Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Club and Car Park Upgrade
Dapto Leagues Club, 12 Bong Bong Road, Dapto

Prepared for
Integrated Projects Pty Ltd

Project 221880.00
June 2023

Douglas Partners
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# Report on Geotechnical Investigation
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# Dapto Leagues Club, 12 Bong Bong Road, Dapto

## 1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed club and car park upgrade at Dapto Leagues Club, 12 Bong Bong Road, Dapto. The investigation was commissioned in an email dated 18 April 2023 by Mr Scott McGregor of Integrated Projects Pty Ltd, the project managers working on behalf of the proponent, Dapto Leagues Club, and was undertaken in accordance with Douglas Partners' proposal 221880.00.P.001.Rev1 dated 11 April 2023.

It is understood that the proposed development of the site includes the demolition of the south-western section of the club and reconstruction of a single storey addition. Construction of suspended single level parking over the existing on-grade car park is also proposed. The geotechnical investigation was carried out to provide information on subsurface conditions underlying the site as part of conceptual planning and design, and for possible submission to Wollongong City Council with a Development Application.

Preliminary drawings, survey and services plan were provided by the client for the investigation. The investigation comprised borehole drilling, laboratory testing of selected samples, engineering analyses and reporting. Details of the work conducted, and the results obtained from the investigation are given in this report together with comments relating to design and construction practice.

This report is to be read in conjunction with the notes *About this Report* included in Appendix A.

## 2. Site Description and Regional Geology

The site, which comprises parts of Lot 1 DP 1277336, is an irregular shaped area of about 2,370 $m^2$ with maximum plan dimensions of 36 m by 65 m for the proposed club upgrade, and 6,930 $m^2$ with maximum plan dimensions of 82 m by 85 m for the proposed car park upgrade. It is located within the grounds of the Dapto Leagues Club and is bounded to the north by existing residential dwellings, to the south and east by existing commercial establishments and car parks and to the west by Station Street then Dapto railway station.

Surface levels fall in the northerly direction at grades of 1 in 100 to 1 in 200, with an overall difference in level estimated to be about 1 m from the highest part of the development footprint to the lowest. At the time of the investigation, all of the test locations were on paved surfaces.

Reference to the Wollongong 1:25 000 Quaternary Geology (Department of Industry Resources & Energy) indicates that the site is underlain by Budgong Sandstone from the Shoalhaven Group of Permian age. This formation generally comprises fine grained lithic sandstone. The results of the investigation were consistent with the broad scale geological mapping with sandstone encountered in all boreholes.

# 3. Field Work

## 3.1 Methods

The field work comprised drilling of two boreholes (Bores 1 & 2) for the club upgrade and five boreholes (Bores 3 – 7) for the car park upgrade. Due to access limitations, Bore 1 was drilled with a Kubota U35-4 mini-excavator fitted with a 125 mm diameter power auger attachment to a refusal depth of 8.5 m. Bores 2 – 7 were drilled with SCD 115 track mounted auger rotary soil sampling and drill rig. Bores 2 – 7 were drilled to refusal of the solid flight auger at depths of 7.2 – 8.5 m. Bores 4 & 6 were continued below auger refusal depths and into the rock using NMLC (50 mm diameter core) to termination to depths of 9.8 – 10 m. Standard penetration tests (SPTs) were carried out at nominal 1 – 1.5 m depth intervals in the overburden. Details of the SPT method is given in the accompanying notes in Appendix A and the penetration N value is shown on the logs. Undisturbed samples of the overburden were taken (in 50 mm diameter thin-walled tubes) in Bores 2 – 7 at alternating depths of 1.5 m & 3 m depth.

Following completion of drilling, groundwater monitoring wells were installed in Bores 1 & 7. Details of the well installation are given in the Remarks section on the borehole logs. Each well was terminated at ground level and fitted with a gatic cover to enable longer term monitoring groundwater levels, if required.

The approximate locations of the field tests are shown on Drawing 1 (Appendix B). Drilling setup at selected borehole locations are shown on attached Photos 1 – 4 in Appendix B. The surface levels to Australian Height Datum (AHD) and the coordinates to Map Grid of Australia (MGA) were determined using a differential GPS receiver, for which a typical accuracy of ±0.1 m is expected. It is noted that accuracy can be variable depending on choice of GPS, satellite coverage and site conditions. Furthermore, it is important to note that DP is not a registered surveyor, hence the coordinates and elevations are considered approximate.

## 3.2 Results

Details of the subsurface conditions encountered during the field investigation are given on the borehole logs in Appendix B, which should be read in conjunction with notes defining classification methods and descriptive terms.

Relatively uniform conditions were encountered underlying the site with the succession of strata broadly summarised as follows:

WEARING COURSE: asphaltic concrete/concrete to depths, 30 – 150 mm thick, in Bores 2– 7;

FILL: gravelly/clayey sand/sandy clay to depth of 0.3 – 0.7 m in all bores;

ALLUVIUM: typically soft to firm clay/silty/sandy clay to depths of 2 – 3.6 m;

RESIDUAL: variably stiff to hard clay/sandy clay to depths of 8.1 m and 7.2 m in Bores 4 and Bore 6 respectively and to the termination depths in Bores 1 – 3, 5 & 7;

ROCK: initially very low strength becoming at least low strength at refusal of the auger at depths of 7.2 – 8.5 m in Bores 1 – 3, 5 & 7. The recovered core from Bores 4 & 6 comprised variably low to high strength, moderately weathered sandstone to the termination depths of 10.0 m and 9.8 m, respectively.

### 3.3 Groundwater

Groundwater was observed at depths of 0.7 – 3 m in Bores 1 – 3 & 5 – 7 during auger drilling. Groundwater was intersected within the alluvial clay above the rock level. No free groundwater was observed in Bore 4 for the short time that the borehole was left open. The non-piezometer boreholes were backfilled immediately following drilling which precluded long term monitoring of groundwater level. It is also noted that groundwater levels are dependent on preceding climatic conditions and soil/rock permeability and can therefore fluctuate with time.

Monitoring of the standpipe piezometers in Bores 1 and 7 indicated standing water at depths of 3 m (RL 11.3) and 1.7 m (RL 11.8) on 6 June 2023 after being developed following installation. A summary of depths where groundwater was observed, and subsequent monitoring results are given in Table 1.

**Table 1: Depth/Level of Groundwater**

| Bore No | Surface RL (m AHD) | 22 – 23 May 2023 | | 6 June 2023 | |
|---|---|---|---|---|---|
| | | Depth (m) | RL (m AHD) | Depth (m) | RL (m AHD) |
| 1 | 14.3 | 2.9 | 11.4 | 3 | 11.3 |
| 2 | 14.3 | 3 | 11.3 | - | - |
| 3 | 13.9 | 2.5 | 11.4 | - | - |
| 4 | 13.7 | NFGWO | NFGWO | - | - |
| 5 | 13.6 | 0.8 | 12.8 | - | - |
| 6 | 13.4 | 0.7 | 12.7 | - | - |
| 7 | 13.5 | 1.6 | 11.9 | 1.7 | 11.8 |

Note NFGWO – No free groundwater observed

# 4. Laboratory Testing

## 4.1 Geotechnical

Disturbed and undisturbed samples from Bore 1 (depth: 0.9 – 1 m) & Bore 2 (depth: 1.5 – 1.9 m) were tested in the laboratory for the measurement of field moisture content, Atterberg limits, linear shrinkage and shrink-swell properties. The detailed laboratory test report sheets are included in Appendix C, with the results summarised in Table 2.

**Table 2: Results of Laboratory Testing - Field Moisture Content, Atterberg Limits & Shrink Swell**

| Bore | Depth (m) | FMC (%) | LL (%) | PL (%) | PI (%) | LS (%) | Shrink (%) | Swell (%) | Iss (% per ΔpF) | Material |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 – 1 | 36.8 | 103 | 31 | 72 | 26 | - | - | - | Sandy CLAY |
| 2 | 1.5 – 1.9 | - | - | - | - | - | 6.2 | -0.1 | 3.4 | CLAY |

Note: FMC = Field Moisture Content; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; LS = Linear Shrinkage; Iss = Shrink-swell index

The results indicate that the samples tested are of high plasticity and would be susceptible to shrinkage and swelling movements with changes in soil moisture content.

Point load strength index (Is(50)) tests were carried out on selected samples of the rock core. The results of these tests are included on the borehole logs. Estimated unconfined compressive strength (UCS) of the rock is assessed as generally being in the range 8.4 – 42 MPa, determined using a UCS/Is(50) correlation factor of 20. These strengths are variably within the medium to high strength range, but typically low to medium.

## 4.2 Aggressivity

Selected samples from the boreholes were despatched to Envirolab Services Pty Ltd (Envirolab) for measurement of pH, chloride concentration, sulfate concentration and electrical conductivity. The detailed test report sheets are given in Appendix C with the results summarised in Table 3.

**Table 3: Results of Laboratory Testing - Aggressivity**

| Bore | Depth (m) | pH | Chloride (mg/kg) | Sulfate (mg/kg) | EC (µS/cm) | Material |
|---|---|---|---|---|---|---|
| 1 | 1.4 – 1.5 | 5.3 | 86 | 160 | 130 | CLAY |
| 3 | 2.5 – 3 | 5.4 | 85 | 20 | 82 | Sandy CLAY |
| 5 | 0.9 – 1 | 7.6 | 67 | 560 | 410 | CLAY |
| 7 | 5.5 – 6 | 7.4 | 21 | 35 | 71 | Sandy CLAY |

Note: EC – Electrical Conductivity

Reference to AS2159:2009 *Piling – Design and Installation* indicates that the samples from Bore 1 (depth: 1.4 – 1.5 m) & Bore 3 (depth: 2.5 – 3 m) can be classified as *mildly aggressive* to concrete and *non-aggressive* to steel. The samples from Bore 5 (depth: 0.9 – 1 m) & Bore 7 (depth: 5.5 – 6 m) can be classified as *non-aggressive* to both concrete and steel.

## 4.3 Acid Sulfate Potential

Samples of fill and alluvial clays from Bores 1 – 7 were tested in the DP laboratory for measurement of pH in $H_2O$ ($pH_F$) and pH after oxidation with $H_2O_2$ ($pH_{FOX}$). The detailed results of the screening tests ($pH_F$ and $pH_{FOX}$) are given in Appendix C and are summarised below:

- The pH of the samples in $H_2O$ ($pH_F$) were in the range 5.3 – 12.6;
- The pH of the samples following addition of $H_2O_2$ ($pH_{FOX}$) were in the range 3.4 – 13.1; and
- Lowering of the pH following addition of $H_2O_2$ ($pH_{FOX}$) were in the range 3.4 – 7.8.

