PROJECT: Proposed Mixed Use Development
LOCATION: 79-81 Queens Road & 2-8 Spencer Street, Five Dock NSW

SURFACE LEVEL: 2.1 AHD
COORDINATE: E:325989.6, N:6250729.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH107S
PROJECT No: 224583.01
DATE: 22/05/24 - 23/05/24
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] DENSITY.[*]	MOISTURE	REMARKS	SAMPLE TYPE	SAMPLE INTERVAL	SAMPLE DEPTH (m)	TESTING TEST TYPE	TESTING RESULTS AND REMARKS	BACKFILL	WELL PIPE
	2	0.15	CONCRETE			ND	NA							Bentonite	50mm
			FILL / Sandy CLAY, trace gravel: grey-brown; medium plasticity; fine to coarse sand; fine to coarse gravel.		FILL	VSt	w<PL								
Seepage 14/05/24	1	0.80	Silty SAND (SC): orange-brown, grey; fine to medium.		ALV	D	W				1			Gravel	50mm
						L									
MW5 31/05/24 01:00		1.30	Peaty CLAY (OH): orange-brown; medium to high plasticity.		ALV	(St)	w>PL								
31/05/24 01:00 MW5 31/05/24	0		Borehole discontinued at 1.50m depth. Target depth reached.												
	-1														
	-2														

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

PLANT: Comacchio 205
METHOD: HA to 1.5 m
REMARKS:

OPERATOR: Ground Test (George)

LOGGED: JAL/JJ
CASING: HW to 2.5m

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

Douglas PARTNERS

Terminology, Symbols and Abbreviations

November 2023

Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- Soil Descriptions;
- Rock Descriptions; and
- Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

Abbreviation Codes

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style XW. Code usage conforms with the following guidelines:

- Textual codes are case insensitive, although herein they are generally presented in upper case; and
- Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example `PL` is used for plastic limit in the context of soil moisture condition, as well as in `PL(A)` for point load test result in the testing results column)).

Data Integrity Codes

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

Term	Description	Abbreviation Code
Core loss	No core recovery	KL
Unknown	Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned.	UK
No data	Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others	ND
Not Applicable	Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement	NA

Graphic Symbols

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.

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Soil Descriptions

Terminology
Symbols
Abbreviations

March 2024

Introduction

All materials which are not considered to be "in-situ rock" are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:



The "classification" comprises a two character "group symbol" providing a general summary of dominant soil characteristics. The "name" summarises the particle sizes within the soil which most influence its behaviour. The detailed description presents more information about composition, condition, structure, and origin of the soil.

Classification, naming and description of soils require the relative proportion of particles of different sizes within the whole soil mixture to be considered.

Particle size designation and Behaviour Model

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either "fine grained" (also known as "cohesive" behaviour) or "coarse grained" ("non cohesive" behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

Particle Size Designation	Particle Size (mm)	Behaviour Model	
		Behaviour	Approximate Dry Mass
Boulder	>200	Excluded from particle behaviour model as "oversize"	
Cobble	63 - 200		
Gravel[1]	2.36 - 63	Coarse	>65%
Sand[1]	0.075 - 2.36		
Silt	0.002 - 0.075	Fine	>35%
Clay	<0.002		

[1] – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer "component proportions" below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a "Sandy CLAY", this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

Component proportions

The relative proportion of the dry mass of each particle size fraction is assessed to be a "primary", "secondary", or "minor" component of the soil mixture, depending on its influence over the soil behaviour.

Component Proportion Designation	Definition[1]	Relative Proportion	
		In Fine Grained Soil	In Coarse Grained Soil
Primary	The component (particle size designation, refer above) which dominates the engineering behaviour of the soil	The clay/silt component with the greater proportion	The sand/gravel component with the greater proportion
Secondary	Any component which is not the primary, but is significant to the engineering properties of the soil	Any component with greater than 30% proportion	Any granular component with greater than 30%; or Any fine component with greater than 12%
Minor[2]	Present in the soil, but not significant to its engineering properties	All other components	All other components

[1] As defined in AS1726-2017 6.1.4.4

[2] In the detailed material description, minor components are split into two further sub-categories. Refer "identification of minor components" below.

Composite Materials

In certain situations, a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example, "INTERBEDDED Silty CLAY AND SAND".

Soil Descriptions

Classification

The soil classification comprises a two character group symbol. The first character identifies the primary component. The second character identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

Soil Name

For most soils, the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way, the soil name also describes the general composition and indicates the dominant behaviour of the material.

Component [1]	Prominence in Soil Name
Primary	Noun (eg "CLAY")
Secondary	Adjective modifier (eg "Sandy")
Minor	No influence

[1] – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

Materials of "fill" or "topsoil" origin are generally assigned a name derived from the primary/secondary component (where appropriate). In log descriptions this is preceded by uppercase "FILL" or "TOPSOIL". Origin uncertainty is indicated in the description by the characters (?), with the degree of uncertainty described (using the terms "probably" or "possibly" in the origin column, or at the end of the description).

Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

Minor Component Proportion Term	Relative Proportion	
	In Fine Grained Soil	In Coarse Grained Soil
With	All fractions: 15-30%	Clay/silt: 5-12% sand/gravel: 15-30%
Trace	All fractions: 0-15%	Clay/silt: 0-5% sand/gravel: 0-15%

The terms "with" and "trace" generally apply only to gravel or fine particle fractions. Where cobbles/boulders are encountered in minor proportions (generally less than about 12%) the term "occasional" may be used. This term describes the sporadic distribution of the material within the confines of the investigation excavation only, and there may be considerable variation in proportion over a wider area which is difficult to factually characterise due to the relative size of the particles and the investigation methods.

