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Remediation Action Plan

Proposed PLC Hotel Development
1 Eels Place, Parramatta, NSW

Prepared for
Parramatta Leagues Club

Project 94523.00
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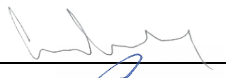
Author		7 December 2018
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Table of Contents

Page

Remediation Action Plan
Proposed PLC Hotel Development
1 Eels Place, Parramatta, NSW

1. Introduction

This remediation action plan (RAP) prepared by Douglas Partners Pty Ltd (DP) documents a strategy for site remediation for a proposed plc hotel development at 1 Eels Place, Parramatta (the site). The investigation was commissioned by Thomas Gould of APP Corporation Pty Ltd on behalf of Parramatta Leagues Club (PLC) and was undertaken in accordance with DP's proposal NWS180079 dated 11 October 2018.

Specifically, the RAP proposes a strategy for remediation of asbestos-impacted soil at the site. A locality and site plan are shown on Drawing 1, Appendix A.

It is understood that the RAP is required to support a development application (DA) for the site. Therefore, the goal/objective of the remediation programme will be to render the site suitable for the proposed multi-storey Parramatta Leagues Club (PLC) Hotel development.

The proposed development involves the construction of a 17 storey hotel building with a single level basement. The basement level is at RL 10.0 m AHD (approximately 3.5 m below the existing ground surface), the lower ground floor is at RL 12.35 m AHD and upper ground floor at RL 13.8 m AHD.

The approximate boundaries of the building footprint and lower floor footprint are shown on Drawing 1, Appendix A.

The following provides a list of previous relevant reports undertaken at the site by Environmental Investigation Services (EIS) and DP (discussed in Section 4):

- EIS - Report to Parramatta Leagues Club, Preliminary Environmental Site Assessment for a Proposed Multistorey Car Park at Parramatta Leagues Club, O'Connell Street, Parramatta NSW, REF: E28152KHrpt, 18 March 2015 (EIS, 2015a);
- EIS - *Report to Parramatta Leagues Club, Stage 2 Environmental Site Assessment for a Proposed Multistorey Car Park at Parramatta Leagues Club, O'Connell Street, Parramatta NSW*, REF: E28152KHrpt2, 9 July 2015 (EIS, 2015b);
- EIS - Report to Parramatta Leagues Club, Remediation Action Plan for a Proposed Multistorey Car Park at Parramatta Leagues Club, O'Connell Street, Parramatta NSW, REF: E28152KHrpt3-RAP-rev1, 14 October 2015 (EIS, 2016); and
- DP - Report on *Detailed Site Investigation Proposed PLC Hotel Development, 1 Eels Place, Parramatta*, DP Ref: 94523.00.R.002.Rev0, dated 30 November 2018 (DP, 2018).

The scope of the RAP has been established on the basis of the findings of the previous investigations and in the context of the proposed development. The scope of the RAP is to:

- Provide a summary of the site history, regional topography, geology and hydrogeology;
- Provide a summary of soil and groundwater data to date;
- Provide a conceptual site model (CSM);
- Establish appropriate remediation acceptance criteria (RAC);
- Undertake a remediation options evaluation;
- Select a preferred remediation option(s);
- Establish appropriate requirements for the validation and verification of remediation;
- Outline the requirements for the remediation works to be completed in an environmentally acceptable manner; and
- Outline the requirements for appropriate work, health and safety (WHS) procedures to be adopted for the remediation work so as not to pose a threat to the health of site workers.

2. Site Identification and Description

The site is identified as part Land Crown Plan 80-3000. The street address is 1 Eels Place, Parramatta. The site is shown on Drawing 1, Appendix A.

The site is irregular in shape, covers an area of approximately 0.3 hectares, and is located on reasonably level ground format approximately 12 m relative to Australia Height Datum (AHD).

At the time of previous investigations, the site comprised a car park constructed of asphaltic concrete pavement and was bounded by Parramatta Leagues Club (PLC) to the northeast, PLC multi-story carpark to the northwest, Ross Street Gatehouse to the south east, Parramatta Stadium to the south and open space to the southwest.

3. Proposed Development

Following a review of client supplied return brief for the proposed development[1], the proposed development will involve the construction of a 17 storey hotel building with a single level basement. The building footprint extends beyond the basement footprint on its western side. Filling will be required on the western side to build up existing ground surface levels to the underside of the floor slab.

From information provided, the basement floor level is at RL 10.0 m AHD, lower ground floor is at RL 12.35 m AHD and upper ground floor at RL 13.8 m AHD. Based on these levels bulk excavation to depths in the order of 3.5 m is proposed. The basement footprint is not expected to extend to the site boundaries. The basement will include storage, locker rooms and laundry facilities.

[1] Hassell, Parramatta Leagues Club, Hotel Development, Return Brief, Rev2, dated June 2018

Light poles are located in the car park and a number are located on the southern nature strip bordering the carpark. Decommissioning and removal of the light poles is required prior to excavations due to underground services. Stormwater pipes located on site and generally expected to at depths of 0.5 m to 1.0 m below existing levels. The presence of the stormwater is/is not expected to impact on the proposed development except where stormwater lines are to be diverted, relocated or decommissioned.

A large Eucalyptus tree is located adjacent to the eastern boundary of the site. This Eucalyptus tree is to be retained during the development.

The layout of the proposed development is shown on Drawing 1 (Appendix A).

The development is proposed to include the upgrade of existing areas surrounding the proposed hotel building to integrate with existing infrastructure.

4. Roles and Responsibilities

In order to achieve the goals of the capping/earthworks programme, the following roles have been identified for the contractor and consultants:

Contractor(s)

The contractor(s) is responsible for on-site operations including (but not limited to):

- Handling of fill materials (contaminated or otherwise) including excavations, stockpiles, segregation, placement, compaction, and disposal of excess fill materials. Considering the presence of FA/AF, all remediation works involving fill at the site must be undertaken by a licensed SafeWork NSW Class A – Asbestos Removalist.
- Management of water on site including water storage, treatment and disposal;
- Safety of all personnel on site; and
- Measures to minimise environmental effects.

Douglas Partners Pty Ltd – General Site Validation

- Full-time attendance during excavation of asbestos-impacted fill and part time attendance during earthworks;
- Sampling and classification of on-site and imported fill materials (where required); and
- Provision of a validation report detailing the works undertaken to render the site suitable for the proposed development.

APP Corporation Pty Ltd – Project Manager

- Engagement of the contractors;
- Organisation, management and overseeing of earthworks and construction;
- Contingency plans to respond to site incidents;
- Prior to the commencement of remediation, a site meeting between the contractor, APP and DP is recommended to confirm responsibilities and procedures in accordance with the agreed management plan.

5. Geology and Hydrogeology

Reference to DP (2018) indicates that the site is underlain by Ashfield Shale of the Wianamatta Group. Ashfield Shale typically comprises dark grey to black shale, siltstone and laminate which weathers to a residual clay profile of medium to high plasticity. The site is located on residual soil of the Lucas Heights residual Landscape Group. The Lucas Heights Group is characterised by stony soils of low fertility and low water capacity.

DP (2018) indicates that the site is classified as Soil Class 5. The Parramatta River, located approximately 160 m west of the site classifies as Class 1, with Class 1, 3 and 4 located on a meander bend to the south. As per the Parramatta Local Environment Plan 2011, any works done on a site that is below 5 metres AHD and by which the water table is likely to be lowered below 1 metre AHD on adjacent Class 1, 2, 3 or 4 land, present an environmental risk.

It is noted that some alluvial sediments (river deposited sands, silts and clays) may be present overlying the bedrock associated with the nearby Parramatta River and possible old creek line located to the south-west of the site.

Groundwater was previously reported in EIS (2015b) at approximately 4.98 m below ground level (bgl), however, it was not encountered during groundwater investigations at 3 m to 6 m bgl in DP (2018). Groundwater is considered likely to flow in a south and south westerly direction towards the Parramatta River, located approximately 160 m to the west.

6. Summary of Previous Investigations

6.1 EIS (2015a) – Preliminary Site Investigation

EIS previously conducted a preliminary environmental site assessment (PESA) for an area to the northwest of the site which included the recently constructed multi-story car park. The EIS (2015a) investigation boundary encroached onto the northwest of the site.

EIS (2015a) included a review of 1943 and 2011 historical aerial photographs, a site inspection and sampling and analysis from five boreholes, two of which (BH4 and BH5) were located in the current site boundary.

The key findings of EIS (2015a) were as follows:

- The historical investigation indicated that the site land use comprised a park prior to 1947, with the land use changing to a car park prior to 2015. No other historical information was provided;
- Fill extended to a depth of approximately 0.5 m in the current site;
- Results of chemical analysis reported no exceedances of the following contaminants of potential concern (COPC): TRH, PAH, BTEX, OPP, OCP and PCB;
- Two nickel exceedances of the ecological criteria was reported at BH4/0.1-0.2 and BH5/0.1-0.2;
- Fill in BH1 (outside the current site boundary) contained traces of ash in fill and asbestos was detected at between 2.5 m and 2.8 m below ground level (bgl) in the form of fibre cement fragments. The fill was considered likely to be backfill associated with the nearby sewer; and
- Data gaps were identified and it was indicated that further assessment of fill, including the extent of asbestos would need to be assessed.

6.2 EIS (2015b) – Phase 2 Contamination Investigation

A stage two environmental site assessment was carried out on a larger area covering the EIS (2015a) site to the northwest and the current site, and included the drilling of boreholes, sampling and analysis.

For a 12,500m^2 site a minimum of 23 sampling points are recommended (NSW EPA Contaminated Sites Sampling Design Guidelines, 1995). This investigation included the drilling of 18 boreholes, seven of which (BH101, BH111, BH114 to BH118) were located in the current site boundary. The investigation and also included the results of the five boreholes drilled previously as part of EIS (2015a). The total density (23 locations) met the minimum sampling density recommended.

The following discusses the findings of EIS (2015b) relevant to the site.

Intrusive Investigations

- Pavement /asphaltic concrete was reported up to 0.1m bgl;
- Fill was reported beneath pavement in all boreholes and generally extended to depths of 0.2 - 0.5 m bgl;
- Natural soils were encountered to depths of approximately 5.0 m to 5.8 m bgl; and
- Bedrock (sandstone bedrock) was encountered to maximum depths of 9.58 m bgl.

Groundwater

- Groundwater monitoring wells were installed in BH1 and BH4 (with BH4 located within the current site area). The standing water levels (SWLs) were measured at 3.63 m and 4.98 m bgl in the monitoring wells, respectively.

Laboratory Testing

- Soil and groundwater samples were tested for a suite of common contaminants;
- Heavy metals, BTEX, PAH, OCP, OPP and PCB results were below adopted health site assessment criteria;
- Several nickel and copper results were above the adopted ecological site assessment;
- Asbestos in the form of loose fibre bundles and bonded asbestos cement was detected in a fill sample from BH101 and BH104. BH101 was located within the current site area. The fragment at BH101 (weighing 3.22 g) was reported in fill 0.3 - 0.5 m bgl adjacent to a sewer and was reported to be potentially friable; and
- There were exceedances of nickel and zinc in the groundwater samples.