Several samples showed a drop in pH following the addition of $H_2O_2$ and lower $pH_{FOX}$ in general, and could therefore indicate a potential acid sulfate soils (PASS). Upon approval of client in an email dated 6 June 2023, three samples were despatched to Envirolab for standard chromium suite test to allow for the calculation of the various acid-producing components of the soil. The method includes measurement of pH in potassium chloride (KCl), sulfidic – Titrable Actual Acidity (s-TAA), Chromium Reducible Sulfur ($S_{CR}$), Net Acid Soluble Sulfur ($S_{NAS}$) and Acid Neutralising Capacity (s-ANC), in order to determine Net Acidity. The detailed test report sheets are given in Appendix C with the results summarised in Table 4 and the discussion on the test results is given in Section 6.5 of this report.

**Table 4 Results of Laboratory Testing - Acid Sulfate Potential**

| Bore | Depth (m) | Chromium Suite Test Results (%w/w S) | | | | | | Material |
|---|---|---|---|---|---|---|---|---|
| | | $pH_{KCl}$ | Potential Sulfidic Acidity ($S_{CR}$) | Total Actual Acidity (s-TAA) | Retained Acidity (s-$S_{NAS}$) | Acid Neutralising Capacity (s-$ANC_{BT}$) | Net Acidity | |
| 2 | 0.4 – 0.5 | 4.2 | 0.02 | 0.03 | 0.014 | NT | 0.07 | Fill |
| 4 | 1 – 1.5 | 3.4 | <0.005 | 0.18 | 0.021 | NT | 0.20 | Silty CLAY |
| 7 | 1 – 1.5 | 3.4 | 0.01 | 0.18 | 0.009 | NT | 0.20 | Silty CLAY |
| Action Criteria for <1000 tonnes of soil disturbed (Stone, Ahern, & Blunden, 1998) | | | | | | | 0.1 | Clay |
| Action Criteria for >1000 tonnes of soil disturbed (Stone, Ahern, & Blunden, 1998) | | | | | | | 0.03 | Clay |

Note: $S_{CR}$ = Chromium Reducible Sulfur
sTAA = sulfidic – Titrable Actual Acidity
$S_{NAS}$ = Net Acid Soluble Sulfur
s-$ANC_{BT}$ = Acid Neutralising Capacity by back titration
Net Acidity = $S_{CR}$ + s-TAA + $S_{NAS}$ – s-$ANC_{BT}$
NT = Not tested

# 5. Proposed Development

It is understood that the proposed development on the site will comprise demolition of south-western section of the club and reconstruction of a single storey addition. Construction of suspended single level parking over the existing on-grade car park is also proposed. No excavation nor filling is proposed for the construction of suspended car park deck.

Whilst details have not been provided for the re-built of the section of the club, given the slight grades over the building footprint, it is anticipated that the upgrade will take place at or close to existing levels.

# 6. Comments

## 6.1 Geotechnical Model

The geotechnical model for the site comprises:

- Wearing course (eg, asphalt/concrete) to depths of 30 – 150 mm in Bores 2 – 7;
- Fill to depths of 0.3 – 0.7 m in all bores;
- Soft to firm alluvial clay to depths of 2 – 3.6 m;
- Stiff to hard residual clay; overlying
- Sandstone bedrock at depths of 7.2 – 8.5 m below existing surface levels;
- Groundwater levels at depths of 0.7 – 3 m, generally within the overlying alluvium.

## 6.2 Site preparation and Earthworks

### 6.2.1 General

Consideration has initially been given to site preparation to facilitate high level footings systems. However, due to the presence of soft to firm clays in the subsurface profile, the use of high level footings is considered not feasible.

Consequently, earthworks could be limited to the construction of a platform that would be sufficient to provide form-fill support only to the club addition. In order to prepare platforms for slab construction, the following site preparation measures are suggested:

- remove existing concrete slabs, asphaltic wearing course and any deleterious materials (vegetation, topsoil, building rubble, filling, oversize fractions) and remove to spoil;
- inspect and test roll the exposed surface in the presence of a geotechnical engineer prior to the placement of fill materials;
- place approved filling (where required) in layers not exceeding 300 mm loose thickness and compact to a dry density ratio of at least 95% relative to Standard compaction. Moisture contents should be maintained within 2% of standard optimum moisture content.

The site preparation works could be undertaken under Level 2 geotechnical control with reference to AS 3798 – 2007.

When compaction of the filling has been completed, it will be necessary to prevent desiccation of the clays exposed at subgrade level. This could be achieved by spreading and compacting a 300 mm layer of road base or crushed sandstone material over the area, which will also provide a uniform trafficable surface. Prior to placement of the concrete floor slabs, it is recommended that final moisture content checks be made to ensure that the filling or the natural clay have not dried out. Failure to carry out compaction at or near the optimum moisture content and to maintain the moisture after compaction could result in shrinkage of the clays, with the possibility of post-construction swelling occurring.

### 6.2.2 Excavation Conditions

Fill, alluvial and natural soils could be expected to be removed using conventional earthmoving plant and as such no difficulties are anticipated with the exception of wet soils should they become exposed to inundation or saturation.

Groundwater seepage into excavations must be expected to occur particularly after periods of rain.

## 6.3 Seismic Classification

Earthquake Hazard Maps published by the Australian Geological Survey Organisation are reproduced in AS1170.4:2007. The anticipated peak ground acceleration or acceleration coefficient for the Wollongong area is quoted as 0.9 m/sec or 0.09 g. Furthermore, based on a comparison of the soil profile encountered during the field testing with those included in AS1170.4:2007, it is suggested that a Class $C_e$ classification be adopted for design purposes.

## 6.4 Site Classification

Based on the results of the field investigation, which have indicated the presence of soft to firm clay and to depths in excess of 0.7 m, the site is classified as Class P in accordance with the requirements of AS 2870:2011 *Residential Slabs and Footings* (AS 2870, 2011). Notwithstanding the P classification, the underlying stiff to hard clay profile would be equivalent to Class H2 (highly reactive) conditions.

It is noted however, that classification is aimed at classifying the site from the reactivity viewpoint only and is independent of site preparation and construction. Due to the extent of works proposed, design should be undertaken by a suitably qualified engineer using engineering principles that take into account the loads proposed and the encountered subsurface profiles.

It is further noted that Clause 3.1.1 of AS 2870 indicates that the standard foundation details in the code are not strictly applicable to non-residential buildings or buildings longer than 25 m. The design of slabs and footings should therefore be undertaken by a suitably qualified structural engineer using sound engineering principles with reference made to Section 6.6 of this report with respect to foundation requirements.

## 6.5 Acid Sulfate Soil Assessment

Based on the laboratory test results and the ASSMAC (Stone, Ahern, & Blunden, 1998) and QASSIT (Dear, et al., 2014) guidelines, the following interpretations are made with respect to acid sulfate potential:

- The results of the screening tests pH in $H_2O$ ($pH_F$) were in the range 5.3 – 12.6. Results in excess of $pH_F$ 5.5 are generally considered to indicate the absence of Actual Acid Sulfate Soils (AASS). No results were less than $pH_F$ 4, which would provide conclusive indication (at the screening stage) of the presence of AASS;
- The results of the initial screening tests for pH following addition of $H_2O_2$ ($pH_{FOX}$) were in the range 3.4 – 13.1. 18 of the 27 samples provided a positive indicator (i.e. the lowering of the pH by at least one unit following the peroxide oxidation) of potential acid sulfate soil (PASS). Therefore, further confirmation of acid sulfate potential was required. In this regard, samples from Bore 2 (depth: 0.4 – 0.5), Bore 4 (depth: 1 – 1.45) & Bore 7 (depth: 1 – 1.45) were sent to a third party laboratory for Net Acidity (Chromium suite) testing; and
- The results of the detailed Chromium suite testing have indicated Net Acidity greater than the trigger level of 0.03%S (for soil disturbances in excess of 1000 tonnes) for the three samples tested. Furthermore, alluvial samples from Bore 4 (1 – 1.5 m) & Bore 7 (1 – 1.5 m) were greater than the trigger level of 0.1%S (for soil disturbances less than 1000 tonnes) confirming acid sulfate potential.

In summary, the results of the investigation indicate the presence of acid sulfate conditions within some of the fill and alluvial samples underlying the site. As samples tested confirmed acid sulfate potential, an Acid Sulfate Soil Management Plan (ASSMP) will be required. The purpose of an ASSMP is to provide objectives, methods and procedures by which construction work will be managed and adverse environmental impacts minimised in relation to acid sulfate soils.

Based on the results obtained to date, a preliminary liming rate of around 3 – 10 kg agricultural lime (with at least a 95% neutralising value) per tonne of fill is anticipated as being required to achieve appropriate neutralisation. DP can assist in preparing an ASSMP, if required.

It is noted that the underlying natural clays are derived from the weathering of the underlying sandstone and accordingly, inconsistent with the formation of estuarine acid sulfate soils. As such, management and treatment will be limited to fill and alluvial materials.

## 6.6 Foundations

### 6.6.1 General

Consideration has initially been given to the use of high-level footings systems. However, due to the presence of weak soils (including soft to firm clays), settlements (both total and differential) would be beyond tolerable limits. Accordingly, a deep footing system will be required to transfer the loads to an underlying stiffer stratum such as the very stiff to hard silty clay or weathered rock. In this regard, pre-formed steel screw piles or cased bored piers are likely to be the most practical deep foundation alternatives.

### 6.6.2 Club Upgrade

Pre-formed steel screw piles are considered a viable deep foundation system for this section. Steel screw piles consist of a conventional circular hollow steel section which acts as the pile shaft and a helical steel plate section is attached to the shaft near the toe to form a bearing element. As screw piles are a proprietary product, advice should be sought from specialist contractors on pile capacity, founding levels, installation techniques and costs. The full structural capacity of screw piles (which could be up to 800 kN but dependent on manufacturer's specifications) will only be achieved for units installed to cone probe refusal at depths ranging from 7.3 – 8.5 m. It is likely however that reduced capacities would be possible in the overlying very stiff to hard clay at depths of 2.5 – 3.5 m below existing levels.

### 6.6.3 Car Park Upgrade

It is recommended that piled foundations (eg, cased bored piers or auger grouted piles) founded in rock be adopted for this portion of the site. Design could be based on the parameters given in Section 6.6.4.

It is important to note that the use of temporary or sacrificial liners will be required, particularly to intersect the clay/rock interface, mitigate groundwater ingress and provide sidewall stability. As such, the work should be undertaken by contractors experienced in challenging ground conditions with concrete placed using tremmie techniques immediately following base cleaning and inspection. Load capacity due to side adhesion must be neglected in those instances where liners are installed. Auger grouted (grout injected) piles (although possible more expensive) may be considered as lower risk alternative foundation systems for proposed structures. This option should be undertaken by an experienced contractor.