Soil Composition

Plasticity

Descriptive Term	Laboratory liquid limit range	
	Silt	Clay
Non-plastic materials	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

Type		Particle size (mm)
Gravel	Coarse	19 - 63
	Medium	6.7 - 19
	Fine	2.36 – 6.7
Sand	Coarse	0.6 - 2.36
	Medium	0.21 - 0.6
	Fine	0.075 - 0.21

Grading

Grading Term	Particle size (mm)
Well	A good representation of all particle sizes
Poorly	An excess or deficiency of particular sizes within the specified range
Uniformly	Essentially of one size
Gap	A deficiency of a particular size or size range within the total range

Note, AS1726-2017 provides terminology for additional attributes not listed here.

Soil Condition

Moisture

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

Applicability	Term	Tactile Assessment	Abbreviation code
Fine	Dry of plastic limit	Hard and friable or powdery	w<PL
	Near plastic limit	Can be moulded	w=PL
	Wet of plastic limit	Water residue remains on hands when handling	w>PL
	Near liquid limit	"oozes" when agitated	w=LL
	Wet of liquid limit	"oozes"	w>LL
Coarse	Dry	Non-cohesive and free running	D
	Moist	Feels cool, darkened in colour, particles may stick together	M
	Wet	Feels cool, darkened in colour, particles may stick together, free water forms when handling	W

The abbreviation code NDF, meaning "not-assessable due to drilling fluid use" may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

Consistency/Density/Compaction/Cementation/Extremely Weathered Material

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the "consistency" describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials, the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented "strength" is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered material origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description.

Quantitative engineering performance of these materials may be determined by laboratory testing or estimated by correlated field tests (for example penetration or shear vane testing). In some cases, performance may be assessed by tactile or other subjective methods, in which case investigation logs will show the estimated value enclosed in round brackets, for example (VS).

Consistency (fine grained soils)

Consistency Term	Tactile Assessment	Undrained Shear Strength (kPa)	Abbreviation Code
Very soft	Extrudes between fingers when squeezed	<12	VS
Soft	Mouldable with light finger pressure	>12 - ≤25	S
Firm	Mouldable with strong finger pressure	>25 - ≤50	F
Stiff	Cannot be moulded by fingers	>50 - ≤100	St
Very stiff	Indented by thumbnail	>100 - ≤200	VSt
Hard	Indented by thumbnail with difficulty	>200	H
Friable	Easily crumbled or broken into small pieces by hand	-	Fr

Relative Density (coarse grained soils)

Relative Density Term	Density Index	Abbreviation Code
Very loose	<15	VL
Loose	>15 - ≤35	L
Medium dense	>35 - ≤65	MD
Dense	>65 - ≤85	D
Very dense	>85	VD

Note, tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided.

Compaction (anthropogenically modified soil)

Compaction Term	Abbreviation Code
Well compacted	WC
Poorly compacted	PC
Moderately compacted	MC
Variably compacted	VC

Cementation (natural and anthropogenic)

Cementation Term	Abbreviation Code
Moderately cemented	MOD
Weakly cemented	WEK

Extremely Weathered Material

AS1726-2017 considers weathered material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. less than very low strength rock). These materials may be identified as "extremely weathered material" in reports and by the abbreviation code XWM on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

Soil Origin

Term	Description	Abbreviation Code
Residual	Derived from in-situ weathering of the underlying rock	RS
Extremely weathered material	Formed from in-situ weathering of geological formations. Has strength of less than 'very low' as per as1726 but retains the structure or fabric of the parent rock.	XWM
Alluvial	Deposited by streams and rivers	ALV
Fluvial	Deposited by channel fill and overbank (natural levee, crevasse splay or flood basin)	FLV
Estuarine	Deposited in coastal estuaries	EST
Marine	Deposited in a marine environment	MAR
Lacustrine	Deposited in freshwater lakes	LAC
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
Slopewash	Thin layers of soil and rock debris gradually and slowly deposited by gravity and possibly water	SW
Topsoil	Mantle of surface soil, often with high levels of organic material	TOP
Fill	Any material which has been moved by man	FILL
Littoral	Deposited on the lake or seashore	LIT
Unidentifiable	Not able to be identified	UID

Cobbles and Boulders

The presence of particles considered to be "oversize" may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with "MIXTURE OF".

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

[1] Rock strength classification is based on UCS. The UCS to $I_{s(50)}$ ratio varies significantly for different rock types and specific ratios may be required for each site. The point load Index ranges shown above are as suggested in AS1726 and should not be relied upon without supporting evidence.

The following abbreviation codes are used for soil layers or seams of material "within rock" but for which the equivalent UCS strength is less than 0.6 MPa.

Scenario	Abbreviation Code
The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The properties of the material encountered over this interval are described in the "Description of Strata" and soil properties columns.	SOIL
The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The prominence of the material is such that it can be considered to be a seam (as defined in Table 22 of AS1726-2017) and the properties of the material are described in the defect column.	SEAM

Degree of Weathering

The degree of weathering of rock is classified as follows:

Weathering Term	Description	Abbreviation Code
Residual Soil[1]	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.	RS
Extremely weathered[1]	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	XW
Highly weathered	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.	HW
Moderately weathered	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.	MW
Slightly weathered	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.	SW
Fresh	No signs of decomposition or staining.	FR
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	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.	DW

[1] The parent rock type, of which the residual/extremely weathered material is a derivative, will be stated in the description (where discernible).