CSM

The CSM identified fill (in particular deep fill in the western section of the EIS (2015b) site and hazardous building materials (from previously demolished buildings) to be potential sources of contamination.

Recommendations

EIS (2015b) highlighted the following data gaps:

- The horizontal extent of asbestos contamination has not been adequately addressed, however, it was considered that contamination likely extends over the whole of the larger site;
- The nature of the asbestos encountered has not been confirmed, however, indicated the potential for friable material due to presence of 'loose fibre bundles'.

EIS considered the larger site could be made suitable for the car park development provided that the below recommendations were carried out and data gaps were closed out to mitigate further risks:

- Prepare a remediation action plan (RAP);
- Prepare an asbestos management plan (AMP);
- Prepare a validation assessment; and
- Prepare an environmental management plan (EMP).

6.3 EIS (2016) – Remediation Action Plan

The EIS RAP was prepared to identify potential remediation options, outline the remediation procedures, and validation sampling and analysis plan for the remediation work based on the results of EIS (2015a) and EIS (2015b).

As per EIS (2015c), all fill at the site was considered to be impacted with asbestos, with remediation options comprising either (i) off-site disposal, or (ii) on-site capping.

Considering no excavations for the proposed development were planned at that stage, it was considered that capping of the site (with hardstand and soil materials) was the most appropriate remediation method.

6.4 DP (2018) – Detailed Site Investigation

A detailed site investigation (DSI) was undertaken to supplement the EIS (2015a and 2015b) contamination investigations and included a desktop study and intrusive investigations in three boreholes (BH201, BH202 and BH203). The three boreholes were converted into groundwater monitoring wells at the conclusion of drilling. Considering the presence of acid sulfate soils (ASS) within 160 m of the site, testing was undertaken to investigate if ASS or potential ASS (PASS) was present. Test locations are shown on Drawing 1 in Appendix A. The report findings are summarised as follows:

Desktop Study

- The site's land use appeared to comprise open space associated with Parramatta Park until the 1960s when site began to be used as a car park, and appeared to be utilised as a car park until present day;
- Soil fill or a ground disturbance was noted across much of the surface of the site in the 1970s;
- Asphalt appeared to have been laid at the site on at least two occasions, potentially introducing coal tar to the site;
- Former structures were observed in the south of the site in the 1960s which were demolished in the 1970s; and
- Current and former off-site service stations and dry cleaners were identified as potential sources of contamination groundwater at the site.

Conceptual Site Model

The CSM identified fill across the surface of the site underlying the asphalt concrete, potentially hazardous building materials (from previously demolished structures), the car park, and off-site service stations and dry cleaners to be potential sources of contamination.

Field Work

- Asphaltic concrete was present (70 mm to 150 mm thick) overlying road base gravels to depths ranging between 0.25 m and 0.4 m;
- Fill comprising grey silty clay or gravelly sand filling with traces of gravel and sand was reported in all three boreholes to depths ranging 0.4 m to 0.6 m bgl;
- The underlying material comprised residual soils described as typically very stiff or hard silty brown, orange and red mottled grey silty clay with traces of gravel. In BH203, light brown clayey silt was encountered below the filling to a depth of 0.8 m and sandy clay was encountered below a depth of 5.5 m;
- Extremely low strength white/grey weathered sandstone was encountered in BH201 and BH202 at depths of 3.1 m and 4.8 m, respectively;

- No groundwater was reported during drilling or at the conclusion of installing the groundwater monitoring wells; and
- No signs of contamination, such as asbestos, staining or odours were reported.

Bore logs are provided in Appendix C.

Laboratory Testing

- Soil samples were tested for a suite of common contaminants;
- Reported concentrations of BTEX, TRH, PAH, OCP, phenols, OPP and PCB were below adopted site assessment criteria;
- Reported concentrations of heavy metals did not exceed the adopted site assessment criteria with the exception of nickel and copper from EIS investigations, which reported ecological exceedances in fill at BH111, BH115, BH116, BH117 and BH118;
- Trace asbestos in the form of friable asbestos/asbestos fines FA/AF was reported in a surface fill sample from BH202 at a concentration below the adopted site assessment criteria;
- The laboratory analysis indicated that ASS was not present but that site soils are acidic; and
- No groundwater samples were able to be collected for analysis as the wells, after being inspected on two consecutive occasions, were dry.

Summary Tables H1 and H2 extracted from the DSI are provided in Appendix B.

Conclusions/Recommendations
The investigation identified asbestos and elevated nickel and copper in the fill. Management of these were required during the development of the site.

The fill at the site waste classified as Special (Asbestos) Waste – General Solid Waste (non-putrescible) and the natural soils, which are acidic, have been preliminarily classified as General Solid Waste.

Further investigation of groundwater at the site was not required unless plans for development change to extend beyond the proposed 3.5 m depth.

It was recommended that a remediation action plan (RAP) was prepared with reference to NSW OEH, *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites* (OEH, 2011). The RAP was recommended to include:

- Assessment and management of the extent of asbestos impacted filling;
- Assessment and management of filling to remain on site;
- Assessment and management of acidic soils; and
- An unexpected finds protocol to manage contamination encountered during the works.

7. Revised Conceptual Site Model

The conceptual site model (CSM) in the DSI has been revised based on the findings of the DSI. The revised CSM is summarised in Table 1 below.

Table 1: Summary of Potential Complete Pathways Based on Proposed Development (DP, 2018)

Source and COPC	Findings of Investigation	Transport Pathway	Receptor	Risk Management Action Recommended
S1: Filling impacted with metals and FA/AF asbestos	Friable asbestos/asbestos fines was reported in a surficial fill sample at BH202, and potentially friable asbestos was reported in surface fill at BH101. Ecological exceedances for copper and nickel were reported in samples at BH111, BH115, BH116, BH117 and BH118	P1: Ingestion and dermal contact P2: Inhalation of dust and/or vapours	R1: Current users and workers R2: Construction and maintenance workers R3: End users and workers	Fill at the site is considered to be impacted with metals and asbestos, and as such, require further assessment and / or management / remediation given the potentially complete exposure pathway under the proposed land use.
		P2: Inhalation of dust and/or vapours	R4: Adjacent site users	
		P3 – Surface water run-off P4: Lateral migration of groundwater providing base flow to water bodies	R5: Surface water	
		P5 – Leaching of contaminants and vertical migration into groundwater	R6: Groundwater	
		P6 –Contact with terrestrial ecology	R7 – Terrestrial ecology	

8. Remediation Acceptance Criteria

On the basis of the proposed land use (i.e. commercial), the DP (2018) adopted SAC will also be used as the remediation acceptance criteria (RAC) as follows:

- **Health Investigation levels (HIL) - D** – Commercial land use;
- **Health Screening Levels (HSL) - D** – Commercial land use for vapour intrusion;
- **Ecological Investigation Levels (EIL) - D** – Commercial land use; and
- Ecological Screening Levels (ESL) – D – Commercial land use.

The contaminants relevant to site remediation are metals and asbestos. However, given the potential for unexpected finds during site remediation and development, the RAC for other contaminants have also been included for reference.

The RAC for asbestos are as follows:

- 0.001 % asbestos for FA/AF;
- 0.05 % w/w asbestos for ACM – Commercial; and
- No visible asbestos for surface soils.

Tables 2, 3 and 4 list the RAC for metals and other potential contaminants requiring remediation at the site. Refer to DP (2018) for more information relating to the inputs of derivation. Generic land uses are described in detail in the NEPC (2013), Schedule B7 Section 3.

Table 2: Health Investigation and Screening Levels (HILs/HSLs) in mg/kg

Contaminants		HIL-D	HSL- D Vapour Intrusion 0-<1 m
Metals	Arsenic	3000	-
	Cadmium	900	-
	Chromium (III+VI)	3600	-
	Copper	240,000	-
	Lead	1,500	-
	Mercury	730	-
	Nickel	600	-
	Zinc	400,000	-
TRH	C6 – C10 (less BTEX) [F1]	-	310
	>C10-C16 (less Naphthalene) [F2]	-	NL
	>C16-C34 [F3]	-	NL[3]
	>C34-C40 [F4]	-	NL[3]
BTEX	Benzene	-	4
	Toluene	-	NL[3]
	Ethylbenzene	-	NL[3]
	Xylenes	-	230
PAH	Benzo(a)pyrene TEQ[1]	40	-
	Naphthalene	-	NL[3]
	Total PAH	4000	-

Contaminants		HIL-D	HSL- D Vapour Intrusion 0-<1 m
OCP	Aldrin + Dieldrin	45	-
	Chlordane	530	-
	DDT+DDE+DDD	3600	-
	Endosulfan	2000	-
	Endrin	100	-
	Heptachlor	50	-
	HCB	80	-
	Methoxychlor	2500	-
OPP	Chlorphyrifos	2000	-
PCB [2]		7	-
Pentachlorophenol (used as an initial screen)		660	-

Notes:

1 sum of carcinogenic PAH

2 non dioxin-like PCBs only

3 The soil saturation concentration (Csat) is defined as the soil concentration at which the porewater phase cannot dissolve any more of an individual chemical. The soil vapour that is in equilibrium with the porewater will be at its maximum. If the derived soil HSL exceeds Csat, a soil vapour source concentration for a petroleum mixture could not exceed a level that would results in the maximum allowable vapour risk for the given scenario. For these scenarios, no HSL is presented for these chemicals and the HSL is shown as 'not limiting' or 'NL'.

Table 3: EIL in mg/kg

Analyte		EIL	Comments
Metals	Arsenic	160	**Adopted parameters** pH = 5.8 (average) CEC = 4.25 "Aged" (>2 years) source of contamination Low for traffic volumes in NSW Urban residential Clay content estimated at 10%
	Copper	130	
	Nickel	45	
	Chromium III	670	
	Lead	1800	
	Zinc	380	
PAH	Naphthalene	370	
OCP	DDT	640	

Table 4: Ecological Screening Levels (ESL) in mg/kg

Analyte		ESL – Commercial (Coarse)[1]	Comments
TRH	C6 – C10 (less BTEX) [F1]	215*	All ESLs are low reliability apart from those marked with * which are moderate reliability
	>C10-C16 (less Naphthalene) [F2]	170*	
	>C16-C34 [F3]	1700	
	>C34-C40 [F4]	3300	
BTEX	Benzene	75	
	Toluene	135	
	Ethylbenzene	165	
	Xylenes	180	
PAH	Benzo(a)pyrene	1.4	

Notes: The ESL have been calculated for a coarse soil based on sand being the predominant soil type and commercial classification.

9. Remediation Options Evaluation

Results reported in EIS (2015a and 2015b) and DP (2018) indicate that asbestos (FA/AF) and metals-impacted soils are present throughout fill at the site to depths of fill ranging between 0.2 m and 0.6 m below ground level. The lateral extent of fill has not been delineated. Limited results collected below the fill indicate that contamination of the underlying natural material is not likely, however, further sampling will be required to confirm this.

The EPA's preferred hierarch options for site remediation as cited in NSW EPA (2017) Guidelines for the NSW Site Auditor Scheme (3rd Edition) are as follows:

- Do nothing;
- On-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level;
- Off-site treatment of excavated soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to the site;
- Consolidation and isolation of the soil by on-site containment within a properly designed barrier (capping); or
- Removal of contaminated soil to an approved site or facility, followed where necessary by replacement with clean fill.