Allowance should be made for inspection of footings by a suitably qualified engineer prior to steel and concrete placement to confirm the adequacy of the bearing stratum for the adopted design pressure. Care must be exercised to ensure that DA Consent conditions are satisfied with respect to footing inspection, and the engineering discipline to undertake the inspections is appropriate (e.g. a structural engineer cannot be used as a substitute for a geotechnical engineer).

Articulation should be provided between the new and existing sections of the club, to facilitate some differential movement without causing structural damage.

### 6.6.4 Design Parameters

Based on the results of the field investigation, the design of footings could be proportioned using the following allowable foundation parameters (next page):

Settlements from the adoption of the below design pressures and structural loads would be negligible, provided bases are cleaned of loose debris prior to the placement of concrete.

- Base bearing pressure on very low to low strength rock (below depths of 7.2 – 7.5 m below existing levels) — 800 kPa
- Allowable shaft adhesion in very low to low strength rock (compression) — 80 kPa
- Allowable shaft adhesion in very low to low strength rock (tension) — 60 kPa
- Base bearing pressure on low to medium strength rock (below depths of 8.1 – 8.5 m below existing levels) — 1,200 kPa
- Allowable shaft adhesion in low to medium strength rock (compression) — 120 kPa
- Allowable shaft adhesion in low to medium strength rock (tension) — 90 kPa

### 6.6.5 Ground Slabs

Provided site preparation is undertaken in accordance with Section 6.2.1, the design of on-ground slabs can be based on a subgrade CBR value of 3%.

Corresponding moduli of subgrade reaction would be 20 – 25 kPa/mm for point loads, 5 – 6 kPa/mm for loads up to 2 m wide and 1 – 2 kPa/mm for uniformly distributed loads up to 20 kPa, but dependant on the area of loading.

## 6.7 Site Maintenance and Drainage

Whilst it must be accepted that minor cracking in most structures is inevitable, site maintenance practices aimed at minimising shallow foundation and slab movement should be adopted to keep cracking within acceptable limits. Articulation should be included between the new and existing sections of the building to allow some differential movement without causing structural damage.

Surface and subsurface drainage should be installed and maintained to protect the subgrade. The subsurface drains should be located at a minimum of 0.5 m depth below select subgrade level and installed around the perimeter of the building slab. It should be noted that subsurface drainage could be integral with other drainage works proposed, such as bedding for stormwater lines. However, to facilitate drainage of the bedding layer, inlets to the pits via (say) a 3 m length of slotted pipe will need to be incorporated into the works. Weep holes should also be included within each pit beneath the level of the inlet of the subsurface pipe to ensure that all water collected within the bedding is also discharged into the respective pits.

All collected stormwater, groundwater and roof runoff should be discharged in a controlled manner away from the building area.

# 7. References

AS 1170.4. (2007). *Structural Design Actions, Part 4: Earthquake Actions in Australia.* Reconfirmed 2018. Incorporating Amendments 1 & 2: Standards Australia.

AS 2870. (2011). *Residential Slabs and Footings.* Standards Australia.

AS2870. (2011). *Residential Slabs and Footings.* Standards Australia.

AS3798. (2007). *Guidelines on Earthworks for Commercial and Residential Developments.* Standards Australia.

Dear, S., Ahern, C., O'Brien, L., Dobos, S., McElnea, A., Moore, N., & Watling, K. (2014). *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines.* (QASSIT). Brisbane: Department of Science: Department of Science, Information, Technology, Innovation and the Arts, Queensland Government.

Department of Industry Resources & Energy. (n.d.). *Wollongong 1:25 000 Quaternary Geology.*

Department of Mines. (1974). *Geology of Kiama 1:50 000 Geological Series Sheet No 9028 – 1.* NSW State Archives and Records.

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

## 8. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Dapto Leagues Club, Station St corner Bong Bong Road, Dapto in accordance with DP's proposal dated 11 April 2023 and acceptance received from Mr Scott McGregor dated 18 April 2023. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Integrated Projects Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical 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. DP cannot be held responsible for interpretations or

conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

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

**Douglas Partners Pty Ltd**

# Appendix A

About This Report

# About this Report

Douglas Partners

## Introduction

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

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

## Copyright



## Borehole and Test Pit Logs

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

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

## Groundwater

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

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

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

## Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

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

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

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

# *About this Report*

## Site Anomalies

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

## Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

## Site Inspection

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

## Sampling

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

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

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

## Test Pits

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

## Large Diameter Augers

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

## Continuous Spiral Flight Augers

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

## Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

## Continuous Core Drilling

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

## Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

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

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

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

### Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

## Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

## Soil Types

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

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

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

| Type | Particle size (mm) |
|---|---|
| Coarse gravel | 19 - 63 |
| Medium gravel | 6.7 - 19 |
| Fine gravel | 2.36 – 6.7 |
| Coarse sand | 0.6 - 2.36 |
| Medium sand | 0.21 - 0.6 |
| Fine sand | 0.075 - 0.21 |

Definitions of grading terms used are:

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

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

In fine grained soils (>35% fines)

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

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

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

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

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

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

# Soil Descriptions

## Cohesive Soils

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

| Description | Abbreviation | Undrained shear strength (kPa) |
|---|---|---|
| Very soft | VS | <12 |
| Soft | S | 12 - 25 |
| Firm | F | 25 - 50 |
| Stiff | St | 50 - 100 |
| Very stiff | VSt | 100 - 200 |
| Hard | H | >200 |
| Friable | Fr | - |

## Cohesionless Soils

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

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

## Soil Origin

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

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

## Moisture Condition – Coarse Grained Soils

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

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

## Moisture Condition – Fine Grained Soils

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

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

## Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

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

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

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

## Degree of Weathering

The degree of weathering of rock is classified as follows:

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

# *Rock Descriptions*

## Degree of Fracturing

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

| Term | Description |
|---|---|
| Fragmented | Fragments of <20 mm |
| Highly Fractured | Core lengths of 20-40 mm with occasional fragments |
| Fractured | Core lengths of 30-100 mm with occasional shorter and longer sections |
| Slightly Fractured | Core lengths of 300 mm or longer with occasional sections of 100-300 mm |
| Unbroken | Core contains very few fractures |

## Rock Quality Designation

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

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

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

## Stratification Spacing

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

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

# Symbols & Abbreviations



## Introduction

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

## Drilling or Excavation Methods

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

## Water

| | |
|---|---|
| ▷ | Water seep |
| ▽ | Water level |

## Sampling and Testing

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

## Description of Defects in Rock

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

### Defect Type

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

### Orientation

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

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

### Coating or Infilling Term

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

### Coating Descriptor

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

### Shape

| | |
|---|---|
| cu | curved |
| ir | irregular |
| pl | planar |
| st | stepped |
| un | undulating |

### Roughness

| | |
|---|---|
| po | polished |
| ro | rough |
| sl | slickensided |
| sm | smooth |
| vr | very rough |

### Other

| | |
|---|---|
| fg | fragmented |
| bnd | band |
| qtz | quartz |

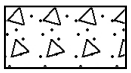
# *Symbols & Abbreviations*

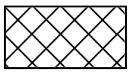
## Graphic Symbols for Soil and Rock

### General

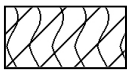

Asphalt

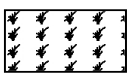

Road base

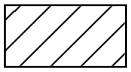

Concrete

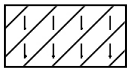

Filling

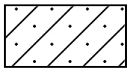
### Soils


Topsoil

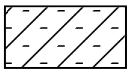

Peat

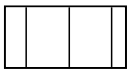

Clay

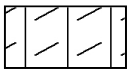

Silty clay

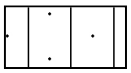

Sandy clay

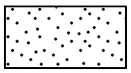

Gravelly clay

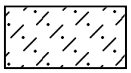

Shaly clay

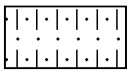

Silt


Clayey silt


Sandy silt

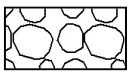

Sand

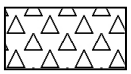

Clayey sand


Silty sand


Gravel

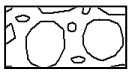

Sandy gravel


Cobbles, boulders

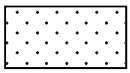

Talus

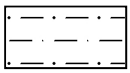
### Sedimentary Rocks

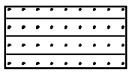

Boulder conglomerate

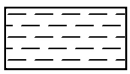

Conglomerate


Conglomeratic sandstone

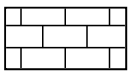

Sandstone


Siltstone

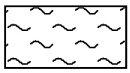

Laminite

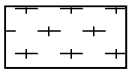

Mudstone, claystone, shale

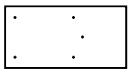

Coal


Limestone

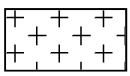
### Metamorphic Rocks

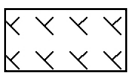

Slate, phyllite, schist

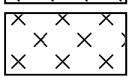

Gneiss

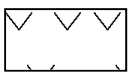

Quartzite

### Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

# Appendix B

Borehole Logs
Site Photographs
Drawing 1

# BOREHOLE LOG

**CLIENT:** Integrated Projects Pty Ltd
**PROJECT:** Proposed Club and Car Park Upgrade
**LOCATION:** Dapto Leagues Club, 12 Bong Bong Road, Dapto