Degree of Alteration

The degree of alteration of the rock material (physical or chemical changes caused by hot gasses or liquids at depth) is classified as follows:

Term	Description	Abbreviation Code
Extremely altered	Material is altered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.	XA
Highly altered	The whole of the rock material is discoloured, usually by staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is changed by alteration. Some primary minerals are altered to clay minerals. Porosity may be increased by leaching or may be decreased due to precipitation of secondary materials in pores.	HA
Moderately altered	The whole of the rock material is discoloured, usually by 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.	MA
Slightly altered	Rock is slightly discoloured but shows little or no change of strength from fresh rock	SA
Note: If HA and MA cannot be differentiated use DA (see below)		
Distinctly altered	Rock strength usually changed by alteration. The rock may be highly discoloured, usually by staining or bleaching. Porosity may be increased by leaching or may be decreased due to precipitation of secondary minerals in pores.	DA

Degree of Fracturing

The following descriptive classification apply to the spacing of natural occurring fractures in the rock mass. It includes bedding plane partings, joints and other defects, but excludes drilling breaks. These terms are generally not required on investigation logs where fracture spacing is presented as a histogram, and where used are presented in an unabbreviated format.

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:

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

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

These terms may be used to describe the spacing of bedding partings in sedimentary rocks. Where used, these terms are generally presented in an unabbreviated format

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

Defect Descriptions

Defect Type

Term	Abbreviation Code
Bedding plane	B
Cleavage	CL
Crushed seam	CS
Crushed zone	CZ
Drilling break	DB
Decomposed seam	DS
Drill lift	DL
Extremely Weathered seam	EW
Fault	F
Fracture	FC
Fragmented	FG
Handling break	HB
Infilled seam	IS
Joint	JT
Lamination	LAM
Shear seam	SS
Shear zone	SZ
Vein	VN
Mechanical break	MB
Parting	P
Sheared Surface	S

Rock Defect Orientation

Term	Abbreviation Code
Horizontal	H
Vertical	V
Sub-horizontal	SH
Sub-vertical	SV

Rock Defect Coating

Term	Abbreviation Code
Clean	CN
Coating	CT
Healed	HE
Infilled	INF
Stained	SN
Tight	TI
Veneer	VNR

Rock Defect Infill

Term	Abbreviation Code
Calcite	CA
Carbonaceous	CBS
Clay	CLAY
Iron oxide	FE
Manganese	MN
Pyrite	Py
Secondary material	MS
Silt	M
Quartz	Qz
Unidentified material	MU

Rock Defect Shape/Planarity

Term	Abbreviation Code
Curved	CU
Discontinuous	DIS
Irregular	IR
Planar	PR
Stepped	ST
Undulating	UN

Rock Defect Roughness

Term	Abbreviation Code
Polished	PO
Rough	RF
Smooth	SM
Slickensided	SL
Very rough	VR

Defect Orientation

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

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Cone Penetration Testing

November 2023

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

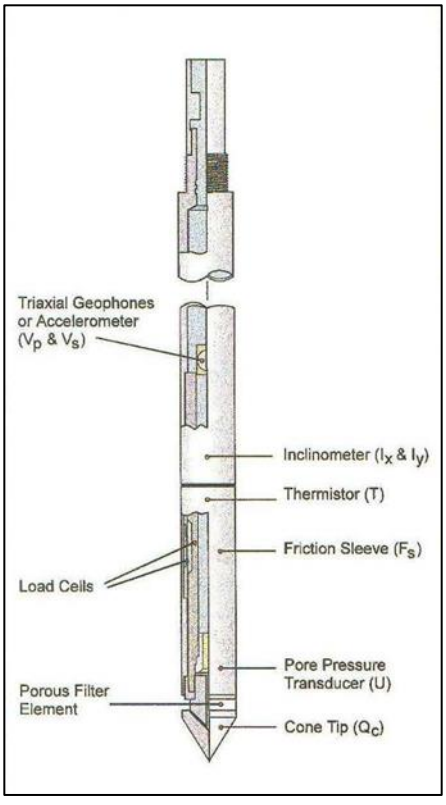


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.



Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (qc, fs, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (□) plus basic parameters
Seismic	Shear wave velocity (Vs), compression wave velocity (Vp), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration testing

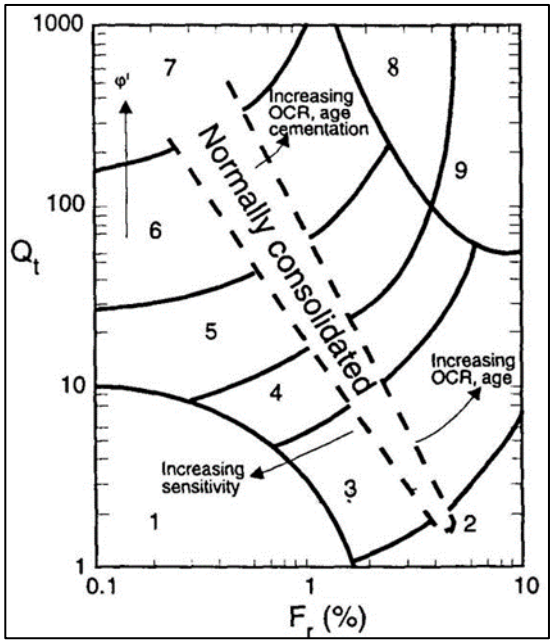


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation.