Table 5 below summarise the remediation options for asbestos.

Table 5: Remediation Options Evaluation for Asbestos and Metals Impacted Soils

Option	Asbestos	Metals	Option Ranking
Option 1: Do nothing	The presence of asbestos presents a potentially unacceptable risk to site workers, site users and adjacent site users	The presence of metals presents an unacceptable risk to local ecological receptors	Not applicable.
Option 2: On site treatment prior to on site re-use	On site treatment would involve excavation of all filling and removal of asbestos from the soils sufficiently to render the site suitable for the continued commercial land use. This option is not considered viable given on-site treatment is not a viable option to remediate FA/AF.	Not applicable considering the fill is likely impacted with asbestos	Not applicable.
Option 3: Off-site treatment prior to on site re-use	DP is not aware of any facilities licenced for the treatment of asbestos impacted soils in NSW.	Not applicable considering the fill is likely impacted with asbestos	Not applicable.
Option 4: Containment of the impacted soil on site beneath an engineered barrier	Capping of the material would involve removal of a chosen volume of material for the proposed development and capping to contain the remaining asbestos within the site. Capping options include a 0.5 m soil cap or concrete cap. Considering asbestos soils may remain on site at the conclusion of works, an EMP may be required for ongoing management of asbestos at the site.	Can be contained and capped as the material is considered non-leachable. However an EMP may be required for ongoing management of metals at the site.	2 Contingency.
Option 5: Off-site disposal to landfill	Given that the development involves construction of basements, there is likely to be a net surplus of soil. Considering the fill at the site is reported to depths ranging between 0.2 m to 0.6 m bgl, it may be economical to dispose of contaminated material off-site to an appropriately licenced landfill than cap the site. Given all filling would be removed under this option, there theoretically would not be a legacy of asbestos remaining on the site, and an EMP should not be required.	Removes the contaminated soil from the site Given all filling would be removed under this option, there theoretically would not be a legacy of metals in soil remaining on the site, and an EMP should not be required.	1 Preferred.

10. Preferred Remediation Option

Based on the evaluation of remediation options presented in Table 4, the preferred remediation strategy for metals and asbestos-impacted fill at the site, considering the site setting, exposure risk and likely volumes, is Option 5 - excavation and off-site disposal to an appropriately licensed landfill.

11. Remediation and Validation

Considering the presence of loose fibre bundles and FA/AF, remediation at the site must be undertaken by licensed SafeWork Class A, Asbestos Removalist. An Asbestos Management Plan[2] (AMP) and Environmental, Construction and Site Management Plan[3] (ECSMP) are being prepared concurrently with this RAP. The AMP will aim to minimise the risks of human exposure and environmental contamination associated with ACM encountered during the work comply with relevant regulatory requirements pertaining to the management of ACM, while the ECSMP focuses on the general soil and groundwater management requirements related to remediation and bulk earthworks at the site

Remediation of the site will generally involve the following:

- Installation of a protection zone surrounding the large Eucalyptus tree in the east of the site. Advice from Parramatta City Council should be sought regarding the extent of the exclusion zone, a tree permit may be required to excavate fill within the designated exclusion zone;
- Removal of asphaltic concrete and decommissioning/removal of light poles;
- Daily air quality monitoring (AQM) undertaken by a licensed Asbestos Assessor;
- Assess the likely extent of impacted fill through test pitting or strip trenching;
- Excavation of all fill at the site - reported to range between 0.2 m and 0.5 m in thickness. Fill is reported to range between 0.2 m and 0.6 m in depth below ground level and is described as brown and grey silty clay or gravelly sand filling with traces of gravel and sand. The underlying materials are expected to comprise typically very stiff or hard, red brown silty clay with traces of gravel and light brown clayey silt. Refer to the ECSMP for greater detail for fill removal. Any filling that cannot be removed from site, such as at the base of the Eucalyptus tree to remain on site must be assessed in accordance with this RAP; Loading, transport and disposal of fill to a licensed facility under an assigned waste classification;
- Validate the ground surface following the removal of fill or validate any fill proposed to remain in place as follows;
    - Base of excavation – approximately one sample per nominal 10 m x 10 m grid;
    - Side of excavations - one sample per 10 linear metre and 1 m depth intervals; and
    - Analysis of validation samples for the contaminants of concern (i.e. asbestos and metals).
- Assess the extent of acidic soils at the site (as per Section 11.2)
- Waste classify any materials to be removed from site or treat any soil proposed to remain on site;

[2] DP *Draft Asbestos Management Plan, Proposed PLC Hotel Development, 1 Eels Place, Parramatta*, Project 94523.00.R.004.December 2018
[3] DP *Draft Environmental, Construction and Site Management Plan, Proposed PLC Hotel Development, 1 Eels Place, Parramatta*, Project 94523.00.R.005.December 2018

- Validate the ground surface to show that acidic soils have either been removed or have been treated and shown to be suitable to remain on site as follows;
    - Base of excavation – approximately one sample per nominal 10 m x 10 m grid;
    - Side of excavations - one sample per 10 linear metre and 1 m depth intervals; and
    - Analysis of validation samples as per Section 11.2.
- Conduct a VENM assessment of any rock or un-impacted material required to be disposed from site.

Soil validation sampling results are to be assessed against the RAC.

Additional excavation (chase-out) of material and further validation sampling will be required, where feasible) if initial validation samples fail to meet the RAC.

The Environmental Consultant will undertake the validation sampling.

For fill that cannot be removed from site, such as soils in the tree-protection zone, samples for validation should be collected at a rate of one sample per 5 m^3, or a minimum of three. Samples that fail the criterion may need to be capped as per the below:

- Placement of a Class A geotextile fabric (such as Polyfabric Australia's Terrastop A1 Marker Layer material or equivalent); and
- Placement of a minimum of 100 mm of VENM or impermeable material (such as hardstand).

Note. If impacted soils are to remain on site, a long term environmental management plan (EMP) may need to be implemented. The requirement for an EMP is to be decided by the Environmental Consultant.

11.1 Interim Controls

Prior to the commencement of site remediation works, the following interim controls will be in place:

- The construction of permanent fences around the subject area meeting appropriate specifications to prevent unauthorized entry;
- Allocation of a treatment area for acidic soils (if soils are to be treated on site – refer to the ECSMP);
- Any pits or unstable areas on site that may generate potential OH&S or operational risk should be demarcated and taped off, with appropriate rectification action undertaken (e.g. backfilling of pits as soon as practicable to prevent undue injuries to workers etc.);
- Air quality monitoring for airborne asbestos fibres is to be conducted on a daily basis when works involving the excavation, transport or placement of asbestos impacted and potentially impacted soils/materials are being conducted within the site. The environmental consultant is to conduct the air quality monitoring or manage the works through an experienced contractor; and
- All appropriate demarcation, signage and precautions in accordance with NSW legislative requirements including (but not limited to) all SafeWork requirements, must be implemented.

11.2 Basement Excavation

Basement excavation should proceed as part of the general bulk earthworks with all excavated fill disposed off-site to a licensed facility under an assigned waste classification or validated as suitable to remain on site from a contamination and geotechnical standpoint (refer to the ECSMP for geotechnical considerations).

Based on the depth of the proposed excavation (3.5 m bgl), and the minimum depth of groundwater (ie. minimum of 5 m bgl) reported in EIS (2015b) dewatering is not expected. Notwithstanding, seepage may occur during excavation, therefore dewatering may need to be undertaken as part of the excavation works. Refer to a Geotechnical report4 previously prepared for the site and ECSMP for dewatering requirements for the site.

11.3 Acid Soils

Given the presence of acidic soils at the site, excavated natural soils will require management on-site. Management off-site is not considered a viable option considering DP is not aware of any site in Sydney that can treat soils with the acidic characteristics reported in DP (2018).

The following sections have been devised with reference to the following key guidelines:

- Stone Y, Ahern C R and Blunden B, *Acid Sulfate Soils Assessment Manual,* Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, 1998 (ASSMAC);
- Ahern C R, McElnea A E and Sullivan L A, *Acid Sulfate Soils Laboratory Methods Guidelines*, Queensland Department of Resources, Mines and Energy, Indooroopilly, 2004; and
- NSW Environment Protection Authority (EPA), *Waste Classification Guidelines,* 2014 (EPA, 2014).

The following sections also comply with relevant legislative and regulatory requirements including:

- NSW Environmental Planning and Assessment Act 1979 (EP&A Act); and
- Protection of the Environment Operations Act 1997 (POEO Act).

11.3.1 Site Preparation

On-site treatment will require preparation of a Treatment Area(s), designated Stockpiling Area(s) and, if required (i.e. stockpiles left on site for more than 5 days) Leachate Collection Area(s).

During construction planning, sufficient land should be allowed for the treatment areas. The Leachate collection location, lining and construction should be similarly pre-planned.

Figure 1 shows a cross section of a typical treatment pad.

[4] DP Report on Geotechnical Investigation, *Proposed PLC Hotel Development, 1 Eels Place, Parramatta*, DP Ref: 94523.00.R.001.Rev1, dated 5 December 2018.

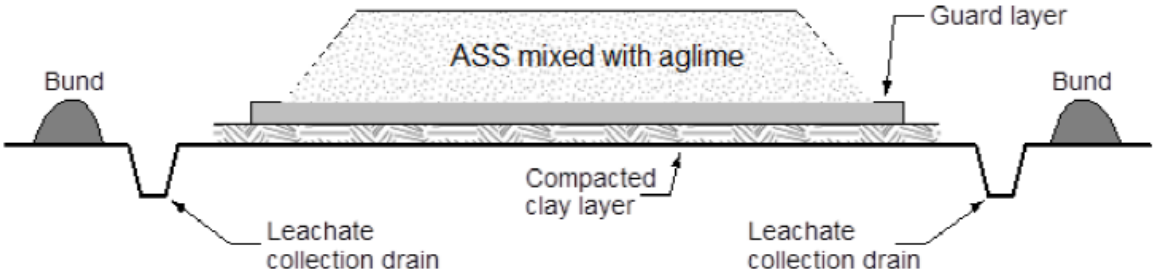


Figure 1: Schematic cross-section of a treatment pad, including clay layer, guard layer, leachate collection drain and bunding[5]

The areas should be prepared as follows:

- Prepare a treatment pad and (if required) stockpile pad of appropriate area for the volume of soil to be treated/ stored. The pad should be prepared on relatively level or gently sloping ground to minimise the risk of any potential instability issues, with a natural (or shaped) fall to the local drainage sump. The treatment area should be located as far as practical from any potential ecological receptors such as drainage lines which enter the stormwater system;
- Lining of the surface of the pad with selected compacted clay (at least two layers to a combined compacted thickness of 0.5 m) or a geosynthetic liner as approved by the environmental consultant;
- Apply a guard layer of fine agricultural lime ('ag lime') over the compacted clay or geosynthetic liner, to neutralise downward seepage. This guard layer of lime should be applied at a rate of approximately 10 kg fine ag lime per m^2 per vertical metre of stockpile, i.e. if a treatment stockpile of 3 m is proposed, the guard layer would need to comprise approximately 30 kg of ag lime per m^2 of surface area. The guard layer should be re-applied following removal of treated soils prior to addition of untreated soils; and
- Liming pads should be bunded and a circumference drain excavated to collect and contain leachate, if determined to be required by the environmental consultant. The drain and inner bund slopes should be covered with a layer of fine lime applied to neutralise any possible leachate migrating from the stockpiled material. The drain should direct soil into an appropriately sized sump or retention pond. Collected waters should be monitored and if necessary treated before reuse or release. Alternatively water from the drain can be pumped into on-site tanks for storage, testing and treatment, if required.