**SURFACE LEVEL:** 14.3 AHD
**COORDINATE E:**297291 **N:** 6180892
**DATUM/GRID:** MGA94 Zone 56
**DIP/AZIMUTH:** --/---

**LOCATION ID:** 1
**PROJECT No:** 221880.00
**DATE:** 29/05/23
**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 |
| | 14 | 0.0 | FILL/ (SW) Gravelly SAND; dark grey brown; sand fraction fine to coarse; gravel fraction fine to medium | | FILL | | D | | A | 0.1–0.2 | 0.1 | | |
| | | 0.15 | FILL/ (CI) Sandy CLAY, with gravel; grey brown; clay fraction medium plasticity; sand fraction fine to coarse; gravel fraction fine to medium | | FILL | | >PL | | A | 0.4–0.5 | 0.2 | | |
| | | 0.7 | (CI) CLAY, trace sand; brown mottled red; clay fraction high plasticity; sand fraction fine to medium | | ALV | F | =PL | | A | 0.9–1.0 | 0.4 | | |
| | 13 | 1 | | | | | | | | | 0.5 | | |
| | | | | | | | | | A | 1.4–1.5 | 0.9 | | |
| | | | | | | | | | | | 1.0 | | |
| | | 2.0 | (CI) CLAY; brown; medium plasticity | | ALV | ST | =PL | | A | 2.4–2.5 | 1.4 | | |
| | 12 | | | | | | | | | | 1.5 | | |
| | | | | | | | | | A | 2.9–3.0 | 2 | | |
| | | 3.0 | (CI) CLAY, trace gravel; grey brown mottled brown; clay fraction medium plasticity; gravel fraction fine | | RES | ST | =PL | | | | 2.4 | | |
| | 11 | 3.5 | (CL) Sandy CLAY, trace gravel; brown; clay fraction low plasticity; sand fraction fine; gravel fraction fine | | RES | VST | >PL | | A | 3.9–4.0 | 2.5 | | |
| | | | | | | | | | | | 2.9 | | |
| | | | | | | | | | | | 3.0 | | |
| | | 4 | | | | | | | | | 3.9 | | |
| | 10 | | | | | | | | | | 4.0 | | |
| | | 5 | | | | | | | | | 5 | | |
| | | | | | | | | | A | 5.4–5.5 | 5.4 | | |
| | | | | | | | | | | | 5.5 | | |
| | 9 | | | | | | | | A | 5.9–6.0 | 5.9 | | |
| | | 6.0 | (CH) Sandy CLAY, trace gravel; brown mottled grey; clay fraction medium plasticity; sand fraction fine; gravel fraction fine to medium | | RES | H | >PL | | | | 6.0 | | |
| | | | | | | | | | A | 6.9–7.0 | 6.9 | | |
| | 8 | 7 | | | | | | | | | 7.0 | | |
| | | 8 | | | | | | | | | 8 | | |
| | 7 | | | | | | | | | | | | |
| | | 8.5 | Borehole discontinued at 8.50m depth<br>Limit of investigation. Refusal on low to medium strength sandstone. | | | | | | A | 8.4–8.5 | 8.4 | | |
| | 6 | | | | | | | | | | 8.5 | | |
| | | 9 | | | | | | | | | 9 | | |
| | 5 | | | | | | | | | | | | |

3.02 m depth, 06/06/22

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:** Kubota U35-4
**OPERATOR:** Coast Excavation
**LOGGED:** JG

**METHOD:** 125mm power auger.
**CASING:**

**REMARKS:** Groundwater observed at 2.9mbgl during auger drilling. Standpipe piezometer installed: screened 5.5-8.5m, sand filter 4-5.5m, bentonite 3-4m, cuttings 0.3-3m, concrete 0-0.3m.

# BOREHOLE LOG

**CLIENT:** Integrated Projects Pty Ltd
**PROJECT:** Proposed Club and Car Park Upgrade
**LOCATION:** Dapto Leagues Club, 12 Bong Bong Road, Dapto

**SURFACE LEVEL:** 14.3 AHD
**COORDINATE** **E:**297323 **N:** 6180952
**DATUM/GRID:** MGA94 Zone 56
**DIP/AZIMUTH:** --/---

**LOCATION ID:** 2
**PROJECT No:** 221880.00
**DATE:** 22/05/23
**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 | RESULTS AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14 | 0.08 | FILL/ ASPHALTIC CONCRETE; black dark grey; well graded, fine to medium; Wearing course | | FILL | | D | | A | 0.1 - 0.2 | 0.1 | | |
| | | | | | | | | | A | 0.4 - 0.5 | 0.4 | | |
| | | 0.5 | FILL/ (SC) Clayey SAND; dark grey mottled brown; sand fraction fine to coarse; clay fraction medium plasticity; Basecourse (degraded) | | | | | | | | 0.5 | | |
| | 13 | 1 | (Cl) CLAY, trace sand; grey mottled brown; clay fraction high plasticity; sand fraction fine to medium | | ALV | S TO F | =PL | | A | 0.9 - 1.0 | 0.9 | | |
| | | | | | | | | | SPT | | 1.0 | SPT | 0,1,2 N=3 |
| | | | | | | | | | U50 | 1.45 - 1.5 | 1.45 | | |
| | 12 | 2 | | | | | | | | 1.9 | 1.9 | | |
| | | 2.5 | (Cl) CLAY; grey mottled brown; medium plasticity | | RES | VST | =PL | | SPT | | 2.5 | SPT | 6,8,9 N=17 |
| 3 m depth, 22/05/23 | 11 | 3 | | | | | | | | | 2.95 | | |
| | | 3.5 | 3.0-4.0m: band of extremely low strength sandstone | | | | | | | | | | |
| | | 4 | (Cl) Sandy CLAY; grey mottled brown; clay fraction medium plasticity; sand fraction fine to coarse grained | | | | | | SPT | | 4.0 | SPT | 3,6,9 N=15 |
| | 10 | | | | | | | | | | 4.45 | | |
| | | 5 | | | RES | VST TO H | =PL | | | | 5 | | |
| | 9 | | | | | | | | SPT | | 5.5 | SPT | 8,10,10 N=20 |
| | | 6 | 5.0-7.0m: becoming gravelly | | | | | | | | 5.95 | | |
| | 8 | | | | | | | | | | | | |
| | | 7 | | | | | | | SPT | | 7.0 | SPT | 20,25/90 |
| | 7 | 7.3 | Borehole discontinued at 7.30m depth<br>Limit of investigation. Refusal on very low to low strength sandstone | | | | | | | | 7.3 | | |
| | | 8 | | | | | | | | | 8 | | |
| | 6 | | | | | | | | | | | | |
| | | 9 | | | | | | | | | 9 | | |
| | 5 | | | | | | | | | | | | |

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

**PLANT:** SCD-115
**METHOD:** SFA (TC bit) to 7m.
**REMARKS:**

**OPERATOR:** South Coast Drilling
**CASING:**

**LOGGED:** JG

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# BOREHOLE LOG

**CLIENT:** Integrated Projects Pty Ltd
**PROJECT:** Proposed Club and Car Park Upgrade
**LOCATION:** Dapto Leagues Club, 12 Bong Bong Road, Dapto

**SURFACE LEVEL:** 13.9 AHD
**COORDINATE E:**297344 **N:** 6180984
**DATUM/GRID:** MGA94 Zone 56
**DIP/AZIMUTH:** --/---

**LOCATION ID:** 3
**PROJECT No:** 221880.00
**DATE:** 23/05/23
**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 |
| | | 0.0 | FILL/ CONCRETE; pale grey | | FILL | | D | | A | | 0.2 | | |
| | | 0.15 | FILL/ (SC) Clayey SAND, with gravel; dark grey mottled brown; sand fraction fine to medium; clay fraction low plasticity; gravel fraction fine to medium | | FILL | | D | | | | 0.3<br>0.4 | | |
| | | 0.7 | (CI) Silty CLAY, trace sand; grey mottled orange, red; clay fraction high plasticity; sand fraction fine | | ALV | F | =PL | | A<br>SPT<br>U50 | | 0.9<br>1.0<br>1.45<br>1.5 | SPT | 2,2,3<br>N=5 |
| | | 2.0 | (CI) Sandy CLAY; yellow grey-brown; clay fraction medium plasticity; sand fraction fine | | RES | ST | =PL | | A<br>SPT | | 1.9<br>2<br>2.5<br>2.95 | SPT | 5,5,8<br>N=13 |
| 2.5 m depth, 23/05/23 | | 3.5 | (CL) Sandy CLAY; yellow brown mottled red, grey; clay fraction low plasticity; sand fraction fine | | RES | VST TO H | <PL | | SPT<br>SPT | | 4.0<br>4.45 | SPT<br>SPT | 9,11,10<br>N=21<br>7,14,18<br>N=32 |
| | | | | | | | | | SPT | | 5.0<br>5.5<br>5.95 | | |
| | | 7.3 | (SP) SAND, with gravel, trace clay; red brown mottled yellow; sand fraction fine; gravel fraction fine to coarse | | XWM | XWR | D | | SPT | | 7.0<br>7.45 | SPT | 17,24,19<br>N=43 |
| | | 7.5 | Borehole discontinued at 7.50m depth<br>Limit of investigation. Refusal on very low to low strength sandstone | | | | | | | | | | |

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

**PLANT:** SCD-115
**METHOD:** Dia tube to 0.15m, SFA (TC) bit to 7m.
**REMARKS:**

**OPERATOR:** South Coast Drilling
**CASING:**

**LOGGED:** JG

EXPORTED 27/06/23 10:22. TEMPLATE ID: DP_101.02.00_SOILLOG

# BOREHOLE LOG

**CLIENT:** Integrated Projects Pty Ltd
**PROJECT:** Proposed Club and Car Park Upgrade
**LOCATION:** Dapto Leagues Club, 12 Bong Bong Road, Dapto

**SURFACE LEVEL:** 13.7 AHD
**COORDINATE E:**297404 **N:** 6180963
**DATUM/GRID:** MGA94 Zone 56
**DIP/AZIMUTH:** --/---

**LOCATION ID:** 4
**PROJECT No:** 221880.00
**DATE:** 23/05/23
**SHEET:** 1 of 2

| GROUNDWATER | RL (m) | DEPTH (m) | DESCRIPTION OF STRATA | GRAPHIC | WEATH. | DEPTH (m) | STRENGTH | RECOVERY (%) | RQD | FRACTURE SPACING (m) | DEFECTS & REMARKS | SAMPLE REMARKS | TYPE | INTERVAL | DEPTH (m) | TEST TYPE | RESULTS AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23/05/23, No free groundwater observed | 13.7 | 0.08 | FILL/ ASPHALTIC CONCRETE; black dark grey; well graded, fine to medium; Wearing course [FILL] | D, PL | | | | | | | | | A | | 0.1 | | |
| | | 0.3 | | | | | | | | | | | | | 0.2 | | |
| | | | | | | | | | | | | | A | | 0.4 | | |
| | 13 | 0.7 | FILL/ (SP) Gravelly SAND; grey; sand fraction fine to coarse; gravel fraction fine to medium; Basecourse [FILL] | F | | | | | | | | | | | 0.5 | | |
| | 1 | | | | | | | | | | | | A | | 0.9 | | |
| | | | | | | | | | | | | | | | 1.0 | SPT | 2,2,3 N=5 |
| | | | (CH) Sandy CLAY, trace gravel; dark grey mottled brown; clay fraction high plasticity; sand fraction fine to medium; gravel fraction fine to medium; [ALLUVIAL] | PL | | | | | | | | | SPT | | | | |
| | 12 | | | | | | | | | | | | | | 1.45 | | |
| | 2 | | (CH) Silty CLAY; grey mottled orange brown red; high plasticity; [ALLUVIAL] | | | | | | | | | | | | 2 | | |
| | | 2.2 | | | | | | | | | | | | | | | |
| | | | (CH) CLAY, trace sand; pale grey mottled grey; clay fraction high plasticity; sand fraction fine; [RESIDUAL SOIL] | ST | | | | | | | | | | | 2.5 | | |
| | 11 | | | | | | | | | | | | SPT | | | SPT | 5,5,8 N=13 |
| | 3 | | | | | | | | | | | | | | 2.95 | | |
| | | | | PL | | | | | | | | | | | 3.0 | | |
| | | | | | | | | | | | | | U50 | | | | |
| | 10 | | | | | | | | | | | | | | 3.4 | | |
| | 4 | | | | | | | | | | | | | | 4.0 | | |
| | | | | | | | | | | | | | SPT | | | SPT | 7,11,17 N=28 |
| | | | | | | | | | | | | | | | 4.45 | | |
| | 9 | | | | | | | | | | | | | | | | |
| | 5 | | | VSTtoH | | | | | | | | | | | 5 | | |
| | | | | | | | | | | | | | | | 5.5 | | |
| | 8 | | | | | | | | | | | | SPT | | | SPT | 9,7,11 N=18 |
| | 6 | | | | | | | | | | | | | | 5.95 | | |
| | 7 | | | | | | | | | | | | | | | | |

NOTES: (#)Soil origin is "probable" unless otherwise stated.