The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

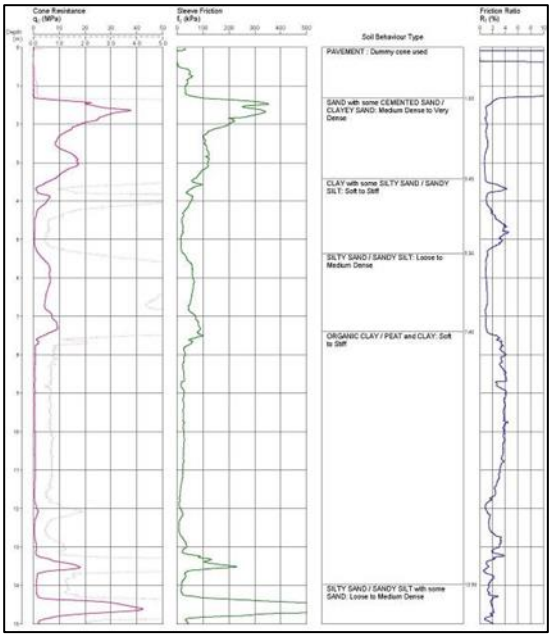
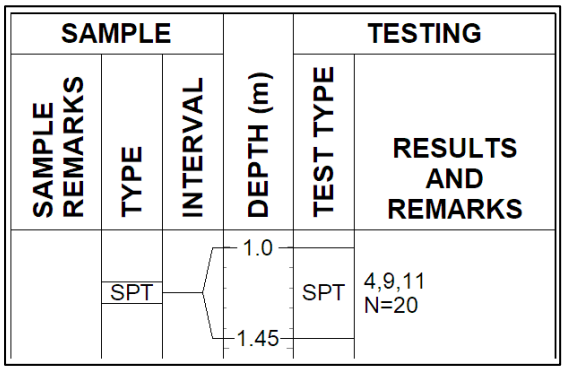


Figure 4: Sample Cone Plot

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Sampling and Testing

A record of samples retained, and field testing performed is usually shown on a Douglas Partners' log with samples appearing to the left of a depth scale, and selected field and laboratory testing (including results, where relevant) appearing to the right of the scale, as illustrated below:



Sampling

The type or intended purpose for which a sample was taken is indicated by the following abbreviation codes.

Sample Type	Code
Auger sample	A
Acid Sulfate sample	ASS
Bulk sample	B
Core sample	C
Disturbed sample	D
Environmental sample	ES
Driven Tube sample	DT
Gas sample	G
Piston sample	P
Sample from SPT test	SPT
Undisturbed tube sample	U[1]
Water sample	W
Material Sample	MT
Core sample for unconfined compressive strength testing	UCS

[1] – numeric suffixes indicate tube diameter/width in mm

The above codes only indicate that a sample was retained, and not that testing was scheduled or performed.

Field and Laboratory Testing

A record that field and laboratory testing was performed is indicated by the following abbreviation codes.

Test Type	Code
Pocket penetrometer (kPa)	PP
Photo ionisation detector (ppm)	PID
Standard Penetration Test x/y =*x* blows for *y* mm penetration HB = hammer bouncing HW = fell under weight of hammer	SPT
Shear vane (kPa)	V
Unconfined compressive strength, (MPa)	UCS
Point load test, (MPa), axial (A), diametric (D), irregular (I)	PLT(_)
Dynamic cone penetrometer, followed by blow count penetration increment in mm (cone tip, generally in accordance with AS1289.6.3.2)	DCP9/150
Perth sand penetrometer, followed by blow count penetration increment in mm (flat tip, generally in accordance with AS1289.6.3.3)	PSP/150
Dynamic probe super heavy, followed by blow count penetration increment in mm	DPSH/100

Groundwater Observations

	water seepage/inflow
	water seepage/outflow
	standing or observed water level
NFGWO	no free groundwater observed
OBS	observations obscured by drilling fluids

Drilling or Excavation Methods/Tools

The drilling/excavation methods used to perform the investigation may be shown either in a dedicated column down the left-hand edge of the log, or stated in the log footer. In some circumstances abbreviation codes may be used.

Method	Abbreviation Code
Direct Push	DP
Solid flight auger. Suffixes: /T = tungsten carbide tip, /V = v-shaped tip	AD[1]
Air Track	AT
Diatube	DT[1]
Hand auger	HA[1]
Hand tools (unspecified)	HAND
Existing exposure	X
Hollow flight auger	HSA[1]
HQ coring	HQ3
HMLC series coring	HMLC
NMLC series coring	NMLC
NQ coring	NQ3
PQ coring	PQ3
Predrilled	PD
Push tube	PT[1]
Ripping tyne/ripper	R
Rock roller	RR[1]
Rock breaker/hydraulic hammer	EH
Sonic drilling	SON[1]
Mud/blade bucket	MB[1]
Toothed bucket	TB[1]
Vibrocore	VC[1]
Vacuum excavation	VE
Wash bore (unspecified bit type)	WB[1]

[1] – numeric suffixes indicate tool diameter/width in mm

Appendix C

Acid Sulfate Soil Formation, Action Criteria and Treatment Verification

1. Introduction

This appendix provides background information on acid sulfate soil formation. Details the acid sulfate soil action criteria, acid sulfate soil treatment verification criteria, equations for net acidity and waste classification criteria are also included. The action criteria are based on Sullivan, et. al. (2018).