If small quantities of soil are to be excavated at any one time, then the use of a properly sealed skip bin may be appropriate instead of treatment pad. Any leachate drainage from the skip bin should be avoided, or otherwise will need to be contained (through bunding) and treated as necessary.

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

11.3.2 Neutralising Materials

Agricultural lime (Calcium Carbonate – $CaCO_3$), commonly known as aglime, is the preferred neutralisation material for the management of acidic soils, as this material is usually the cheapest and most readily available product for acid neutralisation. The aglime should be fine ground (at least <1mm) calcium carbonate or calcite (limestone or marble).

The aglime purity should be 95% or better, (i.e. NV> 95, where NV is the neutralising value, a term used to rate the neutralising power of different forms of materials relative to pure, fine, calcium carbonate which is designated NV = 100). Aglime is usually at NV of 95% to 98%. The aglime should be fine and dry, as texture and moisture can also decrease the effective neutralising value.

Coarse grained calcite is not recommended. Dolomitic aglime, or magnesium blend aglime, should not be used as these materials impose environmental risks from overdosing with the potential to damage estuarine ecosystems.

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

11.3.3 Lime Application Rate

Based on results obtained in DP (2018) which reported Titratable Actual Acidity (TAA) of c.1.0% w/wS, the indicated liming rates for disturbed natural spoil is 4.7 kg/tonne.

11.3.4 Treatment Process

- Prepare a treatment/ stockpiling pad in accordance with Section 11.2.1.1;
- Segregate any filling from the area;
- Transport natural materials to the treatment area (in sealed trucks if required);
- Manage soils during stockpiling and treatment to minimise dust and leachate generation (e.g. by covering, or lightly conditioning with water);
- Spread the soil onto the guard layer in layers of up to 0.3 m thick, leaving a 1 m flat area between the toe of the spread soil and the containment bund or drain. When spreading the first soil layer, care should be taken not to churn up the lime guard layer;
- Let the soil dry to facilitate lime mixing (if too wet, then adequate mixing of lime cannot be achieved);
- Apply ag lime to the stockpiled soil (initial liming rate of 4.7 kg lime/tonne of soil based on worst case results reported in DP, 2018) and harrow/ mix thoroughly prior to spreading the next layer;
- Continue the spreading/ liming/ mixing cycle. This can be done one layer at a time, or with multiple soil layers placed on top of each other;
- Assess the success of the treatment using verification testing (in accordance with Section 11.2.1.5). Samples will need to be collected from all layers. The verification testing has two components: field pH screening (including peroxide pH testing) and laboratory analysis. It is likely that laboratory analysis will only be undertaken after the field screening results have passed;

- If verification sampling indicates that additional neutralisation is required, add additional lime (at an appropriate liming rate) and mix as described above;
- When verification testing indicates that lime neutralisation is complete, then the stockpiled soil may be removed from the treatment pad;
- Re-use the treated soil on-site or dispose off-site in accordance with waste classification ; and
- Management of leachate water (in accordance with Section 11.3.6).

11.3.5 Verification testing

Soil pH should be regularly monitored in the treatment area during treatment. Soil pH will be used as a measure of the effectiveness of neutralisation, and the material will only be considered to be suitably treated when all validation results meet the acceptance criteria (as summarised in Table 6 below).

Table 6: Summary of Monitoring Frequencies and Criteria

Material	Test	Frequency	Acceptance Criteria
Treated Soil (during and following neutralisation)	Field test: pH	Between one sample / 25 m^3 to one sample / 100 m^3 OR a minimum of six samples / treatment batch (depending on homogeneity)	• Field pH (i.e. field pH in water) is ≥ 5.5 (and ≤8.5 for any materials to be re-used on site); • Peroxide pH (i.e. pH after forced oxidation) is ≥ 6.5; • pH_{KCL} is ≥ 6.5; • TAA = 0; and • Net acidity*** is < 0.
Treated Soil (validation testing)	Laboratory analysis: SPOCAS* / Chromium Suite Analytical Method**	Between one sample / 100 m^3 and one sample / 500 m^3 OR a minimum of three samples / batch	

11.3.6 Leachate and Surface Water Collection

All water that has been in contact with acidic soils must be managed, assessed, treated and appropriately disposed of.

Water from the acid soils treatment/ storage area should be collected in the lined drains/ detention basin constructed in accordance with Section 11.3.6, or in a tank. Any other water which may have come into contact with acid soils should be collected in an on-site detention basin/tank.

All water which has potentially come into contact with acid soils requires management in accordance with the below sections.

11.4 Water Storage and Treatment

Water potentially impacted by acid soils must be stored in a lined on-site detention basin or tank. The available storage capacity must take into account potential rainfall to minimise the risk of overflows during heavy rain. The storage facilities and volumes being stored must be managed to ensure that no water overflows from the storage, including over close down-periods (including weekends).

11.5 Water Assessment

All water which has potentially come into contact with acidic soils requires assessment (and if necessary treatment) for the parameters listed in Table 7, below, as a minimum. This table also details the recommended monitoring frequencies and target criteria.

Table 7: Suggested Water Monitoring Frequencies and Target Levels for Disposal to Stormwater

Test	Frequency	Criteria for Disposal to Stormwater
pH	Field measurement: • During storage as required to allow timely treatment; • immediately prior to disposal; and • daily checks during discharge period.	• pH 6.5 – 8.5 (or otherwise determined by discharge authority) or not exceeding local water quality data (yet to be established).
Total Suspended Solids (TSS)	Field measurement: • immediately prior to disposal; and • as required based on visual observations. Visual assessment: • daily during discharge period.	• water observed to be clear; • Turbidity <50 NTU (or otherwise determined by discharge authority).
Oil and Grease	Visual assessment: • immediately prior to disposal; and • daily checks during discharge period; and Laboratory analysis: • as required based on visual observations.	• None observable • <10 mg/L
Iron (total and soluble)	Laboratory analysis: • immediately prior to disposal; and • weekly checks during discharge period; and • as required based on visual observations; and Visual assessment: • daily during discharge	• ≤ 0.3 mg/L filterable iron or not exceeding local water quality data (yet to be established). • No obvious sign of iron staining/ settlement

Test	Frequency	Criteria for Disposal to Stormwater
Metals (aluminium, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, zinc)	Laboratory analysis: • One round of testing before first disposal; • If first round of testing exceeds target levels then further testing prior to disposal is required	• ANZECC (2000) Trigger Levels for 95% Level of Protection for freshwater ecosystems or not exceeding local water quality data (yet to be established)

11.6 Water Treatment

Treatment of water from construction sites is commonly required for pH and total suspended solids (TSS). Aeration and removal of TSS also generally decreases metal concentrations in the water. Standard industry treatment methods and commercial treatment products are suitable for the site and are likely to provide the most efficient treatment.

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

11.7 Disposal Options

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

11.8 Water Discharge

Appropriate approvals must be sought from Council prior to discharge.

Once site water has been effectively treated and assessed to meet the discharge criteria, it can be discharged to the local stormwater system in accordance with Council requirements.

11.9 Waste Classification

Based on the laboratory results reported in DP (2018), fill at the site was pre-classified as **Special (Asbestos) Waste** – General Solid Waste (non-putrescible).

As stated in DP (2018) acidic natural soils will not classify as VENM due to the presence of sulfur and will likely classify as General Solid Waste (non-putrescible). Assessment will be required during or following excavation of surplus natural material to confirm their preliminary classification (refer to Section 11.2.5 for verification testing and to the CESMP for further information related to geotechnical testing of natural soils. Natural bedrock that is not impacted by chemical residues would be classifiable as virgin excavated natural material (VENM) or Excavated Natural Material (ENM).

Fill at the site was classified in the DSI as Special (Asbestos) Waste – General Solid Waste (non-putrescible). Further classification may be required if unexpected conditions are encountered in the fill (such as staining or odours). If potential contamination other than asbestos is observed, excavation of the material should cease and the material treated as an unexpected find (refer Section 10.4).

Natural and fill materials requiring classification will be sampled and analysed as outlined below.

VENM soil/rock samples will be collected and tested at the following frequency:

- Volume ≤250 m^3: one sample per 25 m^3;
- Volume 250 - 1,000 m^3: one sample per 50 - 100 m^3, or a minimum of 10 samples;
- Volume >1,000 m^3: one sample per 100 - 250 m^3, or a minimum of 10 samples; and.
- Analysis of metals, TRH, BTEX, PAH, phenol, PCB and OCP.

ENM soil samples will be collected and tested for the analytes and frequency stipulated in the NSW EPA, Excavated Natural Material Order 2014[6].

11.9.1 Spoil Contingency Plan

Any materials which fail to meet the EPA (2014) criteria for direct landfill disposal (i.e. Hazardous Waste materials) following initial waste classification assessment will require segregation and separate stockpiling pending further testing and treatment. The contingency plan to cater for the storage, treatment and disposal of these materials is as follows:

- On the basis of on-site observations and the contaminant exceedances recorded, materials will be carefully excavated, segregated and placed in well delineated locations;
- Stockpiles of excavated materials will be appropriately bunded with hay bales/sandbags and if required conditioned with water, covered and/or lined with anchored impermeable plastic sheeting to prevent dust generation;
- If considered appropriate, further sampling and analysis will be conducted to more fully characterise the subject material, and confirm its contamination status. If the further characterisation works show that the material can be classified as General Solid Waste or Restricted Solid Waste, dispose of the material directly to an appropriately licensed landfill;

[6] Resource Recovery Order Under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014

- Review potential options for the treatment, re-use or recycling of the material, and adopt options identified to be suitable for the subject material; and
- Review EPA's General Immobilisation Approvals on the EPA website. If an applicable General Immobilisation Approval exists, further assess/dispose of the waste in accordance with the approval and other approvals or licences as required by the EPA.

If no General Immobilisation Approval is applicable to the material, EPA (2014) will apply, and the following will be conducted:

- Conduct additional sampling and analysis as required based on the available results to provide information for immobilisation options. In general immobilisation options include natural immobilisation, chemical fixation, micro-encapsulation and macro-encapsulation;
- Investigate, including trials as appropriate, immobilisation treatment options for the material;
- Apply to the EPA for a Specific Immobilisation Approval; and
- Implement the requirements imposed on management/disposal of the material by the EPA.

11.10 Contingencies for Unexpected Finds

If unexpected conditions are encountered during the remediation (such as buried tanks, significantly stained soils or unexpected contaminated soil or contaminants), the following general approach will be adopted with reference to the AMP and ECSMP as required:

- Stop work in the area of impact and barricade area to prevent access;
- The Site Manager is to contact the Principal's representative and the Environmental Consultant;
- The Environmental Consultant will make an assessment of the severity of the occurrence in terms of the potential impact to human health and the environment;
- The Environmental Consultant will liaise with the Principal's representative as required;
- Provision of advice from the Environmental Consultant to the Principal's representative regarding the recommended course of action;
- Obtaining necessary approvals from Council; and
- Implementation of the agreed management/remediation strategy.