**PLANT:** SCD-115
**OPERATOR:** South Coast Drilling
**LOGGED:** JG

**METHOD:** SFA (TC) bit to 4m, rotary (water) to 8.1m, coring (NMLC) to 8.1m.
**CASING:** HW to 4.1m

**REMARKS:**

EXPORTED 27/06/23 09:52. TEMPLATE ID: DP_102.02.00_ROCKLOG

# BOREHOLE LOG

**CLIENT:** Integrated Projects Pty Ltd
**PROJECT:** Proposed Club and Car Park Upgrade
**LOCATION:** Dapto Leagues Club, 12 Bong Bong Road, Dapto

**SURFACE LEVEL:** 13.7 AHD
**COORDINATE E:**297404 **N:** 6180963
**DATUM/GRID:** MGA94 Zone 56
**DIP/AZIMUTH:** --/---

**LOCATION ID:** 4
**PROJECT No:** 221880.00
**DATE:** 23/05/23
**SHEET:** 2 of 2

| CONDITIONS ENCOUNTERED | | | | | | | | | | | | | | | SAMPLE | | | | TESTING | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GROUNDWATER | RL (m) | DEPTH (m) | DESCRIPTION OF STRATA | SOIL STRENGTH (where encountered) / SOIL MOISTURE | GRAPHIC | WEATH. (RS, XW, HW, MW, SW, FS, FR; DW) | DEPTH (m) | STRENGTH (VL, L, M, H, VH, EH) | RECOVERY (%) | RQD | FRACTURE SPACING (m) (0.01, 0.10, 0.50, 1.00, 5.00) | DEFECTS & REMARKS | SAMPLE REMARKS | TYPE | INTERVAL | DEPTH (m) | TEST TYPE | RESULTS AND REMARKS |
| | 7 | 7.0 | (Cl) Sandy CLAY; grey mottled orange brown yellow; clay fraction medium plasticity; sand fraction fine to medium | VSTto=PL | | | | | | | | | | SPT | | 7.0 | SPT | 8,18,17 N=35 |
| | | | | | | | | | | | | | | | | 7.45 | | |
| | 8 | 8.1 | SANDSTONE; orange mottled white brown; fine | | | MW | 8.1 | L-M | 100 | 68 | | 8.2m: J 10° PL, RO, FE STN<br>8.2-8.25m: J 40° IR, RO, FE STN<br>8.25m: J 0° PL, RO, CLN<br>8.3-8.34m: FCT<br>8.5m: J 0° PL, SM, CLY CO<br>8.8m: J 0° PL, SM, CLN<br>9.06-9.08m: J 25° PL, RO, FE STN<br>9.12-9.14m: FCT<br>9.27m: J 15° CU, RO, FE STN<br>9.4m: J 20° PL, RO, FE STN<br>9.61m: J 10° PL, RO, FE STN<br>9.64m: J 10° PL, RO, FE STN<br>9.68m: J 5° PL, RO, FE STN<br>9.62-9.8m: J 70° CU, RO, CLN<br>9.72-9.83m: J 75° PL, RO, CLN<br>9.75-9.87m: J 70° CU, RO, FE STN<br>9.87-10.0m: FCT | | | 8 | | |
| | 6 | | | | | | | | | | | | | | | | | |
| | 5 | | | | | | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | | | | 9 | PLT | PL(A)=0.42 |
| | 4 | | | | | | | | | | | | | | | | | |
| | | 10.0 | Borehole discontinued at 10.00m depth<br>Limit of investigation. Refusal on low to medium strength sandstone. | | | | 10.0 | | | | | | | | | 10 | | |
| | 3 | | | | | | | | | | | | | | | | | |
| | 11 | | | | | | | | | | | | | | | 11 | | |
| | 2 | | | | | | | | | | | | | | | | | |
| | 12 | | | | | | | | | | | | | | | 12 | | |
| | 1 | | | | | | | | | | | | | | | | | |
| | 13 | | | | | | | | | | | | | | | 13 | | |
| | 0 | | | | | | | | | | | | | | | | | |

NOTES: (#)Soil origin is "probable" unless otherwise stated.

**PLANT:** SCD-115
**OPERATOR:** South Coast Drilling
**LOGGED:** JG

**METHOD:** SFA (TC) bit to 4m, rotary (water) to 8.1m, coring (NMLC) to 8.1m.
**CASING:** HW to 4.1m

**REMARKS:**

EXPORTED 27/06/23 09:52. TEMPLATE ID: DP_102.02.00_ROCKLOG


Douglas Partners
Geotechnics | Environment | Groundwater
Project No: 221880.00
BH ID: BH4
Depth: 8.1 TO 10.0
Core Box No.: 1/1
DAPTO 221880.00 BH4 START @ 8.1m
8m START→
9m
10m

# BOREHOLE LOG

**CLIENT:** Integrated Projects Pty Ltd
**PROJECT:** Proposed Club and Car Park Upgrade
**LOCATION:** Dapto Leagues Club, 12 Bong Bong Road, Dapto

**SURFACE LEVEL:** 13.6 AHD
**COORDINATE E:**297383 **N:** 6181009
**DATUM/GRID:** MGA94 Zone 56
**DIP/AZIMUTH:** --/---

**LOCATION ID:** 5
**PROJECT No:** 221880.00
**DATE:** 24/05/23
**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 | TEST TYPE | RESULTS AND REMARKS |
| 0.8 m depth, 24/05/23 | 13.52 | 0.08 | FILL/ ASPHALTIC CONCRETE; black dark grey; well graded, fine to medium; Wearing course | | FILL | | D | | A | 0.1–0.2 | | |
| | 13.3 | 0.3 | FILL/ (SP) Gravelly SAND; dark grey brown; gravel fraction fine; Basecourse | | | | | | A | 0.4–0.5 | | |
| | 12.6 | 1.0 | (CH) CLAY, trace sand, trace gravel; grey brown red; clay fraction high plasticity; sand fraction fine to coarse; gravel fraction fine to coarse | | ALV | S | >PL | | A | 0.9–1.0 | | |
| | | | | | | | | | SPT | 1.45 | SPT | 3,1,2 N=3 |
| | 11.6 | 2.0 | (CH) Sandy CLAY, trace gravel; grey mottled brown; clay fraction high plasticity; sand fraction fine; gravel fraction fine | | | | | | SPT | 2.5 | SPT | 3,4,8 N=12 |
| | | | | | | | | | U50 | 2.95–3.0–3.4 | | |
| | | | | | RES | ST TO VST | =PL | | SPT | 4.0 | SPT | 7,8,13 N=21 |
| | | | | | | | | | | 4.45 | | |
| | | | | | | | | | SPT | 5.5 | SPT | 6,13,13 N=26 |
| | | | | | | | | | | 5.95 | | |
| | 6.6 | 7.0 | (CH) Sandy CLAY; white grey mottled red; clay fraction high plasticity; sand fraction fine | | XWM | XWR | =PL | | SPT | 7.0–7.21 | SPT | 22,25/60 (HB) |
| | 6.4 | 7.2 | Borehole discontinued at 7.20m depth<br>Limit of investigation. Refusal on very low to low strength sandstone | | | | | | | | | |

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

**PLANT:** SCD-115
**METHOD:** SFA (TC bit) to 7.2m.
**REMARKS:**

**OPERATOR:** South Coast Drilling
**CASING:**

**LOGGED:** JG

EXPORTED 27/06/23 10:22. TEMPLATE ID: DP_101.02.00_SOILLOG

# BOREHOLE LOG

**CLIENT:** Integrated Projects Pty Ltd
**PROJECT:** Proposed Club and Car Park Upgrade
**LOCATION:** Dapto Leagues Club, 12 Bong Bong Road, Dapto

**SURFACE LEVEL:** 13.4 AHD
**COORDINATE E:**297371 **N:** 6181044
**DATUM/GRID:** MGA94 Zone 56
**DIP/AZIMUTH:** --/---

**LOCATION ID:** 6
**PROJECT No:** 221880.00
**DATE:** 24/05/23
**SHEET:** 1 of 2

| CONDITIONS ENCOUNTERED | | | | | | | | | | | | | | SAMPLE | | | | TESTING | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GROUNDWATER | RL (m) | DEPTH (m) | DESCRIPTION OF STRATA | SOIL STRENGTH (where encountered) / SOIL MOISTURE | GRAPHIC | WEATH. | DEPTH (m) | STRENGTH | RECOVERY (%) | RQD | FRACTURE SPACING (m) | DEFECTS & REMARKS | SAMPLE REMARKS | TYPE | INTERVAL | DEPTH (m) | TEST TYPE | RESULTS AND REMARKS |
| 0.7 m depth, 24/05/23 | 13 | 0.0 | | | | | | | | | | | | | | 0.1 | | |
| | | 0.08 | FILL/ ASPHALTIC CONCRETE; black dark grey; well graded, fine medium; Wearing course [FILL] | D | | | | | | | | | | A | | 0.2 | | |
| | | 0.3 | | | | | | | | | | | | | | 0.4 | | |
| | | | | | | | | | | | | | | A | | 0.5 | | |
| | 12 | 1.0 | FILL/ (SP) Gravelly SAND; dark grey; sand fraction poorly graded, fine to medium; gravel fraction fine to medium; Basecourse [FILL] | >PL | | | | | | | | | | A | | 0.9 | | |
| | | | | F | | | | | | | | | | | | 1.0 | | |
| | | | | | | | | | | | | | | SPT | | | SPT | 1,2,3 N=5 |
| | | | (CH) CLAY, trace sand, trace gravel; dark grey brown; clay fraction medium plasticity; sand fraction fine; gravel fraction fine to coarse; [ALLUVIAL] | >PL | | | | | | | | | | | | 1.45 | | |
| | | | | | | | | | | | | | | U50 | | 1.5 | | |
| | | | | | | | | | | | | | | | | 1.9 | | |
| | 11 | 2.0 | (CH) Sandy CLAY, with gravel; grey brown mottled red; clay fraction medium plasticity; sand fraction fine to coarse; gravel fraction fine; Trace of fine sand below 1.5 | ST | | | | | | | | | | | | 2 | | |
| | | | | | | | | | | | | | | | | 2.5 | | |
| | | | | | | | | | | | | | | SPT | | | SPT | 3,4,7 N=11 |
| | | 3 | (CH) Sandy CLAY, trace gravel; grey mottled brown; clay fraction medium plasticity; sand fraction fine; gravel fraction fine; [RESIDUAL SOIL] | STtoVST | | | | | | | | | | | | 2.95 | | |
| | | | | | | | | | | | | | | | | 3 | | |
| | 10 | | | =PL | | | | | | | | | | | | | | |
| | | 4 | | | | | | | | | | | | | | 4.0 | | |
| | | | | | | | | | | | | | | SPT | | | SPT | 12,13,19 N=32 |
| | 9 | | | | | | | | | | | | | | | 4.45 | | |
| | | 5 | | | | | | | | | | | | | | 5 | | |
| | 8 | | | | | | | | | | | | | | | 5.5 | | |
| | | | | | | | | | | | | | | SPT | | | SPT | 11,13,15 N=28 |
| | | 6 | | | | | | | | | | | | | | 5.95 | | |
| | 7 | | | | | | | | | | | | | | | 6 | | |