2. Formation of acid sulfate soils

The key features of landscapes where ASS occurs include:

- Coastal lowlands below 5 m AHD i.e. tidal flats, estuaries, mangroves, and salt marshes;
- Estuarine and marine sediments;
- Floodplains and wetlands i.e. depositional environments where waterlogging persists;
- Backswamps and lagoons i.e. areas of poor drainage where organic-rich sediments accumulate; and
- Certain man-made disturbed areas where land reclamation, dredging, or drainage exposes sulfide-rich sediments to oxygen, leading to acidification.

Reduced inorganic sulfur (RIS) forms readily in landscapes under waterlogged, anoxic conditions where there is a ready supply of organic matter, sulfate and iron. Under such conditions, the formation of RIS occurs via microbially-mediated processes. The occurrence of ASS is associated with areas or regions that have previously been or are currently estuarine environments. Due to changes in sea level or geomorphologic changes to coastal systems, these sediments are often overlain by terrestrial sediments.

When ASS are exposed to air (e.g. due to bulk excavation or dewatering), the oxygen reacts with RIS in the sediment, producing sulfuric acid. This acid can be produced in large quantities and is highly mobile in water. The acid can result in severe acidification of soil and groundwater and mobilise metals (for example arsenic, iron, aluminium, copper, cobalt, zinc), nutrients (for example phosphate) and rare earth elements. The sulfuric acid generated from the site has the potential to impact site soils, groundwater and structures, and can drain into waterways causing severe short and long term socio-economic and environmental impacts, including damage to man-made structures and natural ecosystems (for example fish kills).

The factor common to all ASS materials is that RIS components have either had, or may have, a major influence on the properties or behaviour of these soil materials.

3. Action criteria

The following section provides the action criteria used to assess whether the soil is classified as PASS/ASS.

3.1 Field screening

Field screening indicators do not form part of the action criteria but can be used to provide an indication of the ASS status and to assist in selecting samples for laboratory testing. Indicators of ASS from field screening include:

- Field pH is less than or equal to pH 4;
- pH_{fox} is less than 3;
- A decrease of 1 pH unit or more from the field pH to the pH_{fox};
- Bubbling, production of heat or release of sulphur odours during pH_{fox} testing; and
- Change in colour from grey to brown tones during oxidation.

3.2 Laboratory analysis

The following Table 1 provides the action criteria. As per Sullivan, et. al. (2018).

Table 1: Action criteria

Type of material		Net acidity #	
		1-1000 t materials disturbed	>1000 t materials disturbed
Texture range	**Approx. clay (%)**	**% S-equiv**	**% S-equiv**
Fine: light medium to heavy clay	>40	≥ 0.1	≥ 0.03
Medium: clayey sand to light clays	5-40	≥ 0.06	≥ 0.03
Coarse and Peats: sands to loamy sands	<5	≥ 0.03	≥ 0.03

Notes:
Net acidity can only include a soil material measured acid neutralising capacity (ANC) where this measure has been corroborated by other data

Equation 1 is used to calculate the net acidity when the effectiveness of a soil's measured acid neutralising capacity has not been corroborated by other data.

Net acidity = potential sulfidic acidity + actual acidity + retained acidity.

Net acidity = Scr + S-TAA at pH 6.5 + SNAS.

4. Verification of treatment

The following section provides the equations and methods of verifying that the neutralisation treatment has been successful / completed.

4.1 Field screening

Field screening results will be considered to be acceptable when the results meet 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.

4.2 Laboratory testing

The soil will be considered successfully treated where:

- pH_{KCL} is ≥ 6.5;
- (total actual acidity) TAA = 0; and
- Net acidity ≤ 0. Net acidity must be determined by Equation 2, below.

Equation 2 is used to calculate the verification of post-treatment net acidity.

Verification net acidity = potential sulfidic acidity + actual acidity + retained acidity – (post neutralised acid neutralising capacity – pre neutralised acid neutralising capacity).

Verification net acidity = Scr + S-TAA at pH 6.5 + SNAS – (ANCBT of treated material – ANCBT of untreated material).

5. Off-site disposal requirements

Prior to disposal off-site the soil must be classified in accordance with relevant guidelines.

PASS/ASS and treated PASS/ASS cannot be classified as virgin excavated natural material (VENM). A 'specific exemption' for treated PASS can be sought from NSW EPA under relevant waste regulations for beneficial reuse on a defined receiving site willing to accept the material, however, the application can take some time to process.

If soil is proposed to be disposed to landfill (post-treatment), it must be classified in accordance with the POEO Act, including the current guidelines, namely:

- NSW EPA *Waste Classification Guidelines, Part 1: Classifying Waste* (NSW EPA, 2014a).
- NSW EPA *Waste Classification Guidelines, Part 4: Acid Sulfate Soils* (NSW EPA, 2014b).

6. Disposal as untreated potential acid sulfate soil

Further guidance for the disposal of untreated soil as PASS is provided in Appendix E.

7. References

NSW EPA. (2014a). *Waste Classification Guidelines, Part 1: Classifying Waste*. NSW Environment Protection Authority.

NSW EPA. (2014b). *Waste Classification Guidelines, Part 4: Acid Sulfate Soils*. NSW Environment Protection Authority.

Sullivan, L., Ward, N., Toppler, N., & Lancaster, G. (2018). *National Acid Sulfate Soils Guidance: National Acid Sulfate Soils Sampling and Identification Methods Manual*. Canberra ACT CC BY 4.0: Department of Agriculture and Water Resources.

Appendix D

Liming Rate Calculation

1. Introduction

This Appendix provides background information on selection of liming material and the equations for the calculation of liming rates.

2. Neutralising materials

Agricultural lime (aglime) is the preferred neutralisation material for the management of ASS, as this material is usually the cheapest and most readily available product for acid neutralisation. Furthermore, aglime is slightly alkaline (pH of 8.5 to 9), non-corrosive, of low solubility and does not present handling problems or generate high pH leachate and it only liberates alkalinity in the presence of acid.

Dolomite and calcined magnesia also have low solubility, however, they produce magnesium sulfate during neutralisation reactions which is quite soluble and may degrade water quality in waterways if large quantities are produced. Aglime on the other hand hydrates to gypsum which is less soluble and therefore less likely to affect water quality and also has other beneficial impacts on soil properties particularly soil structure:

- Aglime comprises calcium carbonate ($CaCO_3$), typically made from limestone that has been finely ground and sieved to a fine powder. Aglime with the following properties are the preferred neutralising agent:
    - Purity of at least 98% or better (i.e. NV > 98, 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);
    - NOTE: There could be economic justification for using a less pure grade of aglime, however, under these circumstances, the individual lime dosing rates described in Section 8.3.3 would need to be carefully considered, as the cost savings from using less pure material may be offset by the corresponding increase in the required dosing rates (lime volumes required), and the transport and disposal costs; and
    - Fine ground (at least <0.5mm) and dry, as texture and moisture can decrease the effective NV.

Aglime requires no specialised handling, however, use of safe work practices and good hygiene practices are recommended to avoid eye or skin contact and inhalation. Aglime should be stored in a cool, dry, well-ventilated area inaccessible to the general public (refer to aglime safety data sheets (SDS) for further details). Any aglime stockpiles (where relevant) should be covered by a tarpaulin both to minimise wind erosion and wetting, as the material is more difficult to spread when wet.

Due to its low solubility in water, aglime is not suitable for the neutralisation of leachate, which requires a product with a very quick reaction and high solubility. The most suitable neutralising agent for leachate and retained drainage water / groundwater is slaked lime or hydrated lime (calcium hydroxide ($Ca(OH)_2$)). This is made by treating burnt lime (calcium oxide (CaO)) with water (slaking) and comes as a fine white powder. It has a typical NV of about 135. Due to its very strong alkalinity (pH of about 12.5 to 13.5), slaked lime or hydrated lime should not be allowed to come into contact with the skin or be inhaled and care must be taken to not overshoot pH

adjustment with such alkaline agents. Hydrated lime is not recommended for soil neutralisation. Hydrated lime should be stored in cool protected place (e.g. locked store inaccessible to the general public) away from moisture, strong oxidants or acids and to minimise dust emissions and (refer to hydrated lime SDS for further details).

3. Liming rates

The required liming rate can be calculated from the following formula (per tonne or per m^3).

Table 1: Liming rate equations

Equation 1 for kg lime /m^3 PASS	Equation 2 for kg lime /tonne PASS
$\left(\frac{\%\ S\ x\ 623.7}{19.98}\right)\ x\ \frac{100}{ENV(\%)}\ x\ D\ x\ FOS$	$\left(\frac{\%\ S\ x\ 623.7}{19.98}\right)\ x\ \frac{100}{ENV(\%)}\ x\ FOS$

Notes:
Net acidity (%S) is derived using the maximum net acidity (%S) using the methods in Appendix C
623.7 = % S to mol H^+ / t
19.98 converts mol H^+ / t to kg $CaCO_3$/tonne
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 (e.g. Approx. 98% for fine (0.3 mm grain size) aglime with an NV of 98%)
D = Bulk density, site specific results can be used, or the bulk densities in ASSMAC (1998)
The ENV is calculated based on the molecular weight, particle size and purity of the neutralising agent and should be assessed for proposed materials in accordance with ASSMAC (1998)

An initial liming rate (kg $CaCO_3$/t) based on the laboratory result calculation (excluding ANC) is considered appropriate based on it including a safety factor of 1.5 and the use of aglime with an NV of at least 98% and a grain size of less than 0.3mm. The laboratory result must be multiplied by the soils bulk density (D) to convert to lime rate per volume of soil (kg $CaCO_3/m^3$).

Depending upon the source of the aglime and ultimately the representative ENV of the aglime selected, the minimum lime dosing rate may be increased or decreased. Prior to the commencement of works, the minimum lime dosing rate should be finalised following the results of the DGI and review of the ENV of the selected aglime.

The liming rate to be calculated from the analytical results should therefore be considered as a 'starting point', and pH monitoring should be done during treatment to assess the progress of the neutralisation and the need for additional mixing and/or addition of aglime. Soil will only be considered to have been successfully treated when all soil has been verified in accordance with Section 10 of the ASSMP and Appendix C.

4. References

Stone, Y., Ahern, C. R., & Blunden, B. (1998). *Acid Sulfate Soil Manual.* Acid Sulfate Soil Management Committee (ASSMAC).

Appendix E

Contingency Options to On-site Treatment

1. Introduction

This Appendix provides the contingency options to the selected management option.

2. Off-site treatment and disposal

Where on site treatment of ASS is not possible and/or practical then off-site treatment at a facility appropriately licenced to accept and treat such soil can be considered. The following general procedure is recommended for off-site treatment:

The below works will be undertaken:

- Loading the soil into trucks. If the soils are wet, they will be heavier than soils as normally transported at field moisture. This should be taken into consideration when loading trucks to ensure that trucks are not overloaded;
- Transport must be conducted in a sealed truck which prevents water leaking from the truck during transport;
- 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;
- Transporting of soil to the treatment facility;
- Once the ASS have been accepted by the treatment facility they will treat and manage it in accordance with their Environment Protection Licence (EPL) conditions, subject to the verification procedures documented herein. The liming rate will be based on the liming rate specified in this ASSMP;
- Verification of the treatment of the ASS and classification of the soil by the Environmental Consultant; and
- Transport of the treated, classified ASS to the final receiving site / disposal facility.

3. Off-site disposal as potential acid sulfate soil

3.1 Potential acid sulfate soil criteria

For the purpose of this option, PASS are defined by NSW EPA *Waste Classification Guidelines Part 4: Acid Sulfate Soils* (NSW EPA, 2014b) as:

- 'Soils that contain iron sulfides or sulfidic materials that have not been exposed to air and thus are not oxidised. The pH of these soils in their undisturbed state is 5.5 or more, making them neutral or slightly alkaline.'

NSW EPA (2014) states that PASS may be disposed of in water below the permanent water table, provided:

- 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 NSW EPA (2014) and its EPL conditions.

This is applicable for direct disposal of untreated PASS to a facility licenced by the EPA to accept untreated PASS.

Prior approval from the relevant licensed facility is required prior to implementation of this disposal option.

3.2 **Disposal as potential acid sulfate soil**

The below works will be undertaken by appropriately trained staff:

- Agreement with receiving site on acceptance times for trucks, and allowable time lapse between excavation and acceptance by receiving site;
- Soils will be kept wet at all times, and should be sprayed with water if required to keep them wet;
- Recording of the excavation date, time and source chainage of the excavated soil;
- Inspection of the excavated soil for moisture content, material texture / signs of contamination concern, such as anthropogenic odours, staining or inclusions by all personnel involved in the management / handling of the spoil;
- If visual inspection of the spoil identifies materials not consistent with the materials assessed in situ (e.g. anthropogenic impact or fill are observed), then the spoil will be segregated for further assessment and treatment;
- Measuring the pH in at least one sample per truck load, or as otherwise required by the receiving site, using a calibrated pH meter;
- If the pH is less than 5.5, the soil will not be classified as PASS, and the soil will be segregated for treatment;
- Loading the soil into trucks and ensuring the soil is moist enough to prevent it drying out during transport. Note: due to the soils being wet, they will be heavier than soils as normally transported at field moisture (PASS estimated to be approximately 2 t/m^3). This should be taken into consideration when loading trucks to ensure that trucks are not overloaded;
- Soil should be loaded and transported as soon as possible to minimise the risk of oxidisation, which prevents it from being classified as PASS; and
- Transport must be conducted in a sealed truck which prevents water leaking from the truck during transport.

Completion of site records of the above:

- Completion of records of all information required by the receiving site, and provision of copies of these records to the receiving site, including copies sent with the truck driver for the load being carried;

- Transporting of soil meeting the PASS requirements to the receiving site within 16 hours of excavation (or earlier if required by the receiving site);
- Once the PASS have been accepted by the receiving site, they are required to manage it in accordance with their EPL conditions and NSW EPA (2014). It is not the role of this document to discuss management of soil once they have been accepted by the receiving site; and
- Any soil which is rejected by the receiving facility will be transported back to the site and managed in accordance with the ASSMP.

4. References

Dear, S. E., Williams, K. M., McElnea, A. E., Ahern, C. R., Dobos, S. K., Moore, N. G., & O'Brien, L. E. (2024). *Queensland acid sulfate soil technical manual : soil management guidelines version 5.1*. Department of Environment, Science and Innovation.

NSW EPA. (2014). *Waste Classification Guidelines, Part 4: Acid Sulfate Soils*. NSW Environment Protection Authority.

NSW EPA. (2014b). *Waste Classification Guidelines, Part 4: Acid Sulfate Soils*. NSW Environment Protection Authority.

Appendix F

Water and Groundwater Management

1. Introduction

Water is the main mechanism by which acid and metals from oxidised ASS are mobilised and transported. Careful management of water is therefore important to the effective management of potential adverse impacts from ASS disturbance. Management is required to provide control of treated waters for discharge and provide some margin for heavy rain periods.

The below sections provide potential strategies for management, assessment and disposal of water leaching from ASS, surface water and water from groundwater dewatering. The below requirements are to supplement any requirements in the DMP, which is the overarching plan for managing groundwater seepage and extracted groundwater for the site.

2. Leachate and surface water collection

All water that has been in contact with ASS / assumed ASS must be managed, assessed, treated and appropriately disposed of in accordance with development consent dewatering management plan / ASSMP / other relevant plan.

3. Dewatering and extracted groundwater

In general, risks associated with dewatering in areas underlain by ASS include:

- Acidification of *in situ* soils drained within the dewatering cone of depression and difficulties associated with neutralising these *in situ* soils (this can also impact the possible PASS classification of some soils);
- Acidification of groundwater remaining within the dewatering cone of depression after the system has re-flooded;
- Iron / aluminium (other metals) contamination of groundwater arising from mobilisation of these compounds under low pH conditions; and
- Acidification and contamination of surface water bodies which receive groundwater.

It is considered that there is the potential to expose soils within the proposed excavation areas to air which will allow some acidification to take place. However, the water and ASS from within these areas will be removed and treated, mitigating associated potential risks.

The dewatering should be designed to not significantly affect groundwater levels outside of the areas of excavation, and therefore the potential for oxidation of ASS outside of the excavation areas is expected to be limited.

The following dewatering risk management methods are recommended for the project:

- Conduct all dewatering in accordance with the requirements of the DMP and consent conditions;
- Drawdown outside of the excavation areas should be minimised;
- Drawdown as close as practical to the invert excavation depth;

- Minimise the time and volume of exposed ASS (i.e. stage excavation and dewatering); and
- Monitoring and treatment prior to disposal of the dewatering effluent.

4. Water storage and treatment

Water from dewatering and the ASS leachate should either be pumped directly to an on-site treatment plant for treatment or should be stored in a tank or lined drains / detention basin prior to assessment / treatment.

At a minimum, the combined storage should be designed to store enough water to contain leachate and extracted water from a 1 in 10-year (1 hour) storm event.

5. Water assessment for disposal

Water which has come into contact with ASS requires assessment (monitoring) and if necessary, treatment prior to discharge to stormwater. Little to no treatment may be required for other disposal options (e.g. disposal to an appropriately licenced liquid waste facility).

The consent authority in the local jurisdiction should be consulted for specific approvals and target levels for discharge to stormwater. It is further recommended that pre-disposal water assessment of groundwater and receiving bodies is done to ensure the target levels in Table 1 are suitable (i.e. adjustment of these target levels may be appropriate, subject to approval by the consent authority, where background concentrations for the receiving environment differ from the target levels in Table 1). The minimum monitoring requirements are outlined in Table 1, below. The monitoring is to be undertaken in conjunction with the monitoring specified in the DMP.

Table 1: Water monitoring analytes and frequency

Test	Parameters	Comments
Groundwater		
Physical parameters	Water level, discharge rate	Monitored daily during discharge.
Field parameters	pH, EC, Eh (redox), DO, smell of noxious gases (qualitative)	Monitored daily during discharge, reducing over time. The pH of should be 6.5 to 8.5 or one pH unit from the background pH of the receiving surface water body.
Major cations, anions and nutrients	Major cations, anions and nutrients	Monitored monthly initially to characterise groundwater facies (types), and if field parameters indicate a risk, for example decreasing pH.
Metals	Total and dissolved metals (including Al and Fe)	Monitored monthly initially and if field parameters indicate a risk, for example decreasing pH.
Soil materials within dewatered zone(s)	Net Acidity, peroxide pH	This may be useful if acidic conditions are formed to assess the loss and continued existing hazard in the area of dewatering,

Test	Parameters	Comments
		which may improve the CSM and understanding of the site. This may or may not be necessary depending on degree of risk.
Surface water Parramatta River at discharge point of Stormwater Culvert		
Field parameters	pH, EC, DO	Monitored at the frequency adopted for groundwater testing in the DMP during discharge, reducing frequency over time.
Metals	Total and dissolved metals (including Al and Fe)	Monitored monthly initially and if field parameters indicate a risk, for example decreasing pH.

6. Treatment

6.1 General

The potential impacts of ASS on water generally comprise a decrease in pH, possible elevated total suspended solids (TSS) / turbidity, iron, aluminium and other metals.

Treatment of water from construction sites is commonly required for pH and TSS. Aeration and removal of TSS also generally decreases metal concentrations in the water. Therefore, an on-site water treatment plant is considered likely to be suitable for treatment of ASS impacted water that has not been oxidised. The DMP provides some additional comments on groundwater treatment.

If leachate water is produced when the on-site treatment plan is not operational, of sufficient capacity or design, an alternative treatment method for pH is provided in Section F1.5.2.

If a suitable treatment method for man-made contaminants in the water (e.g. PFAS, VOC, PAH, TPH, BTEX, OCP, metals etc) cannot be implemented, an alternative disposal method may be required (e.g. trucking off-site to a liquid waste disposal facility or disposal to sewer in accordance with a specific Trade Waste Agreement which would need to be obtained from the relevant water / wastewater authority).

6.2 Alternative pH treatment method

It is noted that aglime is generally not suitable for the treatment of leachate / dewatering effluent due to its low solubility in water. A commercial pH adjustment product can be used, or else slaked lime (hydrated lime) as discussed below.

Alternative neutralisation materials include calcined magnesia (magnesium hydroxide, burnt magnesite, or magnesia) and calcium hydroxide (commonly called slaked or hydrated lime).

Calcined magnesia (magnesium hydroxide, burnt magnesite, or magnesia) produces a two-step reaction, which proceeds rapidly at acidic pH and slows down as higher pH is approached, and hence reduces the potential for over-neutralisation. It should be added to the leachate as a slurry and mixing achieved via use of an agitator.

A calcium hydroxide (commonly called slaked or hydrated lime) solution 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. Adequate care should be taken not to 'overshoot' the desired pH with calcium hydroxide.

Quicklime is very reactive, and relatively corrosive (due to its caustic nature). When quicklime is mixed with water, the resulting reaction generates heat. Therefore, if used, 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.

As a guide, the approximate quantities of slaked lime required to neutralise acidic water (i.e. to raise the existing pH to approximately pH 7 / neutral) are provided in Table 2.

Table 2: Approximate liming rates for water for slaked lime (kg slaked lime)

Water pH	Volume of water		
	10 m^3	50 m^3	100 m^3
2	3.7	18.5	37
3	0.37	1.85	3.7
4	0.037	0.185	0.37
5	0.0037	0.0185	0.037
6	0.00037	0.00185	0.0037

7. Water discharge

Following treatment (if required) the water should be assessed to determine if it meets the discharge criteria. Water meeting the conditions can then be disposed of accordingly.

Depending on site conditions, alternative options for water disposal include on-site reinjection, overland infiltration or infiltration via excavation or surface water body.