Any areas of fill exhibiting indications of contamination or that significantly differ from the materials previously assessed must be characterised as part of the remediation works.

11.11 Sample Collection and Handling

The general sampling procedures comprise:

- The use of stainless steel or disposable (e.g. nitrile glove) sampling equipment;
- Washing of all re-usable sampling equipment, in contact with the sample, in a 3% solution of phosphate free detergent (Decon 90) then rinsing with distilled water prior to each sample being collected; transfer of the sample into an appropriate sampling container, sealing of containers to minimise cross contamination during transportation to the laboratory;

- Use of laboratory prepared sampling containers for samples for analysis of chemical contaminants (generally comprising new glass jars sealed with Teflon lined lids). Asbestos 500 mL samples are to be collected in new, re-sealable plastic zip-lock bags;
- Asbestos bulk (10 L) samples are to be collected and screened in the field in accordance with Section 4.1.7 of Western Australian Department of Health Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia 2009 (DoH, 2009) at the rates stipulated in Section 11 of this report;
- Labelling of the sample containers with individual and unique identification including Project No. and Sample No.;
- Placement of the containers into a chilled (where necessary), enclosed and secure container for transport to the laboratory; and
- Use of chain-of-custody documentation so that sample tracking and custody can be cross-checked at any point in the transfer of samples from the field to hand-over to the laboratory.

11.11.1 Field Quality Assurance and Quality Control

Quality assurance (QA) and quality control (QC) procedures will be adopted throughout the field sampling programme to assess sampling precision and accuracy and prevent cross contamination.

The following QA/QC samples will be collected/prepared and analysed:

- 5% intra-laboratory replicate samples (not relevant for asbestos samples);
- 5% inter-laboratory replicate samples (not relevant for asbestos samples);

Appropriate sampling procedures will be undertaken to minimise cross contamination. These include:

- Standard operating procedures are followed;
- Replicate field samples are collected and analysed (if applicable);
- Samples are stored under secure conditions. In the event that chemical samples require collection, they must also be stored under temperature controlled conditions;
- Chain-of-custody documentation is employed for the handling, transport and delivery of samples to the selected laboratory; and
- Proper disposal of contaminated soil, fill or surface water originating from the site is completed.

11.11.2 Laboratory Quality Assurance and Quality Control

A NATA accredited laboratory will be used to conduct analysis. The laboratory will need to undertake analysis in accordance with its accreditation, including in-house QA/QC procedures, potentially involving the routine testing of:

- Reagent blanks;
- Spike recovery analysis;
- Laboratory duplicate analysis;
- Analysis of control standards;

- Calibration standards and blanks; and
- Statistical analysis of QC data including control standards and recovery plots.

11.12 Materials for Use in Backfill and Imported Fill

As noted in Section 3, additional fill material will be required on the western side to build up existing ground surface levels to the underside of the floor slab.

Material required for redevelopment works, or backfill of remediation excavations shall be either (i) validated on-site materials (ie. underlying bedrock or treated natural acidic soils), or (ii) imported material which is to be analysed and certified as VENM or ENM, via a validation certificate by the contractor. Any imported material and material management should also comply with relevant legislation (*eg*. POEO Act 1997).

The report for any imported VENM, ENM or material imported under an EPA exemption, is to be prepared by a suitably qualified consultant. Sampling and analysis of any imported material should be undertaken a suitably qualified consultant to confirm its suitability for use on the site as follows:

Review of available site history information to determine an appropriate sampling plan;

VENM

- As a minimum, collect samples at a density of one sample per 1,000 m^3 of imported VENM, or a minimum of three samples per source site;
- Analysis of samples for metals, PAH, TPH, BTEX, PCB, OCP, OPP, phenol, asbestos and any other identified contaminant of concern;
- Collection and analysis of QA/QC samples in accordance with Section 11.10; and
- Comparison of results with published background levels (as shown in Table 5 (following page) to determine its status as VENM and/or its suitability for use on the site.

ENM

ENM proposed for importation should be tested for the analytes, including asbestos and any other identified contaminant of concern, and frequency stipulated in the NSW EPA, Excavated Natural Material Order 2014.

The VENM/ENM assessment reports will require to be reviewed and approved by DP prior to importation to confirm suitability of the material for use on the site.

Imported material will require to be checked by the Environmental Consultant or a designated gate keeper upon import to ensure that the material received is suitable for the proposed use, matches the description provided in the report and contains no cross contamination.

No blended or processed topsoils are to be imported to the site.

Materials used on site should also meet other requirements (eg: geotechnical requirements).

With regards to any landscaping materials imported to the site, there corresponding documentation must meet the requirements of their appropriate resource recovery orders (RRO). The importer must specify which RRO the material is being imported under, and the appropriate certification must be reviewed by DP, to confirm compliance, prior to import.

Table 5 - Reference Contaminant Values For Virgin Excavated Natural Material (VENM) in mg/kg.

Contaminant [1]	ANZECC [2]
Metals Arsenic (total) Cadmium Chromium (III) Copper Lead Mercury Nickel Zinc	 0.2-30 0.04-2 0.5-110 1-190 <2-200 0.001-0.1 2-400 2-180
TRH $C_6 – C_{10}$ $C_{10} – C_{16}$ $C_{16} – C_{34}$ $C_{34} – C_{40}$	For all organic contaminants, the analytical practical quantitation limits are used as the reference levels for VENM assessment. Special consideration may be given to low levels of naturally-occurring TRH or PAH in shale.
BTEX Benzene Toluene Ethyl Benzene Xylene	
Total Phenols	
PAH Total Benzo(a)Pyrene	
PCB	
OPP	
OCP aldrin dieldrin aldrin + dieldrin chlordane DDT (including DDD, DDE, DDT) Heptachlor	No OCP, OPP or PCB
Asbestos	No asbestos

Notes:

1. Contaminant concentrations must also be evaluated against NEPC (2013).
2. Australian and New Zealand Environment and Conservation Council/National Health and Medical Research Council (ANZECC/NHMRC): Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (1992), Environmental Soil Quality Guidelines Background A [ANZECC A].

12. General Environmental Management Plan

12.1 General

The Contractor(s) will undertake the work with due regard to the minimisation of environmental effects and to meet regulatory and statutory requirements.

The following general measures outlined below should be implemented during the remediation phase. All personnel should be made familiar with the following section prior to the commencement of site works as required.

All works must comply with NSW legislative requirements, including (but not limited to) SafeWork NSW (previously WorkCover NSW) requirements, notification of works to SafeWork NSW by the required date prior to work commencing, preparation and implementation of an Asbestos Removal Control Plan (ARCP) and appropriate Work Method Statements and wearing of appropriate personal protective equipment (PPE).

12.2 Asbestos Specific Requirements

Detailed requirements for asbestos related legislation and management are provided in the AMP. General minimum requirements are noted in the sections below.

12.3 Soil Management Plan

(a) Transport

All transport of waste and disposal of materials shall be conducted in accordance with the requirements of the *Protection of the Environment Operations Act* (1997) (POEO Act). All required licences and approvals required for disposal of the material shall be obtained prior to removal of the materials from the site.

The transport of materials to or from the site will be via an appropriate predefined haul route. All haulage routes for trucks transporting soil, materials, equipment or machinery to and from the site should be selected to meet the following objectives:

- Comply with all road traffic rules;
- Minimise noise, vibration and odour to adjacent premises; and
- Utilise State Roads and minimise use of local roads.

The truck dispatch shall be logged and recorded by the contractor for each load leaving the site. A record of the truck dispatch will be provided to the environmental consultant.

The remediation work will be conducted such that all site vehicles:

- Conduct deliveries of soil, materials, equipment or machinery during the specified hours of remediation, as approved by Council;
- Have securely covered loads to prevent any dust or odour emissions during transportation; and
- Exit the site in a forward direction where possible.

In addition, measures will be implemented to ensure no contaminated material is spilled onto public roadways or tracked off site on vehicle wheels.

All loads will be tarpaulin covered and may be lightly wetted as required to ensure that no materials or dust are dropped or deposited either outside or within the site. Prior to exiting the site each truck should be inspected by the contractor or their designated representative and either noted as clean (wheels and chassis) or hosed down prior to leaving the site. Any soil spilled onto street will be cleaned by mechanical or hand methods on a daily basis.

(b) Disposal of Materials

All materials excavated and removed from the site should be appropriately waste classified and should only be disposed to a site legally allowed to receive it in accordance with relevant legislation, regulatory guidance, licences or EPA approvals/ advice including the POEO Act.

(c) Noise Control Plan

The remediation works should comply with the requirements specified by the authorities (e.g. Council and/or EPA). Noise and vibration should be restricted to reasonable levels. All equipment and machinery should be operated in an efficient manner to minimise the emission of noise.

12.4 Minimisation of Cross Contamination

Measures should be enforced as required to eliminate or at least minimise the potential for cross contamination, from the overlying asbestos-impacted fill to the underlying natural clays, such as full-time supervision during excavations. .

Air monitoring for airborne asbestos fibres must be undertaken at appropriate locations surrounding the remediation areas during removal of asbestos containing materials and in areas of active remediation works where asbestos-based materials have been identified. Daily air monitoring reports will be included in the Final Validation Report.

In addition plant movements within areas of active remediation should be restricted and monitored to ensure vehicles do not unnecessarily pass over validated surfaces or through contaminated areas. Considering the presence of asbestos-impacted soils beyond the site boundaries, traversing plant across validated surfaces and areas beyond the site boundaries should also be avoided. A decontamination (eg. wheel wash) area should be implemented to prevent recontamination of the site from the surrounding impacted soils.

The Project Manager will need to consider the need to stage the works and progressively validate the site. In this way a validated stage will be “closed off” and construction traffic would not be permitted within the closed area.

12.5 Stockpiling Contaminated Material

If required during works, contaminated material shall be stockpiled at a suitable designated location. Dust control is recommended for all stockpiled materials and should include light conditioning with water for exposed materials or covering with anchored geotextile or similar.

Should stockpiles remain for over 48 hours, they should be appropriately managed to prevent fugitive dust leaving the site (e.g. light wetting or covering with anchored geotextile depending on weather conditions) and geotextile silt fences or hay bales should be erected around each stockpile to prevent losses by surface erosion.

The stockpile footprint area may be subject to validation upon removal of the material. The Environmental Consultant shall confirm on a case to case basis. The samples will require to be tested for the contaminants of concern.

Refer to the AMP for further information regarding stockpiling asbestos-impacted materials.

12.6 Vibration Control

The use of any plant and/or machinery should not cause unacceptable vibrations to nearby properties and should meet Council requirements.

12.7 Dust Control

Considering the presence of FA/AF, dust emissions should be confined within the site boundary. The following dust control procedures will be employed to comply with this requirement as necessary:

- Erection of dust screens around the perimeter of the site;
- Securely covering all loads entering or exiting the site;
- Use of water sprays across the site to suppress dust;
- Covering of all stockpiles of contaminated soil remaining onsite more than 48 hours; and
- Keeping excavation and stockpile surfaces moist.