NOTES: (#)Soil origin is "probable" unless otherwise stated.

**PLANT:** SCD-115
**OPERATOR:** South Coast Drilling
**LOGGED:** JG

**METHOD:** SFA (TC bit) to 2.5m, rotary (water) to 7.2m, coring (NMLC) to 9.8.
**CASING:** HW to 3.0m

**REMARKS:**

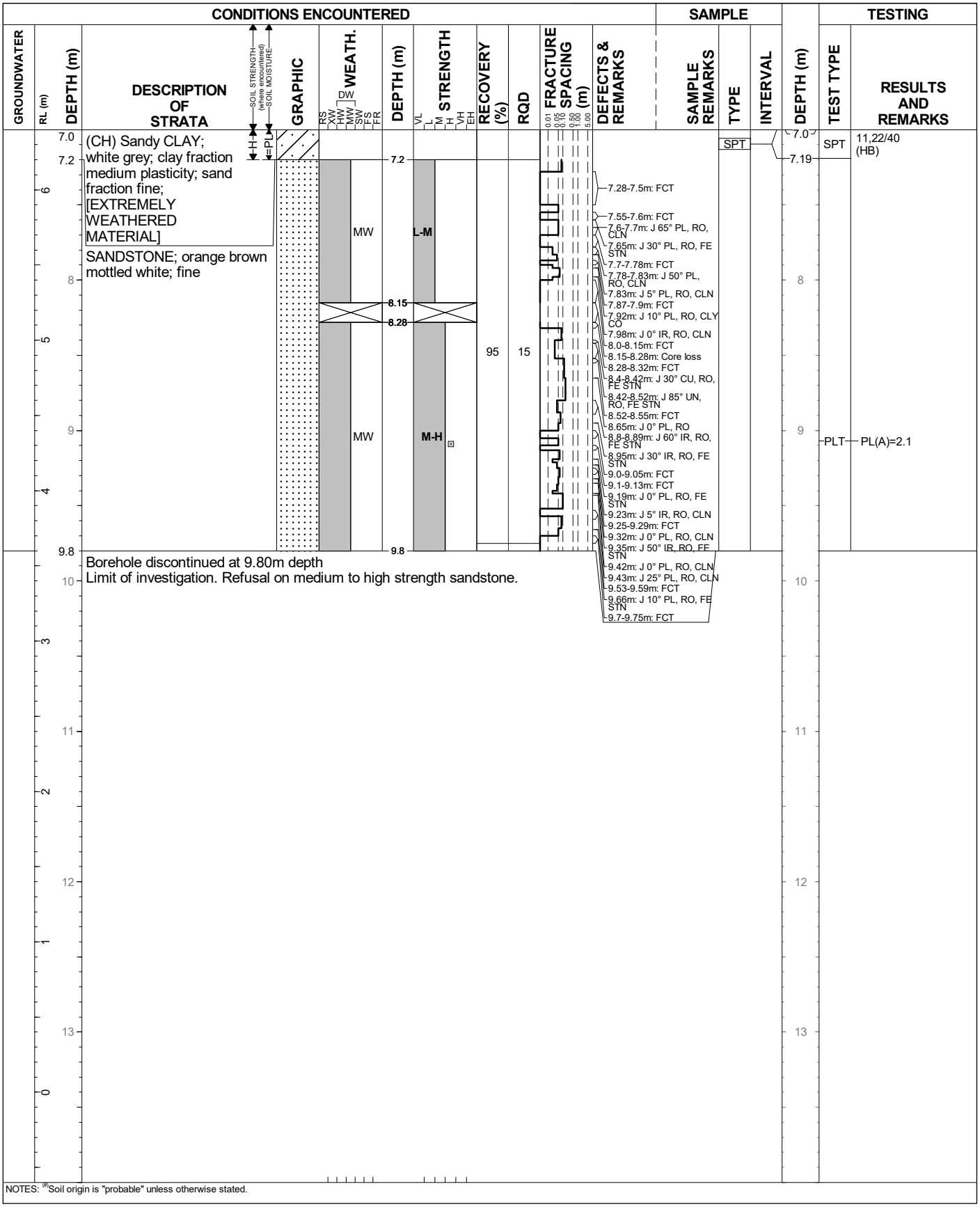
EXPORTED 27/06/23 09:52. TEMPLATE ID: DP_102.02.00_ROCKLOG

# BOREHOLE LOG

**CLIENT:** Integrated Projects Pty Ltd
**PROJECT:** Proposed Club and Car Park Upgrade
**LOCATION:** Dapto Leagues Club, 12 Bong Bong Road, Dapto

**SURFACE LEVEL:** 13.4 AHD
**COORDINATE E:**297371 **N:** 6181044
**DATUM/GRID:** MGA94 Zone 56
**DIP/AZIMUTH:** --/---

**LOCATION ID:** 6
**PROJECT No:** 221880.00
**DATE:** 24/05/23
**SHEET:** 2 of 2




NOTES: (#)Soil origin is "probable" unless otherwise stated.

**PLANT:** SCD-115
**OPERATOR:** South Coast Drilling
**LOGGED:** JG

**METHOD:** SFA (TC bit) to 2.5m, rotary (water) to 7.2m, coring (NMLC) to 9.8.
**CASING:** HW to 3.0m

**REMARKS:**

EXPORTED 27/06/23 09:52. TEMPLATE ID: DP_102.02.00_ROCKLOG


Douglas Partners
Geotechnics | Environment | Groundwater
Project No: 221880.00
BH ID: BH6
Depth: 7.20-9.75m
Core Box No.: 1/1
DAPTO 221880-00 BH6 START @ 7.2m.
7
8
9

# BOREHOLE LOG

**CLIENT:** Integrated Projects Pty Ltd
**PROJECT:** Proposed Club and Car Park Upgrade
**LOCATION:** Dapto Leagues Club, 12 Bong Bong Road, Dapto

**SURFACE LEVEL:** 13.5 AHD
**COORDINATE E:**297431 **N:** 6181023
**DATUM/GRID:** MGA94 Zone 56
**DIP/AZIMUTH:** --/---

**LOCATION ID:** 7
**PROJECT No:** 221880.00
**DATE:** 22/05/23
**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 | RESULTS AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13.5 | 0.03 | FILL/ ASPHALTIC CONCRETE; black dark grey; fine to medium; Wearing course | | FILL | | D | | A | 0.1–0.2 | 0.1 | | |
| | 13.2 | 0.3 | FILL/ (SP) Gravelly SAND; dark grey; sand fraction fine to medium; gravel fraction fine; Basecourse | | ALV | F | =PL | | A | 0.4–0.5 | 0.4 | | |
| | 12.5 | 1 | (CH) Silty CLAY, trace gravel; dark grey brown; clay fraction high plasticity; gravel fraction fine to medium | | ALV | F | =PL | | A | 0.9–1.0 | 0.9 | | |
| 1.65 m depth, 06/06/23 | 12.2 | 1.3 | | | ALV | F | =PL | | SPT | 1.3–1.45 | 1.45 | SPT | 2,2,2 N=4 |
| | 11.5 | 2 | (CH) Silty CLAY; mottled grey yellow brown red; high plasticity | | ALV | ST | =PL | | | | 2 | | |
| | 11.0 | 2.5 | 2.0-3.6m: Becoming sandy | | ALV | ST | =PL | | SPT | 2.5–2.95 | 2.5 | SPT | 5,5,7 N=12 |
| | 10.5 | 3 | | | ALV | ST | =PL | | U50 | 3.0–3.4 | 2.95 | | |
| | 9.9 | 3.6 | (Cl) Sandy CLAY, trace gravel; yellow-brown mottled pale grey; clay fraction medium plasticity; sand fraction fine to coarse; gravel fraction fine | | RES | VST TO H | =PL | | SPT | 4.0–4.45 | 4.0 | SPT | 11,15,16 N=31 |
| | 8.5 | 5 | | | RES | VST TO H | =PL | | | | 5 | | |
| | 8.0 | 5.5 | | | RES | VST TO H | =PL | | SPT | 5.5–5.95 | 5.5 | SPT | 5,10,11 N=21 |
| | 7.5 | 6 | | | RES | VST TO H | =PL | | | | 5.95 | | |
| | 7.0 | 6.5 | | | RES | VST TO H | =PL | | | | 7 | | |
| | 6.2 | 7.3 | (SC) Clayey SAND, trace gravel; red-brown; sand fraction fine; gravel fraction fine to medium; extremely weathered sandstone | | XWM | XWR | M | | SPT | 7.0–7.45 | 7.0 | SPT | 5,7,16 N=23 |
| | 5.0 | 8.5 | Borehole discontinued at 8.50m depth<br>Limit of investigation. Refusal on low to medium strength sandstone. | | | | | | | | 7.45 | | |
| | | | | | | | | | | | 8 | SPT | 25/50 (HB) |
| | | | | | | | | | | | 9 | | |

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

**PLANT:** SCD-115
**OPERATOR:** South Coast Drilling
**LOGGED:** JG

**METHOD:** SFA (TC bit) to 8.5m.
**CASING:**

**REMARKS:** Groundwater observed at 1.6mbgl during auger drilling. Standpipe piezometer installed: screened 5.5-8.5m, sand filter 4-5.5m, bentonite 3-4m, cuttings 0.3-3m, concrete 0-0.3m.

Photo 1 – View north-east at BH 2.

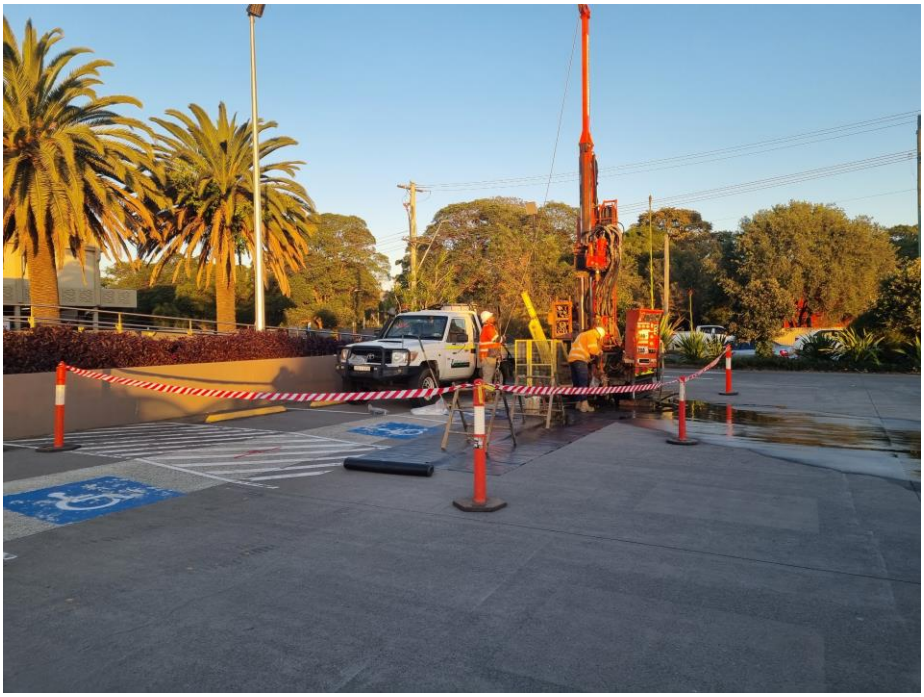


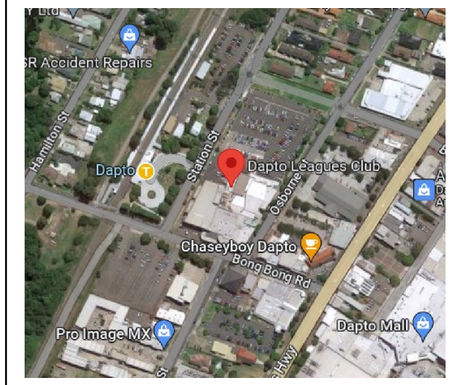
Photo 2 – View south-west at BH 3.

| | | |
|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Site Photographs**<br>**Proposed Club and Car Park Upgrade**<br>**Dapto Leagues Club, Dapto** | PROJECT: 221880.00<br>PLATE No: 1<br>REV: 0 |
| | CLIENT: Integrated Projects Pty Ltd | DATE: Jun 2023 |


Photo 3 – View south-east at BH 4


Photo 4 – View west at BH 6.

| | | | |
|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | **Site Photographs** | PROJECT: | 221880.00 |
| | **Proposed Club and Car Park Upgrade** | PLATE No: | 2 |
| | **Dapto Leagues Club, Dapto** | REV: | 0 |
| | CLIENT: Integrated Projects Pty Ltd | DATE: | Jun 2023 |


Locality Plan

NOTE:
1: Base drawing from Metromap.com (Dated 19/04/2023)

## Legend

- Borehole Location
- Standpipe Piezometer Location
- Approximate Club Upgrade Boundary
- Approximate Car Park Upgrade Boundary

0 10 20 30 40 50

**Douglas Partners**
Geotechnics / Environment / Groundwater

| | | | |
|---|---|---|---|
| CLIENT: | Integrated Projects Pty Ltd | | |
| OFFICE: | Wollongong | DRAWN BY: | JG |
| SCALE: | 1:750 | DATE: | 30/05/23 |

TITLE: Geotechnical Investigation
Proposed Club and Car Park Upgrade
Dapto Leagues Club, Cnr Station St and Bong Bong Rd, Dapto

N

| | |
|---|---|
| PROJECT No: | 221880.00 |
| DRAWING No: | 1 |
| REVISION: | 0 |

# Appendix C

Laboratory Test Results

# Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Unanderra Laboratory
Unit 1/1 Luso Drive Unanderra NSW 2526
Phone: (02) 4271 1836
Email: kevin.spicer@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Kevin Spicer
Laboratory Manager
Laboratory Accreditation Number: 828

**Report Number:** **221880.00-1**
**Issue Number:** 1
**Date Issued:** 10/06/2023
**Client:** Integrated Projects Pty Ltd
PO Box 122, Tanilba Bay NSW 2319
**Contact:** Scott McGregor
**Project Number:** 221880.00
**Project Name:** Proposed Club and Car Park Upgrade
**Project Location:** Dapto Leagues Club, Dapto NSW
**Work Request:** 10305
**Sample Number:** WO-10305A
**Date Sampled:** 22/05/2023
**Dates Tested:** 01/06/2023 - 08/06/2023
**Sampling Method:** Sampled by Engineering Department
*The results apply to the sample as received*
**Preparation Method:** AS 1289.1.1 - Sampling and preparation of soils
**Sample Location:** **1 , Depth: 0.9-1.0m**
**Material:** Sandy CLAY

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 103 | | |
| Plastic Limit (%) | 31 | | |
| **Plasticity Index (%)** | **72** | | |

| Linear Shrinkage (AS1289 3.4.1) | | Min | Max |
|---|---|---|---|
| Moisture Condition Determined By | AS 1289.3.1.2 | | |
| Linear Shrinkage (%) | **26.0** | | |
| Cracking Crumbling Curling | Curling | | |

| Moisture Content (AS 1289 2.1.1) | | Min | Max |
|---|---|---|---|
| Moisture Content (%) | 36.8 | | |

# Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Unanderra Laboratory
Unit 1/1 Luso Drive Unanderra NSW 2526
Phone: (02) 4271 1836
Email: kevin.spicer@douglaspartners.com.au

| | |
|---|---|
| **Report Number:** | **221880.00-1** |
| **Issue Number:** | 1 |
| **Date Issued:** | 10/06/2023 |
| **Client:** | Integrated Projects Pty Ltd |
| | PO Box 122, Tanilba Bay NSW 2319 |
| **Contact:** | Scott McGregor |
| **Project Number:** | 221880.00 |
| **Project Name:** | Proposed Club and Car Park Upgrade |
| **Project Location:** | Dapto Leagues Club, Dapto NSW |
| **Work Request:** | 10305 |
| **Date Sampled:** | 22/05/2023 |
| **Dates Tested:** | 01/06/2023 - 01/06/2023 |
| **Sampling Method:** | Sampled by Engineering Department |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Location:** | Dapto Leagues Club, Dapto |

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Kevin Spicer
Laboratory Manager
Laboratory Accreditation Number: 828

| Shrink Swell Index AS 1289 7.1.1 & 2.1.1 | | | | | |
|---|---|---|---|---|---|
| Sample Number | WO-10305B | | | | |
| Date Sampled | 22/05/2023 | | | | |
| Date Tested | 01/06/2023 | | | | |
| Material Source | ** | | | | |
| Sample Location | 2 (1.5-1.9m) | | | | |
| Inert Material Estimate (%) | 3 | | | | |
| Pocket Penetrometer before (kPa) | 140 | | | | |
| Pocket Penetrometer after (kPa) | 100 | | | | |
| Shrinkage Moisture Content (%) | 25.7 | | | | |
| Shrinkage (%) | **6.2** | | | | |
| Swell Moisture Content Before (%) | 27.3 | | | | |
| Swell Moisture Content After (%) | 28.0 | | | | |
| Swell (%) | **-0.1** | | | | |
| Shrink Swell Index Iss (%) | **3.4** | | | | |
| Visual Description | CLAY | | | | |
| Cracking | UC | | | | |
| Crumbling | No | | | | |
| Remarks | ** | | | | |

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.
Cracking Terminology: UC Uncracked, SC Slightly Cracked, MC Moderately Cracked, HC Highly Cracked, FR Fragmented.
NATA Accreditation does not cover the performance of pocket penetrometer readings.

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

# CERTIFICATE OF ANALYSIS 324627

## Client Details

| | |
|---|---|
| **Client** | Douglas Partners Unanderra |
| **Attention** | Arthur Castrissios |
| **Address** | Unit 1, 1 Luso Drive, Unanderra, NSW, 2526 |

## Sample Details

| | |
|---|---|
| **Your Reference** | **221880.00 Dapto** |
| **Number of Samples** | 4 Soil |
| **Date samples received** | 01/06/2023 |
| **Date completed instructions received** | 01/06/2023 |

## Analysis Details

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

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

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

**Please refer to the last page of this report for any comments relating to the results.**

## Report Details

| | |
|---|---|
| **Date results requested by** | 08/06/2023 |
| **Date of Issue** | 08/06/2023 |

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

**Results Approved By**
Nancy Zhang, Laboratory Manager, Sydney

**Authorised By**
Nancy Zhang, Laboratory Manager

| Misc Inorg - Soil | | | | | |
|---|---|---|---|---|---|
| Our Reference | | 324627-1 | 324627-2 | 324627-3 | 324627-4 |
| Your Reference | UNITS | BH1 | BH3 | BH5 | BH7 |
| Depth | | 1.4-1.5 | 2.5-2.95 | 0.9-1 | 5.-5.95 |
| Date Sampled | | 29/05/2023 | 23/05/2023 | 24/05/2023 | 22/05/2023 |
| Type of sample | | Soil | Soil | Soil | Soil |
| Date prepared | - | 01/06/2023 | 01/06/2023 | 01/06/2023 | 01/06/2023 |
| Date analysed | - | 06/06/2023 | 06/06/2023 | 06/06/2023 | 06/06/2023 |
| pH 1:5 soil:water | pH Units | 5.3 | 5.4 | 7.6 | 7.4 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 130 | 82 | 410 | 71 |
| Chloride, Cl 1:5 soil:water | mg/kg | 86 | 85 | 67 | 21 |
| Sulphate, SO4 1:5 soil:water | mg/kg | 160 | 20 | 560 | 35 |

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

| QUALITY CONTROL: Misc Inorg - Soil | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-1 | [NT] |
| Date prepared | - | | | 01/06/2023 | 1 | 01/06/2023 | 01/06/2023 | | 01/06/2023 | [NT] |
| Date analysed | - | | | 06/06/2023 | 1 | 06/06/2023 | 06/06/2023 | | 06/06/2023 | [NT] |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | 1 | 5.3 | 5.2 | 2 | 101 | [NT] |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | <1 | 1 | 130 | 150 | 14 | 106 | [NT] |
| Chloride, Cl 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | 1 | 86 | 120 | 33 | 97 | [NT] |
| Sulphate, SO4 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | 1 | 160 | 170 | 6 | 113 | [NT] |

## Result Definitions

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

## Quality Control Definitions

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

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

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

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

## Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

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

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

## Report Comments

Holding time exceedance for pH except for sample #2 and #4.