12.8 Odour Control

No odours should be detected at any boundary of the site during remediation works by an authorised Council Officer relying solely on sense of smell. The following procedures should be employed to comply with this requirement as required:

- Use of appropriate covering techniques such as plastic sheeting, polythene or geotextile membranes to cover excavation faces or stockpiles;
- Fine spray of water and/or hydrocarbon mitigating agent on the impacted areas/materials;
- The use of water spray, as and when appropriate, to eliminate wind-blown dust;
- Use of sprays or sprinklers on stockpiles or loads to lightly condition the material;

- Restriction of stockpile heights to 2 m above surrounding site level. If required, restrict uncovered stockpiles to appropriate sizes to minimise odour generation;
- Ceasing works during periods of inclement weather such as high winds or heavy rain;
- Regular checking of the fugitive dust and odour issues to ensure compliance. Undertake immediate remediation measures to rectify any cases of excessive dust or odour (e.g. use of misting sprays or odour masking agent); and
- Adequate maintenance of equipment and machinery to minimise exhaust emissions.

12.9 Stormwater Management and Control

As necessary, the contractor shall take appropriate measures to ensure that potentially contaminated water does not leave the site. Such measures shall inter alia include:

- Construction of stormwater diversion channel and linear drainage sumps with catch pits in the remediation area to divert stormwater from potentially contaminated areas; and
- Provision of sediment traps such as silt fences (or equivalent) at suitable locations on the down-gradient side of the site as necessary.

12.10 Groundwater Management

Although groundwater is not expected to impact the proposed development as it is has been measured at depths of at least 1.5 m below the finished floor slab level of the lowest basement level, considering groundwater is transient and may result in raised groundwater levels during major rainfall events, contingency plans for dewatering may need to be undertaken as part of the works. Refer to the geotechnical report for further comments ECSMP.

12.11 Worker Health and Safety

The Contractors shall develop a site emergency response plan (ERP) and worker health and safety plan (WHS). This will ensure the safety of the personnel working on site, given any likely emergency situation which may occur. The OHSP and ERP should include emergency phone numbers and details of local emergency facilities.

Appropriate fencing and signage should be installed around and within the site to prevent unauthorised access to the site, restricted access remediation areas and deep excavations.

All personnel on site should be required to wear the following personnel protective equipment (PPE) at all times when working in an area with asbestos-impacted fill:

- Safety glasses or safety goggles with side shields meeting AS1337-2010 requirements;
- Disposable coveralls to prevent contact with asbestos fibres, splashed contaminated soil, materials or water;
- Particulate respirator (Class P2) or equivalent;
- Disposable boot covers;

- Steel-capped boots; and
- Hard hat meeting AS1801-1997 requirements.

The following additional PPE will be worn as required:

- Hearing protection meeting AS1270-2002 requirements when working around machinery or plant equipment if noise levels exceed exposure standards;
- Nitrile work gloves meeting AS2161-2000 requirements or heavy duty gauntlet gloves; and
- Any additional protection identified by the Environmental Consultant, a licensed asbestos assessor or licensed asbestos removalist.

Excavation, handling, stockpiling, transport etc. of materials containing asbestos should be undertaken by a licensed contractor in accordance with relevant regulatory requirements.

All contractors are required to show compliance with the Work Health and Safety Regulation 2011, including the preparation of a Site Safety Management Plan and Safe Work Method Statements.

12.12 Hours of Operation

All remediation work should be conducted within the hours specified by Council.

12.13 Contingency Plans to Respond to Site Incidents

The key to effective management of incidents is the timely action taken before any situation reaches a reportable or critical level. Therefore, surveillance activities are extremely important, and should be conducted for the measures prescribed herein and any other measures as seen appropriate by the Project Manager or their designated representative. During work activities on the site, the following inspection or preventative actions must be performed by the contractor(s) and carefully documented:

- Regular inspection of works;
- Completion of routine environmental checklists and follow-up of non-compliance situations;
- Maintenance of supervision on-site; and
- An induction process for site personnel involved in the remediation works that includes relevant information on environmental requirements, and ensures that all site personnel are familiar with the site emergency procedures.

The Principal contractor(s) or their delegated representative should be responsible for initiating an immediate emergency response using the resources available on the site. Where external assistance is required, the relevant emergency services should be contacted. A list containing contact details for key personnel who may be involved in an environmental emergency response should be completed and be readily available to personnel at all times.

12.14 Identify Regulatory Compliance

The work should be undertaken with all due regard to the minimisation of environmental effects and to meet all statutory requirements, including, *inter alia*, provisions specified in:

- POEO Act;
- *Contaminated Land Management Act* 1997;
- *Dangerous Goods Act* 2008;
- *Work Health and Safety Act* 2011;
- *Work Health and Safety Regulation* 2011;
- *Water Management Act* 2000 and any related requirements specified by EPA and Water NSW ; and
- DUAP EPA (1998) *State Environmental Planning Policy No. 55* (SEPP 55).

12.15 Community Consultation

The Project Manager or their delegated representative will manage all community consultation. Site signage in relation to project contact persons will be limited to that required by DA consent conditions and/or regulatory requirements, with additional signage indicating that public enquiries shall be directed to the developer or their delegated representative.

13. Validation Report

A validation assessment report will be prepared by the Environmental Consultant at the completion of the project with reference to OEH (2011) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*. The report will be submitted to Council at the completion of the remediation works programme. The objective is for the validation report to confirm that the site has been remediated to a suitable standard for the proposed redevelopment and occupation and that no significant related adverse human health and environmental effects have occurred as a result of the works. The validation report will also include a summary of the information from previous investigations.

In summary, the validation report will include:

- Details of the earthworks;
- Waste classification results;
- The final disposal destination of the materials removed from site and disposal dockets, where appropriate including all necessary waste tracking information, waste disposal (weighbridge dockets) and waste reconciliation information verifying that the volumes taken off site match the disposed amounts;
- Validation sample results;
- Photographic record during the works;

- All air quality monitoring results and sampling locations, including CQA data;
- Records of any imported VENM; and
- Details of any unexpected finds or environmental incidents.

14. Conclusion

It is considered that remediation of the site in accordance with the procedures and validation methods outlined in this RAP can render the site suitable for the proposed PLC Hotel development and appropriately manage potential temporary impacts on the environment.

15. Limitations

Douglas Partners Pty Ltd (DP) has prepared this plan for this project at 1 Eels Place, Parramatta in accordance with DP's proposal NWS180079 dated 11 October 2018 and acceptance received from Mr Thomas Gould on behalf of Parramatta Leagues Club Pty Ltd dated 19 October 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Parramatta Leagues Club 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.

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

This report must be read in conjunction with all of the attached notes 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.

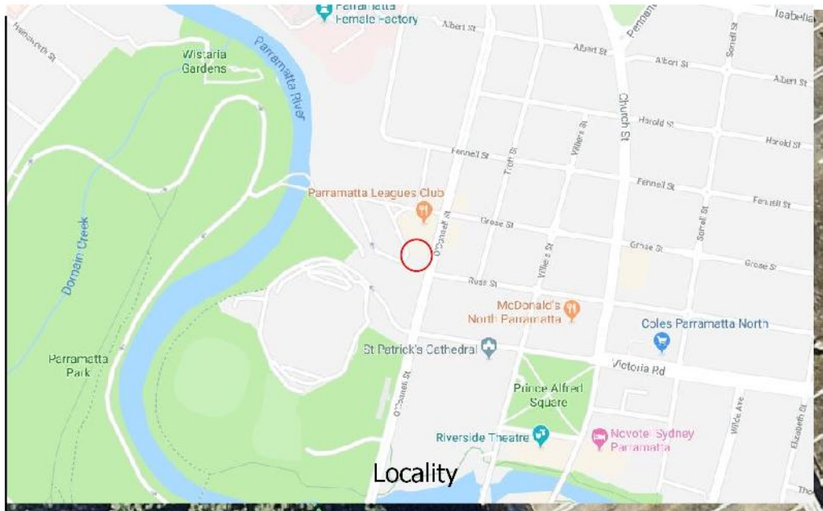
Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

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

Douglas Partners Pty Ltd

Appendix A

Drawing 1



BH4

BH111

BH114

BH5

BH202

BH117

BH201

BH115

BH101

BH116

BH203

BH118

10 0 10 20 m

Legend

- Approximate Site Boundary
- EIS (2015) Site Boundary
- DP (2018) Bore Hole Locations
- EIS (2015a and 2015b) Test Locations
- Proposed Hotel Footprint
- Proposed Lower Ground Floor Level

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: APP Corporation Pty Ltd	
OFFICE: Macarthur	DRAWN BY: CKM
SCALE: 1:25,000	DATE: 4.12.18

TITLE: **Site Locality, Boundary and Test Locations**
Remediation Action Plan
1 Eels Place, Parramatta

N
MGA

PROJ No: 94523.00.R.003	
DRAWING No: 1	
REVISION: A	

Appendix B

DP (2018) Laboratory Summary Tables

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Geotechnics | Environment | Groundwater

Table E1: Summary of Soil Contamination Laboratory Results

				BTEX					Metals														PAH						TRH									
				Benzene	Ethylbenzene	Toluene	Xylene Total	C6-C10 less BTEX (F1)	Arsenic	Cadmium	Chromium (III+VI)[b]	Copper	Lead	Mercury	Nickel	Nickel-TCLP	Zinc	Aldrin + Dieldrin	DDT+DDE+DDD	Endrin	Heptachlor	Methoxychlor	Chlorpyrifos	Benzo(a) pyrene	B(a)P Total Potency Equivalent	Naphthalene	PAHs (Sum of total)	Phenolics Total	PCB (Sum of total +ve)	C10-C16	C16-C34 (F3)	C34-C40 (F4)	FZ-NAPHTHALENE	C6 - C9	>C10 -C40(Sum of total +ve)	pH	Cation Exchange Capacity	Asbestos
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/L	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	pH units	meq/100g	g/kg
PQL				0.2	1	0.5	1	25	4	0.4	1	1	1	0.1	1	0.02	1	0.2	0.1	0.1	0.1	0.1	0.1	0.05	0.5	0.1	0.05	5	0.1	50	100	100	50	25	50	0.1	1	0.1
NEPM 2013 HILs Commercial D Soil				ND	ND	ND	ND	ND	3000	900	3600	240,000	1500	730	6000	ND	400,000	45	3600	100	50	2500	2000	ND	40	ND	4000	120	7	ND	ND	ND	ND	ND	ND	NA	NA	<0.001 % w/w
NEPM 2013 Commerial D Soil HSL for Vapour Intrusion, Sand 0-1m				3	ND	ND	230	260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	500	ND	ND	NA	NA	NA
NEPM 2013 Management Limits in Commercial, Coarse Soil				ND	ND	ND	ND	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		3500	10,000	1000	ND	ND	NA	NA	NA
NEPM 2013 EILs/ESLs for Commercial, Coarse/Sand 0-2m				75	165	135	180	215	160	ND	670	130	1800	ND	45	ND	380	ND	180	ND	ND	ND	ND	1.7	ND	170	ND	ND	ND	ND	1700	3300	170	ND	ND	NA	NA	NA
NSW 2014 General Solid Waste (CT1)				10	600	288	1000	NS	100	20	100	ND	100	4	40	ND	ND	ND	ND	ND	ND	ND	4	0.8	ND	ND	200	288	50	ND	ND	ND	ND	650	10,000	NA	NA	NAD
NSW 2014 General Solid Waste (SCC1 and TCLP1)				18	1080	518	1800	ND	500	100	1900	ND	1500	50	1050	2	ND	ND	ND	ND	ND	ND	7.5	10	ND	ND	200	518	50	ND	ND	ND	ND	650	10,000	NA	NA	NAD
NSW 2014 Restrcited Solid Waste (SCC2 and TCLP2)				72	4320	2073	7200	ND	2000	400	7600	ND	6000	200	4200	8	ND	ND	ND	ND	ND	ND	30	23	ND	ND	800	2073	50	ND	ND	ND	ND	2600	40,000	NA	NA	NAD
BH Location	**Sample Depth**	**Sample Date**	**Strata**																																		
EIS (March 2015)																																					
BH4	0.1-0.2	Mar-15	Fill	<0.2	<1	<0.5	<1	<25	<4	<0.4	15	17	16	<0.1	32	-	16	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.5	<0.1	<0.05	-	<0.1	<50	<100	<100	<50	<25	<100	-	-	NAD
BH4	0.5-0.6	Mar-15	Silty Clay	<0.2	<1	<0.5	<1	<25	4	<0.4	21	12	18	<0.1	25	-	18	-	-	-	-	-	-	-	<0.5	<0.1	<0.05	-	-	<50	<100	<100	<50	<25	<100	-	-	-
BH5	0.1-0.2	Mar-15	Sandy Clay	<0.2	<1	<0.5	<1	<25	<4	<0.4	13	53	38	<0.1	37	-	34	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.5	<0.1	1.7	-	<0.1	<50	140	<100	<50	<25	140	-	-	NAD
EIS (June 2015)																																					
BH101	0.03-0.15	Jun-15	Fill	<0.2	<1	<0.5	<1	<25	<4	<0.4	13	77	8	<0.1	38	-	38	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05	<0.5	<0.1	0.15	-	<0.1	<0.1	170	480	-	<25	650	-	-	Present
BH101	0.3-0.5	Jun-15	Fill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Absent
BH101	1.0-1.5	Jun-15	Silty Clay	<0.2	<1	<0.5	<1	<25	4	<0.4	17	14	16	<0.1	5	-	12	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.5	-	-	<0.1	<100	<100	-	<25	<50	-	-	Absent
BH111	0.05-0.2	Jun-15	Fill	<0.2	<1	<0.5	<1	<25	<4	<0.4	12	78	4	<0.1	48	0.07	36	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.5	<0.1	0.62	-	<0.1	<0.1	470	750	-	<25	1220	-	-	Absent
BH111	0.2-0.4	Jun-15	Silt	<0.2	<1	<0.5	<1	<25	<4	<0.4	13	19	12	<0.1	14	-	17	-	-	-	-	-	-	<0.05	<0.5	<0.1	0.25	-	-	<0.1	<100	<100	-	<25	<50	-	-	Absent
BH114	0.05-0.15	Jun-15	Fill	<0.2	<1	<0.5	<1	<25	<4	<0.4	11	56	14	<0.1	25	-	31	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.5	<0.1	0.81	-	<0.1	<0.1	<100	<100	-	<25	<50	-	-	Absent
BH115	0.07-0.2	Jun-15	Fill	<0.2	<1	<0.5	<1	<25	<4	<0.4	83	66	14	<0.1	82	0.2	57	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.5	<0.1	1.1	-	<0.1	<0.1	740	940	-	<25	1680	-	-	Absent
BH115	0.3-0.4	Jun-15	Silt	<0.2	<1	<0.5	<1	<25	<4	<0.4	11	3	11	<0.1	4	-	7	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.5	-	-	<0.1	<100	<100	-	<25	<50	-	-	Absent
BH116	0.07-0.2	Jun-15	FIll	<0.2	<1	<0.5	<1	<25	<4	<0.4	32	160	4	<0.1	59	0.4	73	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.5	<0.1	0.24	-	<0.1	<0.1	980	1500	-	<25	2480	-	-	Absent
BH117	0.1-0.3	Jun-15	Fill	<0.2	<1	<0.5	<1	<25	<4	<0.4	120	120	6	<0.1	110	0.02	81	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.5	<0.1	0.45	-	<0.1	<0.1	960	1400	-	<25	2360	-	-	Absent
BH118	0.05-0.2	Jun-15	Fill	<0.2	<1	<0.5	<1	<25	<4	<0.4	17	67	3	<0.1	120	0.2	44	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.5	-	-	<0.1	<100	110	-	<25	110	-	-	Absent
BH118	0.25-0.4	Jun-15	FIll	<0.2	<1	<0.5	<1	<25	5	<0.4	17	22	43	0.1	32	-	48	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.5	<0.1	1.6	-	<0.1	<0.1	<100	<100	-	<25	<50	-	-	Absent
DP (2018)																																					
BH201	0.1-0.2	Oct-18	Fill	<0.2	<1	<0.5	<1	<25	<4	<0.4	16	4	13	<0.1	4	-	7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.5	<0.1	<0.05	<5	<0.1	<50	<100	<100	<50	<25	<50	5.3	5.5	Absent
BD1[a]				<0.2	<1	<0.5	<1	<25	<4	<0.4	12	2	15	<0.1	2	-	4	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-	<50	<100	<100	<50	<25	<50	-	-	Absent
BH201	0.5	Oct-18	Fill	<0.2	<1	<0.5	<1	<25	5	<0.4	21	5	12	<0.1	5	-	10	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-	<50	<100	<100	<50	<25	<50	-	-	Absent
BH202	0.12-0.25	Oct-18	Fill	<0.2	<1	<0.5	<1	<25	<4	<0.4	10	2	14	<0.1	2	-	4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.5	<0.1	<0.05	<5	<0.1	<50	<100	<100	<50	<25	<50	-	-	Present
BD2[a]				<0.2	<1	<0.5	<1	<25	<5	<1	14	<5	14	<0.1	3	-	7	-	-	-	-	-	-	<0.05	<0.5	<0.5	<0.05	-	-	<50	<100	<100	<50	<10	<50	-	-	Absent
BH203	0.1-0.3	Oct-18	Fill	<0.2	<1	<0.5	<1	<25	4	<0.4	15	18	42	0.1	7	-	33	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.56	0.9	<0.1	6.1	<5	<0.1	<50	<100	110	<50	<25	110	6.3	3	Absent
BH203	0.5	Oct-18	Fill	<0.2	<1	<0.5	<1	<25	<4	<0.4	8	3	7	<0.1	2	-	5	-	-	-	-	-	-	<0.05	<0.5	<0.1	<0.05	-	-	<50	<100	<100	<50	<25	<50	-	-	Absent

Notes

<PQL	Concentration comprises of sum of a number of individual analytes. All individual analytes below reported PQL
a	QA/QC replicate of sample listed directly below the primary sample. Note - PQLs vary between primary and secondary laboratory
b	All Chromium are assumed to exist in the stable Cr(III) oxidation state, as Cr(VI) will be too reactive and unstable under the normal environment
HIL / HSL D	HIL and HSL for soil contaminants - NEPC 2013, Schedule B1, (Residential C)
EIL / ESL	EI L soil for soil contaminant - NEPC 2013, Schedule B1.
ANZECC	Australian and New Zealand Environment and Conservation Council/National Health and Medical Research Council (ANZECC/NHMRC): Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (1992), Environmental Soil Quality Guidelines, Table 2 Column A Background
NAD	No asbestos detected
ND	Not Defined
NL	No Limit

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Table H2: Summary of Laboratory Results – Asbestos (500 ml)

			Asbestos (500 ml)
			Calculated Asbestos (Nepm)
		PQL	
Sample ID	Depth	Sampled Date	
BH201/0.1-0.2	0m	02/11/2018	NAD
BH202/0.12-0.25	0m	02/11/2018	Detected
BH203/0.1-0.2	0m	02/11/2018	NAD

HIL / HSL exceedance EIL / ESL exceedance ML exceedance HIL/HSL and EIL/ESL exceedance **Bold** = Lab detections Key: Lab result (HIL/HSL value / EIL/ESL value)

ML and HIL/HSL/EIL/ESL exceedance NT = Not tested NL = Non limiting NC = No criteria NAD = No asbestos detected

Notes:

a QA/QC replicate of sample listed directly below the primary sample

Appendix C

DP (2018) Bore Logs

BOREHOLE LOG

CLIENT: Parramatta Leagues Club
PROJECT: Parramatta Leagues Club Hotel
LOCATION: 1 Eels Place, Parramatta

SURFACE LEVEL: 13.5 mAHD
EASTING: 315005.3
NORTHING: 6257461.9
DIP/AZIMUTH: 90°/--

BORE No: 201
PROJECT No: 94523.00
DATE: 2-11-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
13.4	0.1	ASPHALTIC CONCRETE		A/E	0.1		PID=0.1		Concrete 0-0.3m
	0.4	FILLING - light brown silty clay filling, with some gravel and sand (possible roadbase)			0.3				Soil backfill 0.3-0.5m
		SILTY CLAY - brown mottled grey silty clay, with a trace of fine gravel and sand (possible filling)		A/E	0.5 0.6		PID=0.1		Blank 0-1.1m Bentonite 0.5-0.8m
12.5	1.0	SILTY CLAY - very stiff, brown mottled red and grey silty clay, with a trace of gravel (possible filling)		S	1.0		2,6,12 N = 18 PID=0.1		
		- below 1.4m brown		A/E	1.45 1.5 1.6				
11.5	2.0	SILTY CLAY - very stiff, red mottled brown silty clay, with a trace of ironstone gravel		A	2.0 2.1				Sand 0.8-3.1m PVC 50mm screen 1.1-3.1m
		- below 2.4m red brown mottled grey, with occasional extremely weathered, sandstone bands		S	2.5		7,16,17 N = 33		
10.4	3.1			A	2.95 3.0				
	3.15	SANDSTONE - extremely low strength, extremely weathered, light grey sandstone Bore discontinued at 3.15m		A	3.1 3.15				
		- practical refusal on at least very low strength sandstone							

RIG: 109 DB-8 **DRILLER:** Terratest **LOGGED:** PF **CASING:** Uncased

TYPE OF BORING: 125mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. BD2 with sample 0.1-0.3m

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Parramatta Leagues Club
PROJECT: Parramatta Leagues Club Hotel
LOCATION: 1 Eels Place, Parramatta