Douglas Partners
Geotechnics / Environment / Groundwater

# RESULTS OF ACID SULFATE SCREENING TESTS

**Client:** Integrated Projects Pty Ltd

**Project:** Proposed Club and Park Upgrade

**Project Location:** Dapto Leagues Club, 12 Bong Bong Road

**Project No:** 221880.00

**pH Meter:** ☑ TPS with Ionode IJ46/WP80 pH/Temp. Electrode
☑ PH Scan 2

**Calibration Buffer:** ☑ pH4
☑ pH7
☑ pH10

| Sample Location | Depth (m) | $pH_F$ (in distilled water) | $pH_{FOX}$ (oxidised in $H_sO_s$) | | | Strength of Reaction | Soil Description |
|---|---|---|---|---|---|---|---|
| | | Date: 2/06/2023 | Date: 2/06/2023 | Date: | Date: | (1,2,3,4)* | |
| | | Time: 11:00 AM | Time: 1:00 PM | Time: | Time: | F ** | |
| 1 | 0.1 – 0.2 | 8.30 | 7.65 | | | 2 | |
| 1 | 0.4 – 0.5 | 7.55 | 6.31 | | | 1 | |
| 1 | 2.4 – 2.5 | 5.28 | 4.88 | | | 1 | |
| 2 | 0.1 – 0.2 | 9.23 | 7.80 | | | 2 | |
| 2 | 0.4 – 0.5 | 6.15 | 4.05 | | | 2 | |
| 2 | 0.9 – 1 | 5.44 | 4.08 | | | 1 | |
| 2 | 1 – 1.45 | 7.16 | 3.37 | | | 1 | |
| 3 | 0.2 – 0.3 | 7.53 | 6.34 | | | 2 | |
| 3 | 0.4 – 0.51 | 6.82 | 6.30 | | | 1 | |
| 3 | 0.9 – 1 | 6.45 | 5.96 | | | 1 | |
| 3 | 1 – 1.45 | 8.90 | 5.36 | | | 1 | |
| 4 | 0.1 – 0.2 | 7.71 | 7.43 | | | 2 | |
| 4 | 0.4 – 0.5 | 7.64 | 6.36 | | | 1 | |
| 4 | 0.9 – 1 | 5.89 | 4.55 | | | 1 | |
| 4 | 1 – 1.45 | 5.85 | 4.63 | | | 1 | |

*Legend:* * *1 denotes no or slight effervescence*
*2 denotes moderate effervescence*
*3 denotes vigorous effervescence*
*4 denotes "volcano" ie. very vigorous effervescence, gas evolution and heat*
** F after reaction number indicates a bubbling/frothy reaction (organics)

Operator: CS

Date: 2/06/2023

# RESULTS OF ACID SULFATE SCREENING TESTS

| Sample Location | Depth (m) | $pH_F$ (in distilled water) | $pH_{FOX}$ (oxidised in $H_sO_s$) | | | Strength of Reaction | Soil Description |
|---|---|---|---|---|---|---|---|
| | | Date: 2/06/2023 | Date: 2/06/2023 | Date: | Date: | (1,2,3,4)* | |
| | | Time: 11:00 AM | Time: 1:00 PM | Time: | Time: | F ** | |
| 5 | 0.1 – 0.2 | 12.42 | 12.33 | | | 4 | |
| 5 | 0.4 – 0.5 | 9.20 | 7.27 | | | 1 | |
| 5 | 1 – 1.45 | 8.60 | 7.20 | | | 1 | |
| 6 | 0.1 – 0.2 | 12.59 | 13.09 | | | 4 | |
| 6 | 0.4 – 0.5 | 8.63 | 6.84 | | | 2 | |
| 6 | 0.9 – 1 | 9.31 | 7.73 | | | 1 | |
| 6 | 1 – 1.45 | 6.30 | 5.22 | | | 1 | |
| 7 | 0.1 – 0.2 | 12.48 | 13.12 | | | 4 | |
| 7 | 0.4 – 0.5 | 8.05 | 6.83 | | | 1 | |
| 7 | 0.9 – 1 | 8.33 | 6.98 | | | 1 | |
| 7 | 1 – 1.45 | 5.75 | 4.69 | | | 1 | |
| 7 | 2.5 – 2.95 | 5.65 | 4.80 | | | 1 | |

*Legend:* * *1 denotes no or slight effervescence*
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Operator: CS

Date: 2/06/2023

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# CERTIFICATE OF ANALYSIS 325124

## Client Details

| | |
|---|---|
| **Client** | Douglas Partners Unanderra |
| **Attention** | Arthur Castrissios, Christian Serafines |
| **Address** | Unit 1, 1 Luso Drive, Unanderra, NSW, 2526 |

## Sample Details

| | |
|---|---|
| **Your Reference** | **221880.00, Dapto** |
| **Number of Samples** | 3 Soil |
| **Date samples received** | 07/06/2023 |
| **Date completed instructions received** | 07/06/2023 |

## Analysis Details

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

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

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

## Report Details

| | |
|---|---|
| **Date results requested by** | 16/06/2023 |
| **Date of Issue** | 16/06/2023 |

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**Results Approved By**
Nick Sarlamis, Assistant Operation Manager

**Authorised By**
Nancy Zhang, Laboratory Manager

| Chromium Suite | | | | |
|---|---|---|---|---|
| Our Reference | | 325124-1 | 325124-2 | 325124-3 |
| Your Reference | UNITS | BH2 | BH4 | BH7 |
| Depth | | 0.4-0.5 | 1-1.45 | 1-1.45 |
| Date Sampled | | 22/05/2023 | 23/05/2023 | 22/05/2023 |
| Type of sample | | Soil | Soil | Soil |
| Date prepared | - | 15/06/2023 | 15/06/2023 | 15/06/2023 |
| Date analysed | - | 15/06/2023 | 15/06/2023 | 15/06/2023 |
| pH $_{kcl}$ | pH units | 4.2 | 3.4 | 3.4 |
| s-TAA pH 6.5 | %w/w S | 0.03 | 0.18 | 0.18 |
| TAA pH 6.5 | moles $H^+$ /t | 20 | 110 | 110 |
| Chromium Reducible Sulfur | %w/w | 0.02 | <0.005 | 0.01 |
| a-Chromium Reducible Sulfur | moles $H^+$ /t | 15 | <3 | 7 |
| $S_{HCl}$ | %w/w S | 0.012 | 0.023 | 0.037 |
| $S_{KCl}$ | %w/w S | 0.005 | 0.013 | 0.033 |
| $S_{NAS}$ | %w/w S | 0.014 | 0.021 | 0.009 |
| $ANC_{BT}$ | % $CaCO_3$ | [NT] | [NT] | [NT] |
| s-$ANC_{BT}$ | %w/w S | [NT] | [NT] | [NT] |
| s-Net Acidity | %w/w S | 0.070 | 0.20 | 0.20 |
| a-Net Acidity | moles $H^+$ /t | 41 | 120 | 120 |
| Liming rate | kg $CaCO_3$ /t | 3 | 9.3 | 9.2 |
| a-Net Acidity without ANCE | moles $H^+$ /t | 41 | 120 | 120 |
| Liming rate without ANCE | kg $CaCO_3$ /t | 3.1 | 9.3 | 9.2 |
| s-Net Acidity without ANCE | %w/w S | 0.067 | 0.20 | 0.20 |

| Method ID | Methodology Summary |
|---|---|
| **Inorg-068** | Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity.<br><br>Net acidity including ANC has a safety factor of 1.5 applied.<br><br>Neutralising value (NV) of 100% is assumed for liming rate.<br><br>The recommendation that the SHCL concentration be multiplied by a factor of 2 to ensure retained acidity is not underestimated, has not been applied in the SHCL result.<br>However, it has been applied in the SNAS calculation:<br>SNAS % = (SHCL-SKCL)x2 |

| QUALITY CONTROL: Chromium Suite | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-1 | [NT] |
| Date prepared | - | | | 15/06/2023 | [NT] | [NT] | [NT] | [NT] | 15/06/2023 | [NT] |
| Date analysed | - | | | 15/06/2023 | [NT] | [NT] | [NT] | [NT] | 15/06/2023 | [NT] |
| pH $_{kcl}$ | pH units | | Inorg-068 | [NT] | [NT] | [NT] | [NT] | [NT] | 98 | [NT] |
| s-TAA pH 6.5 | %w/w S | 0.01 | Inorg-068 | <0.01 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| TAA pH 6.5 | moles $H^+$ /t | 5 | Inorg-068 | <5 | [NT] | [NT] | [NT] | [NT] | 100 | [NT] |
| Chromium Reducible Sulfur | %w/w | 0.005 | Inorg-068 | <0.005 | [NT] | [NT] | [NT] | [NT] | 102 | [NT] |
| a-Chromium Reducible Sulfur | moles $H^+$ /t | 3 | Inorg-068 | <3 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| $S_{HCl}$ | %w/w S | 0.005 | Inorg-068 | <0.005 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| $S_{KCl}$ | %w/w S | 0.005 | Inorg-068 | <0.005 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| $S_{NAS}$ | %w/w S | 0.005 | Inorg-068 | <0.005 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| $ANC_{BT}$ | % $CaCO_3$ | 0.05 | Inorg-068 | <0.05 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| s-$ANC_{BT}$ | %w/w S | 0.05 | Inorg-068 | <0.05 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| s-Net Acidity | %w/w S | 0.005 | Inorg-068 | <0.005 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| a-Net Acidity | moles $H^+$ /t | 5 | Inorg-068 | <5 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| Liming rate | kg $CaCO_3$ /t | 0.75 | Inorg-068 | <0.75 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| a-Net Acidity without ANCE | moles $H^+$ /t | 5 | Inorg-068 | <5 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| Liming rate without ANCE | kg $CaCO_3$ /t | 0.75 | Inorg-068 | <0.75 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |
| s-Net Acidity without ANCE | %w/w S | 0.005 | Inorg-068 | <0.005 | [NT] | [NT] | [NT] | [NT] | [NT] | [NT] |

## Result Definitions

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

## Quality Control Definitions

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

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

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

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

## Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

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

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