SURFACE LEVEL: 13.5 mAHD
EASTING: 314986.9
NORTHING: 6257467.2
DIP/AZIMUTH: 90°/--

BORE No: 202
PROJECT No: 94523.00
DATE: 2-11-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.15	ASPHALTIC CONCRETE			0.15				Concrete 0-0.3m
	0.25	FILLING - grey gravelly sand filling (possible roadbase)		E			PID=0.1		
				A	0.35				
	0.5	FILLING - brown silty clay filling, with a trace of gravel		A/E	0.45		PID=0.2		
		SILTY CLAY - brown mottled red silty clay			0.5				
					0.6		4,8,14		
	1.0	SILTY CLAY - very stiff, red brown mottled brown silty clay, with a trace of gravel		D	1.0		N = 22		Soil backfill 0.3-1.5m
				S	1.1		PID=0.1		Blank 0-2.0m
					1.45				
				A/E	1.5		PID=0.1		
					1.6				Bentonite 1.5-1.8m
		- below 2m light grey mottled red brown		A	2.0				
					2.1				
					2.5				
				S			3,11,17		
					2.95		N = 28		
				A	3.0				
					3.1				
									PVC 50mm screen 2.0-5.0m
									Sand 1.8-5.4m
				D	4.0				
				S	4.1		4,14,15		
					4.45		N = 29		
	4.8	SANDSTONE - extremely low strength, extremely weathered, orange brown sandstone		A	4.9				
					5.0				
				A	5.3				
	5.4	Bore discontinued at 5.4m			5.4				
		- practical refusal on at least very low strength sandstone							

RIG: 109 DB-8 **DRILLER:** Terratest **LOGGED:** PF **CASING:** Uncased

TYPE OF BORING: 125mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. BD1 with sample 0.15-0.35m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Parramatta Leagues Club
PROJECT: Parramatta Leagues Club Hotel
LOCATION: 1 Eels Place, Parramatta

SURFACE LEVEL: 13.5 mAHD
EASTING: 314972.8
NORTHING: 6257447.1
DIP/AZIMUTH: 90°/--

BORE No: 203
PROJECT No: 94523.00
DATE: 2-11-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
13	0.07	ASPHALTIC CONCRETE		A/E	0.1		PID=0.1		Concrete 0-0.3m
	0.4	FILLING - dark grey mottled brown silty clay filling, with a trace of sand and gravel			0.2				
		CLAYEY SILT - brown clayey silt, with a trace of fine sand		A/E	0.5		PID=0.1		
	0.8				0.6				
12	1	SILTY CLAY - hard, mottled orange brown and grey silty clay, with a trace of ironstone gravel		S	1.0		12,17,18 N = 35		Soil backfill 0.3-2.0m Blank 0-2.5m
				A/E	1.45		PID=0.1		
					1.5				
					1.6				
		1.8m: possible clayey sand band							
11	2	2.0 SILTY CLAY - hard, grey mottled red brown silty clay, with a trace of ironstone gravel		A	2.0				Bentonite 2.0-2.3m
					2.1				
				S	2.5		7,17,25 N = 42		
	3				2.95				
				A	3.0				
10					3.1				
				A	3.5				
					3.6				
	4			S	4.0		11,22,25/110 refusal		PVC 50mm screen 2.5-5.5m Sand 2.3-6.0m
9					4.41				
				A	4.5				
					4.6				
	5	5.0 SILTY CLAY - grey mottled red silty clay, with a trace of fine sand and gravel		A	5.0				
8					5.1				
	5.5	SANDY CLAY - red brown sandy clay, with some silt		A	5.5				
					5.6				
				A	5.9				
	6	6.0 Bore discontinued at 6.0m			6.0				
7									
6									
5									
4									

RIG: 109 DB-8 **DRILLER:** Terratest **LOGGED:** PF **CASING:** Uncased

TYPE OF BORING: 125mm diameter solid flight auger

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Parramatta Leagues Club
PROJECT: Parramatta Leagues Club Hotel
LOCATION: 1 Eels Place, Parramatta

SURFACE LEVEL: 13.6 mAHD
EASTING: 315005.3
NORTHING: 6257462.9
DIP/AZIMUTH: 90°/--

BORE No: 201A
PROJECT No: 94523.00
DATE: 8-11-2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
13.5	0.1	ASPHALTIC CONCRETE										
	0.4	ROADBASE FILLING - grey, gravelly sand roadbase filling, humid										
	0.6	FILLING - light brown, silty clay filling, humid										
13	1	SILTY CLAY - light brown, silty clay, humid 1m: colour change to brown mottled red						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0° and 10°				
12	2											
11	3											
	3.15	SANDSTONE - very low strength, highly weathered, fractured and slightly fractured, pale grey, fine grained sandstone, with some high strength, red brown iron cemented bands						3.2-3.25m: Cs 3.32 & 3.47m: B(x2) 0°, fe, cly 3.58-3.62m: Ds 3.64m: J, 45°, un, ro, he 3.7, 3.82 & 3.97m: B(x3), fe, cly 4.0-4.2m: Ds	C	92	25	PL(A) = 1.58
10	4											
	4.2	SANDSTONE - medium to high then high strength, moderately then slightly weathered, slightly fractured, pale grey and brown, fine to medium grained sandstone, with some extremely low strength bands						4.3m: B0°, cly, 5mm 4.36m: B0°, cly, 30mm 4.56m: B5°, cly, 10mm 4.75-4.85m: fg 4.85m: CORE LOSS: 200mm 5.1m: B0°, cly 30mm				PL(A) = 0.99
9	5											
	5.05							5.35m: J50°, un, ro, cln 5.5 & 5.75m: B0°-5°, fg, 10mm 5.92m: B10°, cbs 10mm 6.16, 6.22, & 6.43m: B(x3) 0°-5°, fe 6.5m: B0°, cly 10mm, fe 6.9m: B0°, fe 7-7.03m: Cs	C	100	83	PL(A) = 1.1 PL(A) = 1.2
8	6											
	7											
	7.03	SANDSTONE - high strength, moderately weathered, unbroken, medium to coarse grained, brown sandstone										PL(A) = 1.69
	8											
	8.0	Bore discontinued at 8.0m										
5	9											
4												

RIG: Bobcat **DRILLER:** JE/GM **LOGGED:** SI/JY **CASING:** HW to 2.5m; HQ to 3.15m

TYPE OF BORING: 150mm diameter spiral flight auger to 2.5m. Rotary (water) to 3.15m; NLMC casing to 8.0m. Rock coring to 8.04m.

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Parramatta Leagues Club
PROJECT: Parramatta Leagues Club Hotel
LOCATION: 1 Eels Place, Parramatta

SURFACE LEVEL: 13.5 mAHD
EASTING: 314987.2
NORTHING: 6257466.1
DIP/AZIMUTH: 90°/--

BORE No: 202A
PROJECT No: 94523.00
DATE: 8-11-2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
13	0.15	ASPHALTIC CONCRETE										
	0.25	ROADBASE FILLING - grey, gravelly sand roadbase filling, humid										
	0.5	FILLING - light brown, silty clay filling, with a trace of gravel, humid										
12	1	SILTY CLAY - light brown, silty clay, humid 1m: colour change to brown 1.5m: colour change to red-brown						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0° and 10°				
11	2											
10	3											
9	4											
	4.8	SANDSTONE - very low strength, highly weathered pale grey brown, fine grained sandstone										
8	5											
	5.35	SANDSTONE - high then medium strength, highly then slightly weathered, slightly fractured, red brown then pale grey, fine grained sandstone, with some very low strength bands						5.23-5.27m: B(x2) 0°-5°, fe, cly 5.43m: J45°, ti 5.52m: B0°, fe, cly, co, 3mm 5.72m: B0°, fe, Ds 40mm 5.86m: B0°, fe, cly 10mm 6.16m: J45°-85°, cu, ro, fe 6.42m: B0°, fe, cly 10mm 6.62m: B0°, Ds 40mm	C	100	60	PL(A) = 1.05 PL(A) = 0.86
7	7											
6	7.35	SANDSTONE - high strength, moderately weathered then fresh, slightly fractured, brown then pale grey medium to coarse grained sandstone						7.37m: B5°, fe 8.3m: B10°, fe, ti 9.17, 9.3 & 9.4m: B(x3) 5°-15°, cly, un, ti	C	100	100	PL(A) = 0.68 PL(A) = 2.43 PL(A) = 1.61
5	8											
4	9											

RIG: Bobcat **DRILLER:** JE/GM **LOGGED:** SI/JY **CASING:** HW to 2.5m; HQ to 4.8m

TYPE OF BORING: 150mm diameter spiral flight auger to 2.5m. Rotary (water) to 4.8m; NLMC casing to 10.11m. Rock coring to 10.11m.

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Parramatta Leagues Club
PROJECT: Parramatta Leagues Club Hotel
LOCATION: 1 Eels Place, Parramatta

SURFACE LEVEL: 13.5 mAHD
EASTING: 314987.2
NORTHING: 6257466.1
DIP/AZIMUTH: 90°/--

BORE No: 202A
PROJECT No: 94523.00
DATE: 8-11-2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	10.11	Bore discontinued at 10.11m										PL(A) = 1.54

RIG: Bobcat **DRILLER:** JE/GM **LOGGED:** SI/JY **CASING:** HW to 2.5m; HQ to 4.8m

TYPE OF BORING: 150mm diameter spiral flight auger to 2.5m. Rotary (water) to 4.8m; NLMC casing to 10.11m. Rock coring to 10.11m.

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

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Appendix D

About this Report

About this Report

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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.

Rock Strength

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

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

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

Degree of Weathering

The degree of weathering of rock is classified as follows:

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

Degree of Fracturing

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

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

Rock Descriptions

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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

Soil Descriptions

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Description and Classification Methods

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

Soil Types

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

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

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

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

The proportions of secondary constituents of soils are described as:

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

Definitions of grading terms used are:

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

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Descriptions

Soil Origin

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

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

Transported soils may be further subdivided into:

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

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

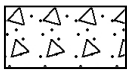
Symbols & Abbreviations

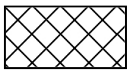
Graphic Symbols for Soil and Rock

General

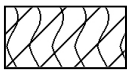

Asphalt

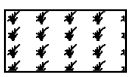

Road base

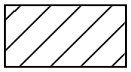

Concrete

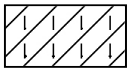

Filling

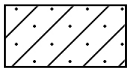
Soils


Topsoil

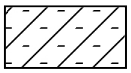

Peat

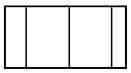

Clay

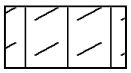

Silty clay

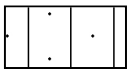

Sandy clay

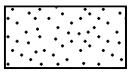

Gravelly clay

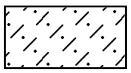

Shaly clay

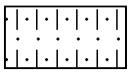

Silt


Clayey silt


Sandy silt

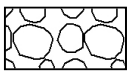

Sand

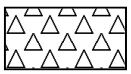

Clayey sand


Silty sand


Gravel

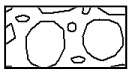

Sandy gravel


Cobbles, boulders

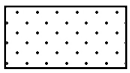

Talus

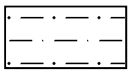
Sedimentary Rocks

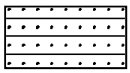

Boulder conglomerate

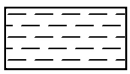

Conglomerate


Conglomeratic sandstone

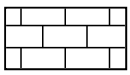

Sandstone


Siltstone

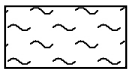

Laminite

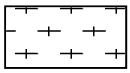

Mudstone, claystone, shale

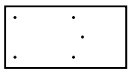

Coal


Limestone

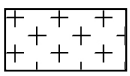
Metamorphic Rocks

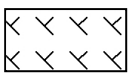

Slate, phyllite, schist

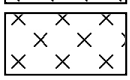

Gneiss

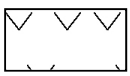

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry