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CORONATION (26 SHEPHERD ST) PTY LTD

Remediation Action Plan

26 Shepherd Street, Liverpool NSW

Report E23125 AC_Rev0

24 March 2017

REPORT DISTRIBUTION

Remediation Action Plan
26 Shepherd Street, Liverpool NSW

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EXECUTIVE SUMMARY

This Remediation Action Plan (RAP) outlines the methods and procedures that will be used to remediate the site identified as 26 Shepherd Street, Liverpool NSW ('the site') to a condition suitable for residential land use with minimal access to soils, without the need for ongoing environmental monitoring. This assessment was conducted in support of a Development Application (DA) to the Liverpool City Council and for the purpose of enabling the developer to meet its obligations under the *Contaminated Land Management Act 1997* (CLM Act), for the assessment and management of contaminated soil.

A detailed site investigation (DSI) undertaken previously by EI, documented intrusive investigation works, laboratory analytical results and recommendations in regards to potential risks to human health, the environment and the aesthetic uses of the land.

Based on preliminary plans, the site has been designated for the construction of a multi-storey residential apartment building overlying a dual level basement car park, as illustrated in the proposed development plans (Ref. Woods Bagot, Job No. 120809), attached in **Appendix A**. It is understood that the basement car park will extend to a depth of approximately 6.2 m Below Ground Level (mBGL) to a finished floor level of approximately RL 4.7 mAHD, with localised deeper excavation (i.e. piling, lift pits).

This RAP follows on from the previous investigations and EI considers that the site can be made suitable for residential use with minimal opportunities for soil access, through the implementation of the following remediation works implemented in stages, as follows:

- **Stage 1** – Site preparation;
- **Stage 2** – Prior to site demolition, carry out a Hazardous Materials Survey;
- **Stage 3** - Post site demolition and removal of the hardstand pavement;
  - A site walkover to assess any visual signs of supplementary asbestos contamination and buried building waste;
- **Stage 4** – Additional investigations to close data gaps;
  - The quality of soils to be retained at the site for deep soil landscaping and characterise soils within the footprint of the warehouse building;
  - Groundwater assessment including, installation of an additional groundwater monitoring well in the footprint of the warehouse building, and one round of groundwater sampling from the existing groundwater monitoring well field; and
- **Stage 5** – Remedial excavation of fill soils, waste classification, and offsite disposal;
  - Classification of the fill material within the basement excavation and deep soil landscape area for offsite disposal in accordance with the EPA (2014) *Waste Classification Guidelines*.

Should unexpected finds be discovered during the course of the site remediation, the procedures described under the Unexpected Finds Protocol and the Site Validation Plan will be implemented, until the site remediation goals have been achieved and the site is deemed suitable for the intended land use.

Following completion of site remedial and validation assessment works a Site Validation Report will be prepared in accordance with the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*. The validation report will include a validation of the remaining surfaces onsite following demolition and excavation of the basement. Systematic sampling will be implemented to validate the remedial excavation areas where infrastructure or contaminated soils have been removed and the remaining surfaces within the basement excavation.

1 INTRODUCTION

1.1 BACKGROUND

Ms Danielle Eloss of Coronation (26 Shepherd St) Pty Ltd ("the Client") engaged EI Australia (EI) to prepare a Remedial Action Plan (RAP) for the property located at 26 Shepherd Street, Liverpool NSW ('the site').

The site is located approximately 28 km south-west of the Sydney Central Business District, within the Local Government Area of Liverpool City Council (**Figure 1**), which encompasses a total area of approximately 2,800 m^2, as depicted in the site plan presented as **Figure 2**.

This assessment was conducted in support of a Development Application (DA) to Liverpool City Council and for the purpose of enabling the developer to meet its obligations under the *Contaminated Land Management Act 1997* (CLM Act), for the assessment and management of contaminated soil and/or groundwater.

The purpose of this RAP is to establish a sequential process for remediation and validation works, as required as part of a DA package to Liverpool City Council to enable the site to be redeveloped for residential / commercial (with minimal soil access) land use. This RAP follows on from a previous Detailed Site Investigation (DSI) prepared by EI, entitled *Detailed Site Investigation, 26 Shepherd Street, Liverpool NSW* (Ref: E23125 AB_Rev0, dated 22 November 2016).

1.2 PROPOSED DEVELOPMENT

Based on preliminary plans, the site has been designated for the construction of a multi-storey residential apartment building overlying a dual level basement car park, as illustrated in the proposed development plans (Ref. Woods Bagot, Job No. 120809), attached in **Appendix A**. It is understood that the basement car park will extend to a depth of approximately 6.2 m Below Ground Level (mBGL) to a finished floor level of approximately RL 4.7 mAHD, with localised deeper excavation (i.e. piling, lift pits). An open space, deep soil landscaping area is proposed in the western area of the site.

1.3 REGULATORY FRAMEWORK

The following regulatory framework and guidelines were considered during the preparation of this RAP:

Legislation

- *Contaminated Land Management Act 1997* (CLM Act 1997);
- *Protection of the Environment Operations Act 1997* (POEO Act 1997) and associated Regulations including *UPSS Regulation 2014* and *Waste Regulation 2014*;
- *State Environment Protection Policy 55 – Remediation of Land (SEPP 55)* under the *Environmental Planning and Assessment Act 1997* (EP&A Act 1997);
- *Liverpool City Council Land Development Control Plan 2008*; and
- *Work Health and Safety Act 2011* (WHS Act 2011) and associated Regulations and Codes of Practice.

Guidelines

- ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*;
- DEC (2007) *Guidelines for the Assessment and Management of Groundwater Contamination*;
- DEC (2006) *Guidelines for the NSW Site Auditor Scheme* (2nd Edition);

- DECCW (2009) *Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008*
- EPA (1995) *Sampling Design Guidelines*;
- NEPM (2013) Schedule B(1) *Guideline on Investigation Levels for Soil and Groundwater*;
- NEPM (2013) Schedule B(2) *Guideline on Site Characterisation*;
- NSW EPA (2012) *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases*
- OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*; and
- WorkCover (2014) *Managing Asbestos In or On Soil*.

1.4 OBJECTIVES

The main objective of this RAP is to inform and guide the site remediation and validation assessment process by:

- Providing detailed procedures on how to carry out remediation works in a safe and environmentally friendly manner, while minimising impacts to human health (including site workers and the general public) and the environment;
- Data gap closure investigations to enable adequate site characterisation, and remediation of impacted fill/soil materials;
- Validation of remediated areas to a standard that is acceptable for the intended residential land uses.
- Providing a preliminary sampling and analytical quality plan to be used for site validation, and
- Complying with the DA Conditions for the development.

1.5 SCOPE OF WORK

With the aim of achieving the above objectives while generally complying with the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*, the scope of work included:

- Review and assessment of the available data relevant to the remediation of the site and provided by the previous investigation reports for the site;
- Definition of remediation goals and acceptance criteria;
- Review and assessment of the latest technical literature on remediation technologies relevant to the site and relevant case studies;
- Technical assessment of alternative remediation technologies;
- Evaluation of available remediation options and selection of the most appropriate remedial strategy (or combination of strategies) for the site;
- Provision of information so that remedial works may be carried out in accordance with relevant laws and regulations;
- Provision of guidance on approvals and licences required for the remedial works, under current legislation (e.g. SEPP 55);
- Provision of information to assist the contractor in their preparation of a Work Health and Safety Plan and other site management/planning documents;
- Development of a sampling, analysis and quality strategy for hotspot delineation and post-remedial validation.

This RAP also outlines measures for the excavation, stockpiling, management and disposal of spoil, water and sediment controls, as well as a contingency plan to handle any additional contamination that may be identified during the additional investigations and/or site remedial works. The measures provided in this RAP are brief and are designed to accompany site-specific management plans, including an Asbestos Management Plan (AMP) and a Construction Environment Management Plan (CEMP). These measures do not replace any other requirements for the site as a whole. A complete set of site specific management plans should be developed and adhered to. An outline of management measures to be addressed is provided in **Section 7.3**.

1.6 DEVIATIONS FROM THIS RAP

While it may be possible to vary the sequence and/or details of the actual site remediation and validation works to meet site constraints, a qualified Environmental Scientist performing the roles of Environmental Management Coordinator and Remediation Supervisor will be appointed to the project to ensure that:

- Critical stages of the site remediation/validation process (including, but not limited to, proper site induction of site personnel in relation to contamination hazards and environmental management issues, marking of remediation areas, inspection of environmental monitoring systems, implementation of specified control measures and required data gap closure and validation sampling), are appropriately supervised, implemented and documented, with the relevant data collected for environmental reporting purposes; and
- Any deviations from the works specified in this RAP are properly documented and approved, as required under the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*.

Performing remedial works without the presence of a qualified environmental engineer/scientist when necessary may lead to project delays and extra costs due to additional environmental investigation requirements imposed to confirm the environmental status of the site.

In worst case scenarios, waste materials removed from the site without proper characterisation and/or waste classification assessment, may lead to regulatory action and potential penalties, as described under the *Waste Regulation 2014*, the *Protection of the Environment Operations Act 1997* and the *Contaminated Land Management Act 1997*.

2 SITE DESCRIPTION

2.1 PROPERTY IDENTIFICATION, LOCATION AND PHYSICAL SETTING

The site identification details and associated information are presented in **Table 2-1**.

Table 2-1 Site Identification, Location and Zoning

Attribute	Description
Street Address	26 Shepherd Street, Liverpool NSW
Site Description	Approx. 27 km south west of Sydney CBD, bound by a construction site (north), Georges River (east), construction site (south) Shepherd Street followed by commercial buildings (west). The site currently occupied by a two storey brick commercial building/warehouse at the north-eastern corner and car parking across the remainder of the site. North eastern corner of the site: GDA94-MGA56 Easting: 308086.972, Northing: 6243378.638 (Source: http://maps.six.nsw.gov.au).
Site Area	Approx. 2,800 m^2
Lot and Deposited Plan (DP)	Lot 23 in DP 859055
State Survey Marks	Three State Survey (SS) marks are situated in close proximity to the site: PM59767D and PM61502 (north-west of the site) on the corner of Atkinson Street and Shepherd Street and SS78222 (south-west of the site) on Shepherd Street. (Source: http://maps.six.nsw.gov.au).
Local Government Authority	Liverpool City Council
Parish	St Luke
County	Cumberland
Current Zoning	R4 – High Density Residential (Liverpool Local Environmental Plan 2008)

2.2 SURROUNDING LAND USE

The site is situated within an area of mixed land uses and current land uses on surrounding properties are described in **Table 2-2**.

Table 2-2 Surrounding Land Uses

Direction	Land Use Description	Sensitive Receptors (& distance from site)
North	Construction site.	Residential dwellings (145 m along Atkinson Street) and construction workers (adjacent northern site boundary).
South	Construction site.	Construction workers (adjacent southern site boundary).
East	Georges River, followed by industrial factories	Georges River (<50 m east) and factory works (160 m East).

Direction	Land Use Description	Sensitive Receptors (& distance from site)
West	Commercial properties, followed by railway corridor.	Factory workers (70 m west), Al Amanah College (290 m north-west).

2.3 REGIONAL SETTING

Regional topography, geology, soil landscape and hydrogeology are summarised in **Table 2-3**.

Table 2-3 Regional Setting Information

Attribute	Description
Topography	The site is relatively flat with a nominal 1% slope to the east, with site typically elevated at approximately 10 mAHD.
Site Drainage	The site is connected to the municipal stormwater system and is expected to drain towards Georges River.
Regional Geology	Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Penrith 1:100,000 Geological Series Sheet 9030 (DMR 1991) indicates the site to be underlain by Tertiary alluvial sediments. Tertiary alluvial sediments generally comprise clayey quartzose sand and clay.
Soil Landscapes	The Soil Conservation Service of NSW Penrith 1:100,000 Soil Landscapes Series Sheet 9030 (2nd Edition) indicates that the site lies on the boundary of the Luddenham Landscape and the Blacktown Landscape. The Blacktown Landscape typically includes gently undulating rises with broad rounded crests and ridges with gently inclined slopes of typically <5 %. Blacktown Landscape soils generally comprises shallow to moderately deep (<1.5 m) red and brown podzolic soils on upper slopes. The Luddenham Landscape typically includes undulating to rolling low hills on Wianamatta Group shales. Luddenham Landscape soils generally comprises moderately deep (<150 cm) yellow podzolic soils and prairie soils on lower slopes and drainage lines.
Acid Sulfate Soil Risk	The City of Sydney LEP 2012 Acid Sulfate Soils Map (Sheet ASS_007) shows the site to be within areas mapped as *Class 1* and *Class 5* Acid Sulfate Soils (ASS). Class 1 areas are likely to locate ASS during any works and Class 5 areas are likely to locate ASS during works within 500 metres of adjacent Class 1, 2, 3, or 4 land which are likely to lower the water table below 1 metre AHD on adjacent Class 1,2, 3 or 4 land.
Likelihood & Depth of Filling	Based on site observations, regional information and previous investigations, the fill depth across the site is approximately 0.0 – 2.0 mBGL.
Nearest Surface Water Feature	The nearest surface water is Georges River, adjacent to the eastern site boundary.
Aquifer Types	The local aquifer is associated with upriver alluvial deposits consisting of sand, silts and gravels. Groundwater from the aquifer is typically well connected with surface water and coupled with coarser sediments, produces high yields.
Depth to Groundwater	Based on the elevation of the site and proximity to Georges River, groundwater is anticipated to occur at a depth of approximately 5 mBGL.
Anticipated Groundwater Flow	Groundwater is anticipated to flow in a east / south-easterly direction towards the Georges River.
Groundwater Salinity	Water quality within the Georges River catchment is variable and largely influenced by surrounding land use. Conductivity has recently been documented in the range of 66.5 – 2,249 µs/cm. (Tippler *et al.* 2012).

3 SITE CHARACTERISATION

3.1 PREVIOUS INVESTIGATION REPORTS

In preparing this RAP, EI have considered the following previous investigations:

- EI (2016) *Preliminary Site Investigation (PSI), 26 Shepherd Street, Liverpool NSW,* Ref: E23125 AA_Rev0, dated 14 October 2016*.*
- EI (2016) *Detailed Site Investigation (DSI), 26 Shepherd Street, Liverpool NSW,* Ref: E23125 AA_Rev0, dated 22 November 2016*.*

3.2 SUMMARY OF PREVIOUS INVESTIGATION FINDINGS

The findings of the previous investigations showed that:

- Historical records indicate the site was historically part of the Challenger Spinning Mill, which occupied the site between the 1930's and 1980's. Between 1965 and 1982 the former mill was demolished and the site cleared and used for storage and vehicle parking;
- The site was not reported as being subject to regulation in relation to environmental impacts, as documented in the NSW EPA/OEH public registers. It should be noted that the adjacent site, 20 Shepherd St (Lot 1 DP 247485) located adjacently north of the site, has been notified to the EPA under section 60 of the CLM Act (1997) and is currently being assessed to evaluate if regulation under section 11 of the CLM Act (1997) is required, however due to the proximity of this property to the site and groundwater flow direction (down-gradient), the risk of off-site sources of contamination impacting the site is considered to be low;
- A WorkCover NSW Authority data search of records relating to historical storage of dangerous goods on the site revealed no records pertaining to the site were held;
- A search of Council records relating to previous development applications, complaints and other information pertaining to previous activities at the site, did not identify any environmental concerns;
- The site walkover inspection identified the following areas of environmental concern:
    - Potential for imported fill material of unknown origin to be present across the site;
    - Potential for buried hazardous building materials from demolished structures and pesticides underlying current and former site structures;
    - Localised impacts from long-term vehicle parking and onsite chemical storage;
    - Migration of contamination onto the site from potential offsite sources.
- The site is located within an area Class 5 Acid Sulfate Soils, and as such, ASS are considered unlikely to be encountered during the works and an ASS Management Plan is not required; and
- A conceptual site model (CSM), and subsequent qualitative risk assessment was derived for the site in this DSI. The CSM identified potential contaminating sources that may occur at the site and evaluated the likelihood for relevant exposure pathways to be complete during and after the proposed development. The risk assessment was then conducted with respect to the proposed development, which involves residential land use with limited access to soils and groundwater. An intrusive sampling program was considered warranted to characterise soils and groundwater at the site;
- Field investigations completed by EI included one round of soil and groundwater sampling;

- Soil sampling and analyses were conducted at nine borehole locations (BH101M – BH109) down to a maximum depth of 9.3 mBGL. The sampling regime was developed using a systematic (triangular grid) sampling pattern, with allowance for structural obstacles (e.g. building walls, underground);
- The sub-surface soil profile comprised primarily of gravelly sandy clay fill material overlying residual sands and clays with underlying shale and sandstone bedrock;
- Laboratory results for all analysed soil samples were compliant with the adopted human health based screening criteria (HSLs).
- Laboratory results for all analysed soil samples were compliant with the adopted human health based screening criteria (HILs/HSLs).
- Zinc was reported in filling soils in the proposed deep soil / landscape area of the site at one location, BH101M_0.2-0.3 (190 mg/kg), at levels exceeding adopted EILs.
- Asbestos was identified in fill material at test bore locations BH101M, BH103 and BH105 at 0.3-0.5 mBGL. Laboratory analysis indicated non-friable asbestos at a weight percentage within HSL criteria.
- Intrusive investigation indicated a low risk of Acid Sulfate Soils (ASS) being present onsite;
- Three test bores were converted to groundwater monitoring wells (BH101M, BH102M and BH104M). Stabilized water levels were encountered between 6.34 – 6.87 mBTOC (approximately 3.53 – 4.29 mAHD).
- Groundwater is inferred to flow in a south-easterly trajectory, with one hydraulic up gradient well (BH102M), and two hydraulic down-gradient wells (BH101M and BH104M). BH101M was unable to be sampled due to internal sediment blockage.
- Minor exceedances of the adopted GILs were reported in both sampled monitoring wells for Copper and Zinc. The heavy metal concentrations in the up-gradient well (BH102M) were reported at higher or equal concentrations to those reported in the downgradient well (BH104M). As such, the results were considered to be representative of urban/industrial environments and therefore not considered to pose an immediate threat to the environment;
- On review of the Preliminary Conceptual Site Model (CSM) developed for site, it was concluded that the model remains valid for the proposed redevelopment. The lack of identified contamination represents incomplete exposure pathways and an overall low risk to potential receptors, however the following data gaps require closure:
    - The potential presence of hazardous materials present within existing site structures;
    - The quality of soils and groundwater beneath the existing storage warehouse remains unknown;
    - Confirmation of any surface asbestos contamination following demolition of structures and removal of site pavements;
    - Quality of deeper fill soils and natural soils onsite is unknown
    - The spatial extent of asbestos and heavy metals within the proposed recreational / landscape area in the western area of the site; and
    - The spatial extent of any asbestos contamination in fill soils onsite requiring offsite disposal as part of basement excavation.

3.3 CONCEPTUAL SITE MODEL

In accordance with NEPM (2013) *Schedule B2 – Guideline on Site Characterisation* and to aid in the assessment of data collection for the site, EI developed a preliminary conceptual site model (CSM) assessing plausible pollutant linkages between potential contamination sources, migration pathways

and receptors. The CSM provides a framework for identifying data gaps in the existing site characterisation and future site assessments.

The CSM takes into account the change in land use from light industrial/commercial to residential / recreational / landscape use, comprising the construction of a mixed use residential / commercial apartment building overlying a two level basement car park, as illustrated in the proposed development plans shown in **Appendix A**.

3.3.1 Subsurface Conditions

The general site geology encountered during the previous investigations (EI, 2016) is described as gravelly sandy clay fill material overlying residual sands and clays with underlying shale and sandstone bedrock.

A summary of the observed subsurface profile is presented in **Table 3-1**.

Table 3-1 Generalised Subsurface Profile

Layer	Description	Depth to top and bottom of layer (mBGL)
Fill	Gravelly Sandy CLAY; low plasticity, dark brown to dark grey, fine to coarse grained sand, fine to medium grained sub angular gravels and red brick fragments throughout.	0.0 - 2.0
Residual Soil	Silty/Sandy CLAY; low to high plasticity, brown/grey/red, fine to medium grained sands. Clayey SAND; light grey/red/ orange-brown, fine to medium grained sands, low to medium plasticity clays.	1.2 – 9.0^{+}
Bedrock	SHALE; Distinctly weathered, grey-brown, very low strength.	7.3^{+}

Notes:
+ Approximate depth shown as mBGL. Refer to borehole logs in **Appendix C** for specific information at individual test bore locations.

3.3.2 Contamination Sources

Site history search findings and previous intrusive investigations identified the following potential contamination sources:

- Imported fill soils of unknown origin and quality distributed across the site;
- Weathering of hazardous building materials (i.e. painted surfaces, metallic structures, asbestos-fibre sheeting, etc.);
- Hazardous building materials within existing and previously demolished structures;
- Migration of contamination onto the site from offsite sources; and

3.3.3 Chemicals of Concern

Based on the findings reported in the DSI (EI, 2016), which reviewed previous environmental assessment reports for the site, the chemicals of concern for site remediation, validation and data gap closure are as follows:

- **Soil** – heavy metals (HMs) and asbestos.

- **Groundwater -** HM, TRH, BTEX, PAH, VOC, phenols and PCPs

3.3.4 Potential Sources, Exposure Pathways & Receptors

Based on the findings of the DSI (EI, 2016), potential contamination sources, exposure pathways, human and environmental receptors that were considered relevant for this assessment are summarised along with a qualitative assessment of the potential risks posed by complete exposure pathways in **Table 3-2**.

Table 3-2 Conceptual Site Model

Potential Sources	Impacted Medium	Potential Contaminants of Concern [1]	Likelihood for Contamination to Occur and Influence End Use of the Proposed Development
Imported fill soils of unknown origin distributed across the site	Soil, and ultimately groundwater due to contamination leaching	HM, TRH, PAH, BTEX, OC/OP Pesticides, PCB and asbestos	**Medium** Thickness and quality of the filling requires confirmation by intrusive soil investigation and sampling. Vertical migration of contamination (if present) to underlying groundwater is possible if contamination is present, however, this is likely to be influenced by the permeability, type and spatial distribution of sedimentary units associated with underlying alluvium.
Possible storage or disposal of wastes (paper and textile) waste form the former Challenger Mill	Soil, and ultimately groundwater due to contamination leaching	HM, Asbestos	**Medium** Migration of contamination to subsurface soils was limited by the presence of concrete hardstand in portions of the site. In addition, considering the overall condition of site structures, degree of soil contamination, if any, is likely to be medium.
Weathering of building structures (i.e. painted surfaces, metallic structures, asbestos-fibre sheeting)	Soil, and ultimately groundwater due to contamination leaching	HM, Asbestos	**Low** Migration of contamination to subsurface soils was limited by the presence of concrete hardstand. In addition, considering the overall condition of site structures, degree of soil contamination, if any, will likely be minor.
Potential on-site use of pesticides underneath existing building footprints	Soil	HM, OC/OP Pesticides	**Medium** Any impacts, should they be present, would likely be present beneath existing structures, and limited to shallow soils considering the nature of the application.
Hazardous building products contained in existing site structures	Building fabric, and ultimately site soils due to poor demolition practises	HM, Asbestos, and PCB,	**Medium** A Hazardous Materials Survey will be required to identify hazardous building products in existing structures to assist with demolition of site structures, and minimise potential secondary contamination of site soils.
Contamination from unknown on-site sources associated with commercial activities;	Soil, and ultimately groundwater due to contamination leaching	HM, TRH, BTEX, PAH, VOC, phenols and PCPs	**Medium** Given the limited information available on the location of timber storage operations on the site, intrusive investigation is considered warranted to verify conditions of site soil and potentially groundwater.

Potential Sources	Impacted Medium	Potential Contaminants of Concern [1]	Likelihood for Contamination to Occur and Influence End Use of the Proposed Development
The potential onsite migration of contamination (soil and groundwater) from unknown offsite sources.	Soil and Groundwater	HM, TRH, PAH, BTEX, VOC and VOCC	**Medium** Properties identified on the NSW EPA public registers are considered to be a low risk of contamination migration due to the distance and groundwater flow direction (down-gradient). Additionally, contemporary operations on neighbouring properties are typically commercial in nature, with heavy industry not observed; however, this does not discount possible historical operations being present.

Notes:
[1] HM – Heavy Metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc) unless otherwise indicated, TRH – Total Recoverable Hydrocarbons, PAH – Polycyclic Aromatic Hydrocarbons, BTEX – Benzene, Toluene, Ethylene and Xylene, OC/OP pesticides - Organochlorine and Organophosphorus Pesticides, PCB - Poly-chlorinated Biphenyls, PCPs - pentachlorophenols, VOC –Volatile Organic Compounds, VOCC – Volatile Organic Chlorinated Compound.

3.4 IDENTIFIED SITE CONTAMINATION

Based on a review of available information from the previous investigations and comparison of the laboratory analytical results to the relevant criteria, the following appraisal of soil contamination at the site identified:

- Asbestos contamination in fill material at test bores BH101, BH103 and BH105 at a depth of 0.2-0.3 mBGL.

3.5 REMAINING DATA GAPS

On the basis of investigation findings in the DSI by EI, the preliminary CSM was considered to appropriately identify contamination sources, migration mechanisms and exposure pathways, as well as potential onsite and offsite receptors. Previously known data gaps were largely addressed in the DSI, however, the following data gaps remain and require additional investigation:

- The potential presence of hazardous materials present within existing site structures;
- The quality of soils and groundwater beneath the existing two-storey storage warehouse remains unknown;

- Confirmation of any surface asbestos contamination following demolition of structures and removal of site pavements;
- Quality of deeper fill soils and natural soils onsite is unknown
- The spatial extent of asbestos and heavy metals within the proposed recreational / landscape area in the western area of the site; and
- The spatial extent of any asbestos contamination in fill soils onsite requiring offsite disposal as part of basement excavation.

3.6 EXTENT OF REMEDIATION REQUIRED

3.6.1 Remediation Areas

Based on all existing site characterisation data the areas of the site requiring remediation are outlined as follows:

- **Asbestos Contaminated Fill Soils** – EI propose that fill material from the western portion of the site and in the vicinity of boreholes BH101M, BH103 and BH105, are delineated, excavated, classified and disposed offsite in accordance with the EPA (2014) *Waste Classification Guidelines,* followed by validation of remedial excavation surfaces.
- **Asbestos –** The presence and extent of any asbestos contamination in surface fill materials. Prior to site demolition, carry out a Hazardous Materials Survey on existing site structures to identify potentially hazardous building products that may be released to the environment during demolition. This survey is necessitated by the legislative requirements of protecting site personnel from potential exposure risks. After demolition of the site building, a qualified environmental scientist/engineer will be required to do a walkover to inspect the presence of any historically buried asbestos on the site. An unexpected protocol will outline the procedure for actioning should supplementary asbestos contamination be identified during the walkover following demolition;

3.6.2 Approximate Soil Volumes

The excavation and offsite disposal remedial option should ensure no sources of soil contamination remain that would trigger the requirement for ongoing environmental management and monitoring.

The quantity of soils to be remediated on the western area of the site, along with any other areas requiring remediation identified during the data gap investigation, would be quantified in the respective waste classification reports as well final validation report.

4 REMEDIATION GOALS & CRITERIA

4.1 REMEDIATION GOALS

The remediation goals for this RAP, are consistent with NSW EPA, SEPP 55 guidelines and Council's contaminated land policy, and include:

- Meeting the conditions of the planning consent and to render the site suitable for the proposed land use(s);
- Demonstrating that the proposed remediation strategy for the site is environmentally justifiable practical and technically feasible;
- Adopting clean-up criteria appropriate for the future use of the site to mitigate possible impacts to human health and the environment;
- Mitigating possible off-site migration of contaminants (including migration in existing utilities such as the sewer, stormwater and other subsurface pipes or service trenches);
- Consideration of the principles of ecologically sustainable development in line with Section 9 of the *Contaminated Land Management Act 1997*;
- Minimising waste generation under the *Waste Avoidance and Resource Recovery Act 2001*;
- To remediate all contamination at the site so there are no unacceptable risks to off-site receptors;
- To remediate the site to a condition where any residual contamination does not require long-term management using an EMP; and
- Demonstrating that the plans for site management of remediation work consider work health and safety, environmental management, community relations and site contingencies.

4.2 REMEDIATION CRITERIA

4.2.1 Soil Remediation (Validation) Criteria

As the proposed site development will comprise medium to high density residential use with minimal accessible soils, the following soil remediation criteria, which are based on NEPM (2013) *Schedule B1 Guideline on Investigation Levels for Soil and Groundwater*, will be adopted as clean up levels for the applicable areas of the site:

Accessible Soil Areas

- NEPM 2013 *HIL-B Health-based Investigation Levels* (HIL-B) for residential settings with minimal opportunities for soil access (including dwellings with fully and permanently paved yard space such as high-rise buildings and apartments);
- NEPM 2013 *HIL-C Health-based Investigation Levels* (HIL-C) for public open space such as parks, playgrounds, paying fields, secondary schools, and footpaths; and
- NEPM 2013 *Soil Health Screening Levels* for vapour intrusion (HSLs A&B) for coarse-textured (sandy) soils on low to high density residential settings.
- NEPM 2013 *Management Limits for TRH fractions* for residential, parkland, and public open space - coarse-textured soils.

The contaminant threshold values relating to the adopted soil remediation criteria are tabulated in **Appendix D, Table D-1**. Conformance with the soil remediation criteria will be deemed to have been attained when soil validation samples from similar lithology and depth show contaminant concentrations that are below the specified criteria, or, as a minimum, the 95% upper confidence limit

(UCL) mean concentration values of each contaminant in the soil remediated area (i.e. across the excavated surface), are below the respective remediation criteria.

Soil samples will also be assessed against the NEPM 2013 EILs for arsenic, copper, chromium (III), nickel, lead, zinc, DDT and naphthalene, which have been derived for protection of terrestrial ecosystems. Soil samples are assessed against the NEPM 2013 ESLs for selected petroleum hydrocarbons & TRH fractions for protection of terrestrial ecosystems. ESLs only apply to the top 2 m of soil (root zone). Soil remediation criteria for EILs and ESLs are tabulated in **Appendix D, Table D-2**

4.2.2 Groundwater Criteria

- *NEPM 2013 Groundwater Investigation Levels (GILs) for Freshwater*, as the site is located immediately adjacent to Georges River (the receiving water body), which is considered to be a freshwater ecosystem;
- *NEPM 2013 Groundwater Investigation Levels (GILs) for Recreational settings (drinking water guidelines multiplied by a factor of 10)*, were applied in light of the potential for industrial and recreational use of groundwater down-hydraulic gradient of the site;
- *NEPM 2013 Groundwater Health Screening Levels* for vapour intrusion (HSLs A&B) for coarse-textured (sandy) soils on low to high density residential settings

The contaminant threshold values relating to the adopted groundwater remediation criteria are tabulated in **Appendix D, Table D-3**. Conformance with the groundwater remediation criteria will be deemed to have been attained when additional groundwater samples show contaminant concentrations that are below the respective remediation criteria.

4.3 WASTE CRITERIA

Prior to being removed from the site, excavated soils must be classified in accordance with the EPA (2014) *Waste Classification Guidelines* (the 'Waste Guidelines'). Under these guidelines, fill/soils may be classified into the following groups: *General Solid Waste*, *Restricted Solid Waste* or *Hazardous Waste*, subject to chemical assessment using NATA-registered laboratory methods for total and leachable contaminant levels.

The total contaminant threshold concentrations and leachate thresholds tested using the TCLP methodology for each relevant contaminant parameter will then be interpreted against the respective EPA (2014) thresholds, which are presented in **Appendix D, Tables D-4** and **D-5**, in order to classify the waste soils. Any soils containing asbestos would also be classified as *Special Waste - Asbestos Waste*. In accordance with the *NSW Waste Regulation 2014*, waste soils must only be disposed to a waste facility that is appropriately licenced to receive the incoming waste. It is therefore recommended that confirmation is obtained from the waste facility prior the materials being removed from the site.

Should the analytical results exceed the SCC2 and/or TCLP2 thresholds, then the materials will be classified as *Hazardous Waste*. In such cases, material stabilisation treatment with EPA approval may be required prior to offsite disposal. Unexpected material may need to be segregated depending on the source of the waste, prior to conducting waste classification assessment. This approach is discussed in more detail under *Contingency Management* in **Section 7.4**.

5 REMEDIATION TECHNOLOGY

5.1 REGULATORY OVERVIEW

In order to attain an environmental outcome, the NEPM 2013 guidelines (Volume 1 Section 16) indicates when assessing contamination, the preferred hierarchy for site remediation options and/or management should be considered including:

- On-site treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level; and
- Off-site treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site; or, if the above are not practicable:
- Consolidation and isolation of the soil on site by containment with a properly designed barrier; and
- Removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material; or,
- Where the assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate management strategy.

When deciding which option to choose, the sustainability (environmental, economic and social) of each option should be considered, in terms of achieving an appropriate balance between the benefits and effects of undertaking the option.

For the site a number of remediation options were reviewed to examine the suitability of each method, the surrounding properties, geological and hydrogeological limitations and the following considerations:

- Development requirements (residential, with accessible soils);
- Prioritisation of works in areas of most concern;
- Ability of remedial method to treat contamination with respect to material and infrastructure limitations;
- Remedial timetable;
- Defensible method to ensure the site is remediated to appropriate levels / validation criteria; and
- Regulatory compliance.

5.2 REMEDIAL TECHNOLOGIES REVIEW

A number of soil and groundwater remediation options were reviewed to examine the suitability of each method, with due regard for the surrounding land uses, as well as the geological and hydrogeological limitations.

Brief discussion on the various remediation technology options is provided in **Appendix E**. Each of the available remediation technologies, except those not commonly used in Australia (for instance in-situ thermal or steam injection), are summarised in terms of their suitability for treatment of soils and groundwater in **Table 5-1**.

5.3 PREFERRED REMEDIATION OPTION

Based on the assessment remedial technologies, the proposed site development (apartment building with three level basement), the potential risks to human health and the environment, and the relative cost effectiveness of feasible remedial techniques, the preferred remedial option for the site is for complete and thorough offsite disposal to licensed waste facilities of all impacted fill soils. Since the

proposed development requires extensive and deep excavation of the site, reinstatement with validated, imported excavated natural materials is unlikely to be required, except for areas located in the deep soil landscaping area in the western portion of the site.

5.4 SITE PREPARATION, LICENCES & APPROVALS

5.4.1 Consent Requirements

In accordance with SEPP 55 (1998) – *Remediation of Land* the category of the remediation works defines whether consent is required prior to the commencement of the works. Under SEPP 55, works where there is the potential for significant environmental impact are classed as Category 1 works and require development consent. Category 2 works pose a low potential for environmental impact and do not therefore require prior consent. The determination for the subject site is outlined in **Table 5-2**.

Table 5-1 Remedial Technology Review - Soils

Remediation Methodology	Description	Advantages	Disadvantages	Suitability
No Action	'No Action' can be considered if: • There is no measurable contamination; • Contaminant concentrations are below assessment guidelines; • Contaminants are not mobile; or • Exposure to contaminated soils is unlikely.	No remediation costs Creates minimal disturbance to the site Retains material on-site	Not applicable to the kind of contamination encountered at the site. Contamination would remain in situ allowing potential vapour intrusion and off-site migration of contamination and impacts on groundwater. Would pose limitations on land use options. Requires an Environmental Management Plan and ongoing monitoring.	Not Suitable – as the key objective of the remedial strategy is to make the site suitable for residential use without the need for ongoing monitoring.
On-site bioremediation	Excavated soils are thoroughly broken down and aerated, mixed with microorganisms and nutrients, stockpiled and aerated in above ground enclosures.	Cost effective if soils are utilised on-site. Lower disposal costs. Limited requirement to import fill material to site. Retains material on-site.	Significant area of site required to land farm material. Undefined remediation timeframe. Potential for odour problems. Not suitable for metals contamination.	Not suitable – Soil contamination is not addressed by this remediation approach. Additionally, soil is required to be removed from site for the accommodation of a two-level basement.
In-situ treatment	*In-situ* treatment of impacted soils within the smear zone and saturated zone using *in-situ* treatment methods such as SVE, steam stripping, ISCO or injection of oxygen releasing compounds.	Creates minimal disturbance to the site (no excavation). Cost effective for large scale site remediation projects of light to mid-weight petroleum hydrocarbons. Potential to simultaneously remediate dissolved phase hydrocarbons in site groundwater.	Not applicable to the kind of contamination encountered at the site. Expensive establishment costs. Potential for odour problems. Requires detailed design, pilot trials and management.	Not suitable – this method is designed for widespread hydrocarbon impacted soils. Since the present dataset does not provide evidence of widespread contamination, this is not considered to be an economically viable option.

Remediation Methodology	Description	Advantages	Disadvantages	Suitability
Consolidation and/or capping	Risk minimisation approach where impacted soils are managed on-site by capping the ground surface with a clean, impermeable layer of fill material.	Effectively removes risk to human health by eliminating exposure pathways.	Importance of capping materials. Contamination would remain in situ allowing potential off-site migration of contamination and impacts on groundwater. Would pose limitations on land use options. Requires an Environmental Management Plan and ongoing monitoring.	Not Suitable – as an environmental management plan (EMP) with ongoing monitoring would be required, due to the retention of contaminated materials on the site, and the key objective of the remedial strategy is to make the site suitable for residential use without the need for ongoing monitoring. Additionally, soil is required to be removed from site for the accommodation of a two-level basement; therefore this approach is not compatible with the overall development design.
Excavation and off-site disposal	Excavate impacted materials. Transport directly to a licensed landfill facility. Re-instate site with imported clean fill material.	Fast – impacted material removed immediately, significantly reducing potential for impact to groundwater. No storage or treatment problems. Reduced vapour/odour issues as impacted materials removed from site. Minimal design and management costs.	Transfer of waste to another location (licensed waste facility). High costs associated with the disposal of waste soils and importation of clean backfill (in the case that a basement car park is not approved). Requires waste classification prior to disposal, keeping of thorough waste records, waste tracking and reporting. Sustainability issues related with disposal to landfill.	Suitable – for meeting the key project objective to make the site suitable for residential use without the need for ongoing monitoring. This will remove any potentially leachable contamination source and prevent vertical migration to the groundwater system.
Natural attenuation	Allowing the contaminants to biodegrade naturally following removal of the contamination source.	No remedial excavation of site. Retains materials on site. Sustainable, cost effective remediation method.	Slow process. Potential for contamination to further impact on the groundwater aquifer and nearby environmental receptors. Would require Environmental Management Plan and ongoing monitoring.	Not Suitable – this approach is primarily suited to addressing groundwater contamination, which is not identified as being significant. In addition, the approach would not address soil impacts.

Table 5-2 Remediation Works Category Determination

Significant Environment Impact	Yes/No	Category
Designated Development or State Significant Development	No	2
Critical or threatened species habitat	No	2
Have significant impact on threatened species, populations, ecological communities or their habitats	No	2
In area identified environmental significance such as scenic areas, wetlands (see list*)	No	2
Comply with a policy made under the contaminated land planning guidelines by the council.	Yes	2
Is work ancillary to designated development	Yes	2

Notes:
* Environmental significance list -coastal protection, conservation or heritage conservation, habitat area, habitat protection area, habitat or wildlife corridor, environment protection, escarpment, escarpment protection or escarpment preservation, floodway, littoral rainforest, nature reserve, scenic area or scenic protection, or wetland.

Based on the above assessment the remediation works for the site are considered as Category 2 remediation works and will not require development consent. Category 2 works do however require notification to the consent authority; therefore, Council should be notified 30 days before commencement of the works. The 30-day limit does not prevent Council intervention after that time for a breach of the EPA Act 1997 or non-compliance with SEPP 55. The notification also serves as the basis for updating Council records on properties in the local government area and must:

- Be in writing;
- Provide contact details for the notice;
- Briefly describe the remediation work;
- Show why the work is considered category 2 remediation work;
- Specify the property description and street address on which the remediation work is to be carried out;
- Provide a location map; and
- Provide estimates for commencement and completion dates of the work.

Provision of this RAP, as well as an indication of commencement and completion dates of the works in writing, is usually sufficient to meet the requirements of this notification.

5.4.2 Development Consent & Control Plans

All works should be in accordance with the Liverpool City Council DCPs and any development consent issued by Council for the development.

5.4.3 Other Licence Requirements

The appointed site contractor should prepare an appropriate Construction Environmental Management Plan (CEMP), health and safety plans and other plans required by the Council DA and DCPs. Where asbestos removal is required, the contractor must be appropriately licensed to perform such works.

6 REMEDIATION WORKS

6.1 REMEDIATION STRATEGY

Following approvals and site establishment, the main site remediation works would include, but not be limited to:

- **Stage 1** – Site preparation;
- **Stage 2** – Prior to site demolition, carry out a Hazardous Materials Survey;
- **Stage 3** - Post site demolition and removal of the hardstand pavement;
  - A site walkover to assess any visual signs of supplementary asbestos contamination and buried building waste;
- **Stage 4** – Additional investigations to close data gaps;
  - ***The quality of soils to be retained at the site for deep soil landscaping and characterise*** soils within the footprint of the warehouse building;
  - Groundwater assessment including, installation of an additional groundwater monitoring well in the footprint of the warehouse building, and one round of groundwater sampling from the existing groundwater monitoring well field; and
- **Stage 5** – Remedial excavation of fill soils, waste classification, and offsite disposal;
  - Classification of the fill material within the basement excavation and deep soil landscape area for offsite disposal in accordance with the EPA (2014) *Waste Classification Guidelines*.

Contingent Action

Should unexpected finds be discovered during the course of the site remediation programme, or should any phase of validation assessment identify residual, high level contamination requiring additional remediation, then the procedures described under the Unexpected Finds Protocol (**Section 7.6**) and/or the Validation Plan (**Section 8**) will be implemented, until the site remediation goals have been achieved and the site is deemed suitable for the intended land use.

6.2 REMEDIATION METHODOLOGY

6.2.1 Stage 1 – Site Preparation

Notice should be given to Council at least 30 days prior to the commencement of remediation works. A list of all required work permits will be obtained from Council and arrangements are to be made to obtain the necessary approvals from the relevant regulatory authorities.

The site itself will be prepared in accordance with the requirements of the Site Management Plan outlined in **Section 7**. The plan includes the requirement for a thorough walkover inspection of the site to assess for visible evidence of fibre cement sheeting, which may include asbestos-containing materials (ACM).

Establishment of environmental controls, site access, security, fencing, warning signage and preparation of a Health Safety and Environment Plan is required prior to works commencement. A project plan should also be developed to outline engineering design for excavation support (if required), water treatment requirements and design, staging of excavation works, stockpiling, waste stabilisation, waste material loading, traffic management and waste tracking.

As part of the site preparation phase and preliminary tasks a remediation workshop should be conducted with the appointed contractor(s) to further develop any remedial measures, excavation plans and environmental management requirements.

Also prior to commencing work the site contractor is to prepare a staging or project plan that outlines the basic stages of the remediation works. The staging plan should include, but not be limited to:

- Staging of areas to be excavated;
- Areas designated for waste segregation, screening and storage (stockpiling), amenities, soil and groundwater treatment (if required);
- Truck movement to allow loading to mitigate impacts to surrounding land users and council infrastructure; and
- Proposed environmental mitigation measures.

6.2.2 Stage 2 – Hazardous Materials Survey

Prior to site demolition, carry out a Hazardous Materials Survey on existing site structures to identify potentially hazardous building products that may be released to the environment during demolition. This survey is necessitated by the legislative requirements of protecting site personnel from potential exposure risks.

6.2.3 Stage 3 – Site Walkover Inspection

Post site demolition and removal of hardstand pavement (where remaining), a site walkover is to be conducted by a qualified and experienced environmental scientist/engineer to assess for any visual signs of contamination, supplementary asbestos contamination in surface fill soils, and buried building waste (potentially containing asbestos) that may have been buried beneath the slab prior to construction of the site buildings. Should unexpected finds be discovered during the course of the site remediation programme, then the procedures described under the Contingency Management (**Section 7.4**) and Unexpected Finds Protocol (**Section 7.6**) are to be implemented until the site remediation goals have been achieved and the site is deemed suitable for the intended land use.

6.2.4 Stage 4 – Additional Investigations for Data Gap Closure

Following demolition of site structures and removal of hardstand pavements, supplementary investigations to close the data gaps, identified in **Section 3.5**, are to be performed. The supplementary investigations will target the deep soil planting area (for evaluating ecological and asbestos risks) and the previously inaccessible warehouse building (soil and groundwater risks), involving:

- Additional intrusive soil investigations within the proposed deep soil landscaping area. This will include:
    - Intrusive investigations of the fill and underlying natural material at six new sampling points;
    - Collection of fill and natural soil samples from the soil surface or immediately below pavements, and at 0.5 m intervals, to at least 0.5 m into natural soils. Each soil sample collected will be screening for soil vapours by the use of a PID. Intrusive investigation is extend to a minimum depth of 0.5 m into underlying natural soils
    - Six soil samples are to be analysed in an accredited laboratory for Asbestos. We note that asbestos analysis will be completed as per NEPM (2013) gravimetric methods;
    - Six soil samples are to be analysed in an accredited laboratory for heavy metals, TRH, BTEX, VOC, PAH, OC/OP pesticides, PCB and phenols, (as listed in **Section 3.2.3**);
    - One groundwater well will be installed at a location within the commercial building as described in the DSI (2016), with groundwater analysis at an accredited laboratory for heavy metals, TRH, BTEX, PAH, VOC and phenols; and

- Should residual contaminants in soil samples collected be found at concentrations exceeding the adopted SILs (**Section 4.2**), soils should be remedially excavated and stockpiled for waste classification, followed by soil validation sampling of excavation walls and base.

- Installation of one groundwater monitoring well to a maximum depth of 9.0 mBGL. The monitoring well will be utilised to assess potential groundwater contamination from potential sources identified in the two-storey storage warehouse located in the western portion of the site:
  - Installation of one groundwater monitoring well to screen soils above the level of groundwater;
  - Collection of groundwater samples from the newly installed and existing groundwater monitoring well field, followed by laboratory analysis for heavy metals, TRH, BTEX, PAH, VOC and phenols;
  - Should residual contaminants in groundwater be found at concentrations exceeding the adopted criteria (**Section 4.2.2**), additional rounds of sampling may be required to satisfactorily characterise prevailing groundwater risks at the site. In addition, a risk assessment may be required to determine if groundwater impacts pose unacceptable risks to human health and/or the environment; and
  - A methodology for groundwater assessment is provided in **Appendix F**.

Should asbestos be confirmed to be present in site fill (i.e. should asbestos be confirmed to be present in the FA form) then excavation works in these areas would need to be undertaken while employing appropriate control measures to avoid dispersion of respirable asbestos fibres into the surrounding ambient atmosphere. The additional occupational health and safety protocols required to manage such a scenario would be clearly outlined as a contingency in the AMP and the CEMP, to be advised and/or prepared by the environmental consultant.

The proposed sampling plan may be varied due to site constraints; however, guidance from the appointed Environmental Consultant must be sought to ensure that deviations from this RAP are properly documented, as required under the OEH (2011) guidelines. Where anomalies in fill/soil consistency are noted (such as heavy staining, odour and/or presence of waste, oils, or other visible contamination), additional sampling and analysis may be necessary and guidance in this regard should be sought from the appointed Environmental Consultant.

6.2.5 Stage 5 – Remedial Excavation and Waste Classification

As soils are required to be bulk excavated for basement construction, fill soils within the basement footprint (and from the deep soils planting area, where required) can be managed by excavation and stockpile waste classification, prior to offsite disposal. As part of the excavation of fill soils, EI recommend over-excavation of fill by a minimum of 0.2 m into underlying natural soils to allow for the removal of any residual impacts to the top of natural soils by overlying fill.

Following the remedial excavation of all fill soils from the basement footprint, the excavation is to be visually assessed to confirm the removal of all fill soils. Following visual assessment, underlying natural soils are to be validated by the collection and laboratory analysis of soil samples for contaminants of concern, in accord with the methodology presented in **Section 8.1**.

For waste classification and offsite disposal of fill soils in accordance with EPA (2014b) *Waste Classification Guidelines*, the methods detailed below are to be implemented.

Management of Stockpiled Contamination Material

Where waste classification of soil stockpiles is required, excavated soils will be stockpiled separately on either hardstand pavement or HDPE plastic liner, and limited to a maximum height of 2.0 m. Stockpiles should be surrounded by star pickets and marking tape, or other suitable material, to clearly delineate their boundaries. Stockpiles shall be lightly conditioned by sprinkler to prevent dust blow. Where stockpiles are to remain onsite for a period >24 hours, silt fences or hay bales should be erected around each stockpile to prevent losses from surface erosion (runoff).

Stockpile Waste Classification

Prior to being assigned to an appropriate waste disposal facility, all waste soils will be classified in accordance with the NSW EPA (2014) *Waste Classification Guidelines.* If prior immobilisation treatment of the waste soils is required, disposal consent will be obtained from the NSW EPA prior to spoil transport.

After waste classification, the materials will be transported and disposed to EPA-licensed, waste landfill facilities.

In accordance with the NEPM (2013) guidelines, stockpiled soils will be sampled and laboratory analysed for waste classification purposes in accordance with the following methodology:

- Collection of one sample per 25 m^3 of stockpiled material for the fill/soils, as per NEPM (2013) guidelines A minimum of three samples is required for waste classification of stockpiles < 25 m^3;
- For stockpiles > 200 m^3 in size (up to 2,500 m^3), a minimum of ten samples are to be collected with statistical analysis applied and classification according to the 95 % UCL of the average concentration of the assessed analytes
- Collection of one intra-laboratory duplicate for every 10 primary samples collected and one inter-laboratory duplicate for every 20 primary samples collected;
- Collection of one rinsate blank per sampling round;
- Analysis of all samples for heavy metals (including lead), TRHs, BTEX, PAHs, OC/OP pesticides, PCBs, and asbestos; and
- Preparation of a Waste Classification Certificate detailing the interpreted soil waste classification for each stockpile, to enable appropriate off-site disposal.

The proposed sampling plan may be varied due to site constraints; however guidance from the appointed Environmental Consultant must be sought to ensure that deviations from this RAP are properly documented, as required under the OEH (2011) guidelines. Where anomalies in fill/soil consistency are noted (such as heavy staining, odour and/or presence of waste or oils), additional sampling and analysis may be necessary and guidance in this regard should be sought from the appointed Environmental Consultant.

If the stockpiled materials contain concentrations of contaminants that exceed the disposal guidelines for *Restricted Solid Waste* (i.e. the materials are classed as potentially *Hazardous Waste*), they will be held on-site pending the determination of alternative disposal arrangements and/or on-site treatment. If required, disposal consent will be sought from the EPA NSW prior to spoil transport. Contingency measures to handle and manage the disposal of spoil materials that fail to meet landfill threshold criteria are provided in **Section 7.4**.

Off-Site Disposal of Contaminated Soils

Waste classified soils for disposal shall be loaded onto EPA-licensed waste vehicles for transport to the designated landfill facility. It is proposed that in-situ waste classified soils will be excavated and directly loaded onto transport vehicles for disposal to landfill. Waste transport contractors must carry a

copy of the relevant Waste Classification Certificate with every transported load. Other important requirements as part of the excavation procedure are as follows:

- Filling soils are to be excavated based on the findings of the *in-situ* waste classification assessment;
- Excavation of the fill soils is to be conducted to the full depth of filling (visually) over the entire site, with regular headspace screening of excavated materials (taken from the excavator bucket) for VOCs using a PID;
- Soils with headspace VOC concentrations >10 ppm, heavy staining and/or odour are to be stockpiled separately from other excavated materials, for supplementary classification sampling and testing; and

Excavation Considerations

Excavation depths should be in accordance with DA conditions. If further excavation is required, it should not jeopardise the stability of adjoining properties and structures.

Loading and Transport of Contaminated Material

Direct loading of contaminated fill / soils to appropriate transport vehicles is preferred, with the transport of contaminated material off the site to be via a clearly distinguished haul route. Removal of waste materials from the site shall only be carried out by a recognised contractor holding the appropriate EPA NSW licenses, consents and approvals.

The transportation and management of asbestos waste must be carried out in accordance with Part 7 of the Protection of the Environment Operations (Waste) Regulation 2014, which includes:

- Appropriate packaging, sealing, covering and/or wetting of the waste, as is required for the form of the asbestos contamination (i.e. bonded asbestos, friable asbestos or asbestos-contaminated soil);
- Reporting on transportation of asbestos waste by the transporter to the NSW EPA as required under Part 7, Section 79 of the Waste Regulation 2014; and
- Disposal to an appropriately licensed (i.e. lawful) premises, with proper advice to the occupier of the premises, while incorporating measures for the prevention of dust generation, in accordance with Part 7, Section 80 of the Waste Regulation 2014.

A site log shall be maintained by the contractor for each discrete excavation (numbered locations) to enable the tracking of disposed loads against on-site origin and location of the materials and corresponding (validation) sample numbers.

Measures shall be implemented to ensure no contaminated material is spilled onto public roadways or tracked off-site on vehicle wheels. Such measures will include the deployment of a vehicle washing/cleaning facility, which should be placed at a location before the egress point on the site. The facility shall be able to handle all vehicles and plant operating on-site.

All trucks transporting soils from the site are to be covered with tarpaulins (or equivalent).

Residue from the cleaning facility will be collected periodically and either dewatered on site in a contained bunded area or disposed as a slurry to an approved facility. Such residue will be deemed contaminated unless shown by validation to be below criteria.

The proposed waste transport route will be notified to Council and truck dispatch shall be logged and recorded by the contractor for each load leaving the site.

Disposal of Contaminated Material and Waste Tracking

All contaminated materials excavated and removed from the site shall be disposed at an appropriately licensed landfill facility. Copies of all necessary approvals shall be provided to the remediation consultant prior to any contaminated material being removed from the site.

Details of all contaminated materials removed from the site shall be documented by the contractor with copies of weighbridge slips, trip tickets and consignment disposal confirmation (where appropriate). Such information should be provided to the remediation consultant for reporting purposes.

Asbestos Management Controls

Due to the presence of asbestos in filling materials onsite, an Asbestos Management Plan (AMP) should be prepared for excavation works associated with contaminated fill soils. The removal of fill soils must also be carried out in accordance with the AMP, and under the supervision of a qualified environmental scientist or occupational hygienist. The control measures established prior to the removal of asbestos contamination must remain in place for the duration of the contaminated soil removal works.

6.2.6 Validation of Imported Backfill Soils

Should soils from offsite be required to backfill excavations, the imported filling material is to be certified as Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM) by the supplying contractor.

Imported soils should also be proven suitable when compared to the validation criteria (**Section 4.2.1**). Analytical results presented by the contractor to validate imported filling must be derived using NATA-accredited methods, obtained on representative samples that were collected at an appropriate frequency (e.g. as described below). Visual inspection of the imported material should be conducted by the appointed Environmental Project Manager to confirm that the delivered material is consistent with the description of the certified material before placement of the fill within the site. All imported clean fill validation results must be included in the final site validation report.

Should materials be identified to be potentially contaminated, or potentially unsuitable for reuse on the subject site, the following confirmation procedure shall be undertaken:

- The identified material is to be visually assessed to determine whether the material can be physically isolated from other potentially contaminated material;
- Materials shall be separately stockpiled in a demarcated area, which is either concrete-paved, or to be lined with an impermeable membrane;
- Verification sampling and analysis shall be conducted on the isolated material at a nominal minimal frequency of one sample per 25 m^3, with a minimum of 3 samples for each individual stockpile. For stockpiles > 200 m^3 in size, a minimum of ten samples are to be collected with statistical analysis applied and classification according to the 95 % UCL of the average concentration of the assessed analytes; and
- Subject to chemical concentrations that are within the criteria, isolated ‘clean’ materials may then be reused as filling material on-site, along with any additional imported and validated backfill materials.

NOTE: Before any soil or rock materials are imported onto the site under the VENM classification for backfilling purposes, supporting documentation must be submitted for review by the appointed Environmental Project Manager for approval.

More details in relation to validation sample collection and handling are provided in **Section 8.1**.

6.3 REMEDIATION SCHEDULE

An estimated schedule for the remedial works is detailed below in **Table 6-1**. The proposed schedule is based on the remedial works being completed as outlined in this RAP and is dependent on Council approval of any DA and conditions of consent.

Table 6-1 Indicative Site Remediation Schedule

Timeframe	Action
Start	Client / Council Approval of Remediation Plan
Week 1/2	Stage 1 – Site Preparation
Week 2/3	Stage 2 – HAZMAT survey
Week 2/3	Stage 3 & 4– Site walkover and additional Investigations to close data gaps
Week 3 to 6	Stage 5 – Excavation of contaminated soils and waste classification

Note: * If human health &/or environmental risk assessment is needed, an additional 2 weeks may apply.

6.4 REMEDIAL CONTINGENCIES

At this stage it is anticipated that the proposed remedial technologies should be effective in dealing with the contamination present, however remedial contingencies may be required should the scenarios detailed in **Table 6-2** arise.

Table 6-2 Remedial Contingencies

Scenario	Remedial Contingencies/Actions Required
Highly contaminated soils not identified during previous investigation are encountered, particularly at site boundaries	Follow the unexpected finds protocol as detailed in **Section 7.6** of this RAP. Work to be suspended until the Environmental Project Manager can further assess impacted soils/ materials and associated risks.
Underground tanks are encountered at the site	Systems to be removed and the excavations appropriately validated and backfilled by experienced contractor. Tank removal works reported by appropriate environmental consultant in accordance with NSW EPA (2014) *Technical Note: Investigation of Service Station Sites* and Australian Standard AS4976 (2008). Follow the unexpected finds protocol as detailed in **Section 7.6** of this RAP.
Highly impacted sludge's are uncovered	The leachability of heavy metals and hydrocarbons will need to be assessed before disposal options are considered. Follow the unexpected finds protocol as detailed in **Section 7.6** of this RAP.
Significant asbestos wastes are encountered	Work to be suspended and asbestos work removed by a suitably qualified contactor, in accordance with WorkCover regulations. Follow the unexpected finds protocol as detailed in **Section 7.6** of this RAP.
Residual soil impacts remain on-site between site boundary and basement excavation	Review/assess potential vapour hazard If there is a vapour risk additional remedial measures may be required including installation of a vapour barrier or passive or active vapour extraction system.
Contamination is identified near heritage items or significant trees (if identified)	Stop work. Review contaminant concentrations and risks to heritage items / flora. Assess human health and environmental risks if contamination remains in place. Review natural attenuation options.
Changes in proposed future land uses at the site	Review of the remediation works completed for the site.

7 SITE MANAGEMENT

7.1 RESPONSIBILITIES AND CONTACTS

The responsibilities for the various parties involved with the remediation programme are outlined in **Table 7-1.**

Table 7-1 Site Management Responsibilities

Responsible Party	Details/Contacts	Responsible for:
Principal Project Manager (PPM)	TBA	Overall management of the site remedial activities
Property Owner	Coronation (26 Shepherd St) Pty Ltd	Management of the site and associated remedial activities, particularly with respect to policy and operational procedures
Environmental Management Coordinator / Remediation Supervisor	TBA	• Ensuring that the site remediation works are carried out in an environmentally responsible manner; • Liaising between the appointed Environmental Consultant and Council providing regular updates and informing of any problems encountered; • Ensuring that all environmental protection measures are in place and are functioning correctly during site remediation works; and • Reporting any environmental issues to owner.
Demolition, Earthworks or Remediation Contractor	TBA	• Ensuring that all operations are carried out as identified in the RAP (demolition and remediation), as directed by the PPM and EMC; • Inducting all employees, subcontractors and authorised visitors on procedures with respect to site works, WHS and environmental management procedures; • Reporting any environmental issues to EMC; • Maintaining site induction, site visitor and complaint registers; • Ensuring that fugitive emissions and dust potentially leaving the confines of the site are suitably controlled and minimised; • Ensuring that water containing any suspended matter or contaminants must not leave the site must be minimised and suitably controlled, so as not to pollute the environment; • Ensuring that vehicles are cleaned and secured so that no mud, soil or water are deposited on any public roadways or adjacent areas; and • Ensure that noise and vibration levels at the site boundaries comply with the legislative requirements.

Responsible Party	Details/Contacts	Responsible for:
Environmental Consultant	EI Australia	• Ensure that all operations are carried out as identified in the RAP (demolition and remediation); and • Assess scenario should deviation from the procedures and requirements detailed in this RAP be required.

7.2 MATERIALS HANDLING AND MANAGEMENT

Table 7-2 summarises the measures that should be implemented in respect of materials handling during excavation and remediation works at the site.

Table 7-2 Materials Handling and Management Requirements

Item	Description/ Requirements
Earthworks contractors	Excavation of fill materials should be completed by a suitably qualified contractor to ensure: • All site staff are aware of the environmental and health and safety requirements to be adhered to; • There is no discernible release of dust into the atmosphere as a consequence of the works; • There is no discernible release of contaminated soil into any waterway as a consequence of the works; and • There are no pollution incidents, health impacts or complaints.
Stockpiling of materials	All stockpiles will be maintained as follows: • Stockpiles must be located on sealed surfaces such as sealed concrete, asphalt, or high density polyethylene; • Should stockpiles be placed on bare soils, these soils should be placed on yet to be remediated areas. Contaminated materials should only be stockpiled in locations that do not pose any environmental risk (e.g. hardstand areas); • Excavated soils should be stored in an orderly and safe condition (≤2 m height); and • Stockpiles should be battered with sloped angles to prevent collapse.
Stockpiling of materials (cont.)	• Stockpiles should be covered after being lightly conditioned by sprinkler to prevent dust blow and control odours; • The CEMP should describe suitable options for the control of air emissions; for example, using a hydrocarbon mitigation agent such as BioSolve®, Pinkwater®, or Anotech (or equivalent product selected by the contractor) in combination with the fine mist spray in the impacted area during disturbance and stockpiling of the TCE-materials; • Should the stockpile remain in-situ for over 24 hours, silt fences or hay bales should be erected around each stockpile to prevent losses from surface erosion (runoff); and • Stockpiles will be strategically located to mitigate environmental impacts while facilitating material handling requirements.

Item	Description/ Requirements
Loading of material	Loading of stockpiles / materials will be as follows: • Transport of contaminated material off the site is to be via a clearly distinguished haul route. • Measures shall be implemented to ensure no contaminated material is spilled onto public roadways or tracked off-site on vehicle wheels. Such measures should include the use of a wheel washing/cleaning facility, placed before the egress point on the site, and should be able to handle all vehicles and plant operating on-site. • Residue from the cleaning facility should be collected, and either dewatered on site in a contained/bunded area or disposed as a slurry to an approved facility. Such residue will be deemed contaminated unless proven otherwise.
Transport of materials	Prior to being assigned to an appropriate waste disposal facility, all waste fill/soils should be classified in accordance with the NSW EPA (2014) Waste Classification Guidelines. If prior immobilisation treatment of the waste soils is required, disposal consent will be obtained from the NSW EPA prior to spoil transport. • All trucks transporting soils from the site are to be covered with tarpaulins (or equivalent). • All haulage routes for trucks transporting soil, materials, equipment and machinery shall comply with all road traffic rules, minimise noise, vibration and odour to adjacent premises, utilise state roads and minimise use of local road. • All deliveries of soil, materials equipment or machinery should be completed during the approved hours of remediation and exit the site in a forward direction. • Removal of waste materials from the site shall only be carried out by a recognised contractor holding the appropriate EPA NSW licenses, consents and approvals. • Waste must be transported less than 150 km from the source (POEO, Waste, 2014) and landfills are required to be licensed for the category of waste they are scheduled to receive.
Material tracking	Materials excavated from the site should be tracked from the time of their excavation until their disposal. Tracking of the excavated materials should be completed by recording the following: • Origin of material; • Material type; • Approximate volume; and • Truck registration number. Disposal locations will be determined by the remediation contractor. Disposal location, waste disposal documentation (weighbridge dockets) and the above listed information should be provided to the remediation consultant for reporting purposes.
Material visual inspection prior to validation sampling.	Following the completion of remedial works as specified within this RAP, the following applies: • A suitably qualified environmental scientist should undertake a visual inspection of the work area. If visual observations indicate contamination, the earthworks contractors should rectify any issues arising from the inspection (i.e. further excavation or 'chasing out' until soils show no evidence of contamination based on visual inspection and/or odours); and • Following satisfactory completion of the visual inspection, validation sampling of soils should be completed. Validation sampling is discussed in **Section 8**. Only following satisfactory validation, will remedial works be deemed as completed.

7.3 MANAGEMENT MEASURES

All work should be undertaken with due regard to the minimisation of environmental effects and to meet all statutory environmental and safety requirements (**Section 7.6**). A CEMP should be

developed for the site works by the site contractor/builder, which takes into account relevant guidance including, but not limited to:

- DA Conditions of Consent;
- Liverpool City Council Development Control Plan 2008; and
- Managing Urban Stormwater, Soils and Construction, Volume 1: 4th edition (March 2004) – often referred to as the 'blue book'.

Overall site management requirements related to the remedial works are presented in **Table 7-3**.

Table 7-3 Site Management Measures

Category	Measure
Asbestos	All works associated with the disturbance and removal of asbestos impacted fill at the site must be undertaken by a Class A licensed Asbestos Removalist in accordance with WorkCover NSW guidelines. Asbestos-contaminated soil comprises non-attached pieces of asbestos cement products and other material containing asbestos uncovered in soil during other work activities. Contamination can be detected during building and road construction and excavation, waste disposal, damage following a severe weather event such as a hail storm, weathering over time, or when asbestos is poorly handled or damaged during removal jobs. Asbestos-contaminated soil is also subject to requirements of other regulatory agencies such as the EPA, Pubic Health and local governments. Where guidance on the assessment and remediation of contaminated sites is sought, the Assessment of Contaminated Sites National Environmental Protection Measure (NEPM) should be referred to. The contaminated sites NEPM are published by the Environmental Protection Heritage Council (EPHC). Removal of asbestos from contaminated soil will require a Class A licensed asbestos removalist for any friable asbestos to be removed, or a Class B licensed asbestos removalist if more than 10 m^2 of non-friable asbestos is to be removed. A person who does not have a licence can remove 10 m^2 or less of non-friable asbestos. Where there is uncertainty as to whether the amount of non-friable asbestos is more or less than 10 m^2, a Class A or Class B licensed asbestos removalist should be engaged. A licensed asbestos removalist must notify the regulator in writing at least five days before the licensed asbestos removal work commences and must also obtain a permit (WorkCover, 2012). The contractor must be provided with a copy of all asbestos related reports for the site which outlines the nature and extent of asbestos in soil contamination. The asbestos removalist must prepare an asbestos removal control plan for the proposed earthworks. A site specific Asbestos Management Plan (AMP) plan must be prepared by a WorkCover licensed asbestos assessor (Hygienist) to document the management measures required to address risk associated with potential exposure to asbestos in accordance with NSW WorkCover requirements and must include: • Work area isolation (barrier protection, buffer zone); • Removal methods (friable/non-friable); • Contamination control methods (decontamination procedures); and • Health and safety procedures (respiratory protection). Asbestos related works at the site involving disturbance of soil must be managed strictly in accordance with this RAP and the AMP. A risk assessment by an independent licensed asbestos assessor or competent person, including contaminated site assessment practitioners, should determine the most appropriate control measures and remediation strategies.

Category	Measure
	Air monitoring for Asbestos fibres by the Occupational Hygienist shall be conducted during the removal of asbestos-contaminated soils and at the completion of the remediation works, as a part of asbestos clearance certification protocols of the AMP. All asbestos fibre air monitoring must be conducted in accordance with the site specific AMP. The licensed asbestos removalist must stop work and notify WorkCover immediately when respirable asbestos fibres are recorded at more than 0.02 fibres/ml in accordance with the NSW workplace Health and Safety Regulation (2011). For all asbestos removal requiring a Class A asbestos removal licence, an air monitoring program must be implemented to ensure the control measures do not release airborne asbestos fibre. When all visible asbestos has been removed, and the air monitoring program indicates that the level of respirable asbestos fibres does not exceed 0.01 f/mL (10 per cent of the asbestos exposure standard), the independent licensed asbestos assessor must complete the clearance certificate. All asbestos and any contaminated soil removed must be disposed of as asbestos waste according to the EPA and the requirements of the local licensed waste disposal facility.
Demolition (including Asbestos Management)	Appropriate measures shall be taken to ensure that demolition works are completed in accordance with WorkCover Standards and Codes of Practice. Any asbestos identified within building materials should be managed in accordance with WorkCover Codes of Practice and Australian Standards, and should be detailed within the EMP. **Note:** a detailed 'emu bob' site walkover will be performed to visually screen the site and assess for visible evidence of fibre cement sheeting (FCS), which could potentially be asbestos-containing material (ACM). All detected fragments of FCS must therefore be collected and bagged for appropriate offsite disposal.
Site Stormwater Management and Control	Appropriate measures shall be taken to ensure that potentially contaminated water does not leave the site. Such measures should include, but not be limited to: • Diversion and isolation of any stormwater from any contaminated areas; • Provision of sediment traps including geotextiles or hay bales; and • Discharge of any water to drains and water bodies must meet the appropriate effluent discharge consent condition under the *Protection of the Environmental Operations Act*.
Soil Management	Appropriate measures shall be taken to ensure soils are excavated using a methodology appropriate to reduce nuisance dust and odours from leaving the boundary, and are disposed of in accordance with the NSW Government *Protection of the Environment Operations (Waste) Regulation* (2014).
Dust and Odour	Control of dust and odour during the course of the remediation works shall be maintained by the contractor to ensure no nuisance dust or odours are received at the site boundary according to requirements of Liverpool City Council DCP (2008). A minimum of four monitoring points on the four site boundaries would be established and monitoring for asbestos fibres, odour and TCE would commence immediately prior to the remedial excavations. Action levels and specific control measures would be described in the site construction phase environmental management plan (CEMP) and may include, but will not be limited to the following: • Site wide water spraying, as and when appropriate, to eliminate wind-blown dust; • Use of mist sprays, and/or sprinklers on stockpiles, fill screening areas and loaded fill to lightly condition the material; • Use of tarpaulin or tack-coat emulsion or sprays to prevent dust blow from stockpiles or from vehicle loads; • Covering of stockpiles or loads with polythene or geotextile membranes; • Restriction of stockpile heights to 2 m above surrounding site level;

Category	Measure
	• Ceasing works during periods of inclement weather such as high winds or heavy rain; • Use of vapour masks or respirators for works near TCE-impacted areas; and • Regular checking of the fugitive dust and odour issues to ensure compliance with the CEMP requirements, undertaking immediate remedial measures to rectify any cases of excessive dust or odour (e.g. use of misting sprays or odour masking agent). EI notes the Council Contaminated Land Policy requires that "No odours shall be detected at any boundary of the site during remediation works by a Council officer who is authorised under the POEO Act and who is relying solely on their sense of smell." Should significant odours be detected, and / or unexpected USTs be identified, which are found to be odorous, additional control measures for odour control may be required under the Liverpool City Council contaminated land policy, being: • Use of appropriate covering techniques such as plastic sheeting to cover excavation faces; • Use of fine mist sprays / hydrocarbon mitigation agent on the impacted areas/materials (Examples of mitigation agents include BioSolve® Pinkwater®, or Anotech, however a similar product may be selected by the contractor); and • Adequate maintenance of equipment and machinery to minimize exhaust emissions. Furthermore, due to the presence of asbestos within fill material, it is advised that all site workers use adequate dust masks during fill excavation, and that machine operators remain within an enclosed, air conditioned cab.
Noise and Vibration	Noise and vibration will be restricted to reasonable levels. All plant and machinery used on site will be noise muffled to ensure that noise emissions do not breach statutory levels as defined within the Liverpool City Council DCP 2008
Hours of Operation	Working hours will be restricted to those specified by Council, which are defined as being 7am to 7pm weekdays and 7am to 5pm Saturdays; no Sunday work permitted. These hours may differ from DA conditions, and DA conditions specified for the site must be adhered to.
Community Engagement	Community engagement should be carried out in accordance with Schedule B (8) of NEPM (2013). Prior to the commencement of any remediation works at the site, every owner and occupier of any land located either wholly or partly within 100 m of the boundary of the premises (including local council and the RMS) should be notified at least 30 days in advance. The notice should include: • Advice of demolition & excavation work to be carried out on the premises; • State the time and date such work is to commence; • Indicate that the works are being conducted to minimise any risk of site contamination impacting on off-site receptors; • Provide appropriate site signage at an easily readable location on the site fencing, including site contact name and phone number to be contacted should any matter arise; provide the phone number of a person present on the premises whilst remediation works are being undertaken; and • Provide contact information and procedure for registering any complaints.
Incident Management and Community Relations	While various environmental management and occupational safety plans will be developed to protect human health and the environment, incidents may occur which pose a risk to the various stakeholders. To mitigate these risks and ensure that a suitable response is carried out quickly, a response plan to any incident that may occur on site should be prepared and various responsibilities assigned. The site health and safety plan and environmental management plan should document these procedures and responsibilities, and incident contact numbers should be maintained in an on-site register. All other relevant emergency contact numbers such as Police, Fire Brigade, and Hospital should be listed in the Health and Safety Plan and posted on-site for easy access.

7.4 CONTINGENCY MANAGEMENT

Contingency plans for anticipated problems that may arise on-site during the course of the site preparation works comprising demolition and remediation are presented below in **Table 7-4**

Table 7-4 Contingency Management

Anticipated Problems	Corrective Actions
Chemical/ fuel spill	Stop work, notify above site project manager. Use accessible soil or appropriate absorbent material on site to absorb the spill (if practicable). Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/treatment option.
Excessive Dust	Use water sprays to suppress the dust or stop site activities generating the dust until it abates.
Excessive Noise	Identify the source, isolate the source if possible, modify the actions of the source or erect temporary noise barriers if required.
Excessive Odours/Vapours	Stage works to minimise odours/vapours. If excessive organic odours/vapours are being generated, stop works and monitor ambient air across site for organic vapours with a PID and odours at site boundaries. Implement control measures including respirators for on-site workers, use of odour suppressants, wetting down of excavated material. EI notes that no nuisance odours shall be detected at any site boundary as part of the remedial works. Should odour emissions be detected at or beyond the site boundary, it is recommended, as part of the CEMP and community consultation procedure, that the Remediation Contractor and the Principal Project Manager: • Notify the owners and occupiers of premises adjoining and across the road from the site regarding potential odour issues. Notification should be in writing. This is also required by the Council Contaminated Land Policy; • In the notification, as well as on street signage, provide contact details of the site personnel for anyone who may be concerned by odour emission during the remediation; • Temporarily pause site works to allow for excess odour to subside to a level acceptable by off-site receptors, should it be necessary, after implementation of the above-listed control measures; and • Record logs for volatile emissions and odours. Such records should be kept on-site and made available for inspection on request.
Excessive Odours/Vapours (continued)	In regard to off-site impact from petroleum vapour, EI notes that odour is generally detected at concentrations much lower than what will constitute a health-based risk. Measures listed above for odour control (**Table 7-3**) may also be applied for vapour control.
Excessive rainfall	Ensure sediment and surface water controls are operating correctly. If possible divert surface water away from active work areas or excavations.
Water in excavations	Collect samples and assess against relevant NSW EPA *Waste Classification Guidelines (2014)* assessment criteria, to enable disposal options to be formulated.
Leaking machinery or equipment	Stop the identified leak (if possible). Clean up the spill with absorbent material. Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/treatment option.
Failure of erosion or sedimentation control measures	Stop work, repair failed control measure.

Anticipated Problems	Corrective Actions
Unearthing unexpected materials, fill or waste	Stop activities, contact the site project manager. Follow the unexpected finds protocol as detailed in **Section 7.6** of this RAP. Prepare a management plan if required, to address the issue.
Identification of cultural or building heritage items	Stop work and notify site project manager. Follow the unexpected finds protocol as detailed in **Section 7.6** of this RAP. Prepare action or conservation plan as required.
Equipment failures	Ensure that spare equipment is on hand at site, or that the failed equipment can be serviced by site personnel or a local contractor.
Complaint Management	Notify Client, Project Managers and Environmental Consultant (if required) following complaint. Report complaint as per management procedures. Implement control measures to address reason of complaint (if possible). Notify complainant of results of remedial actions.

7.5 WORK HEALTH AND SAFETY PLAN

As required by the NSW Work Health and Safety Act 2011 and associated Regulations, a Work Health and Safety (WHS) Plan should be prepared by the Principal Contractor (see **Responsibilities and Contacts, Section 7.1**), to manage the health and safety of site workers and nearby residents, and address such issues as site security, exclusion zones, excavation safety, vibration, noise, odour and dust levels. The plan should address the risks during the remediation works and cover site specific requirements associated with the contaminants present within the site soils and groundwater.

The site officer responsible for implementing health and safety procedures should induct all site personnel so that they are aware of and comply with, the requirements of this document. It is the contractor's responsibility, with assistance from client/owner(s) of the site to ensure that all other permits, approvals, consents or licences are current. The following hazards and mitigation measures relevant to the remedial works are presented in **Section 3**, with a brief summary in **Table 7-5.**

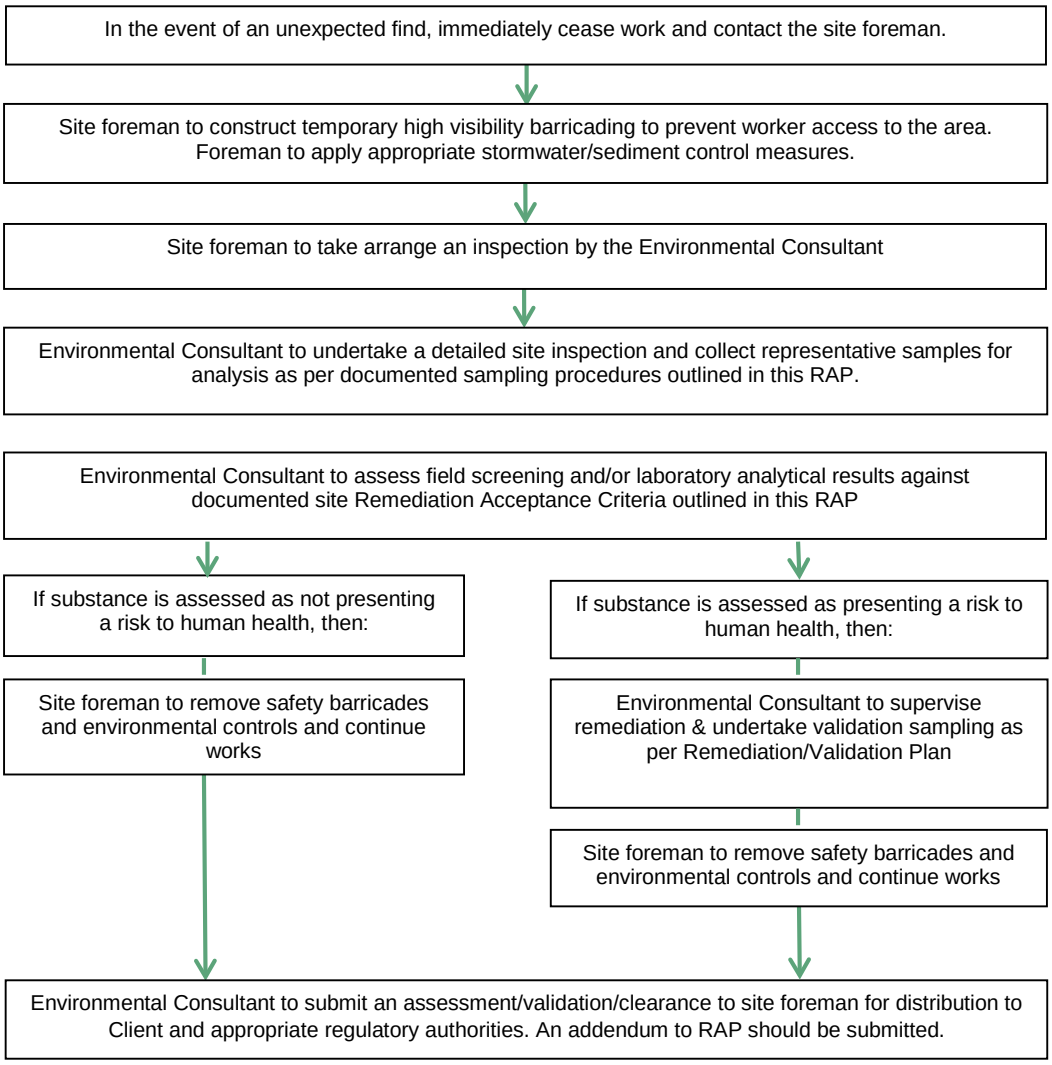
Table 7-5 Remedial Hazards

Anticipated Problems	Corrective Actions
Chemical Hazards	Contaminated sites have chemical compounds substances or materials that may present a risk to human health and the environment. Chemicals of concern and associated risks are as detailed within the Conceptual Site Model, within **Section 3.** The site specific WHS plan should set out controls to mitigate any potential risks.
Physical Hazards	The following hazards are associated with conditions that may be created during site works: • Heat exposure; • Buried services; • Noise, vibration and dust; • Electrical equipment; and • The operation of heavy plant equipment.
Personal Protective Equipment and Monitoring	Personnel should, wherever possible, avoid direct contact with potentially contaminated material. Workers are to ensure that surface waters or groundwater is not ingested or swallowed and that direct skin contact with soil and water is avoided. Standard PPE with the addition of disposable P2 dust masks as specified for the contractor will be sufficient for the prescribed remedial works.

7.6 UNEXPECTED FINDS PROTOCOL

Should unexpected finds be encountered, the approach in **Table 7-6** should be followed.

Table 7-6 Unexpected Finds Protocol



8 VALIDATION SAMPLING AND ANALYSIS QUALITY PLAN

The remediation of the impacted soil areas will be deemed acceptable based on the achievement of the following two validation objectives:

1. ***Remedial Excavations*** – Validation of the remedial excavations will continue to the extent of the impacts as defined by delineation testing, and resulting contaminant concentrations are within the *Remediation (Validation) Criteria* (**Section 4.2**). The sampling frequency will be in accordance with the NEPC (2013) and EPA (1995) sampling design guidelines and all tests shall be performed by NATA-accredited environmental analytical laboratories.

2. ***Backfill Materials*** – Should backfilling be required, validation of imported fill materials used for the backfilling of remediated areas would be required to verify their suitability for the proposed land use.

8.1 VALIDATION SOIL SAMPLING METHODOLOGY

Validation sampling would be undertaken following the removal of identified contaminated material to ensure that the vertical and lateral extent of the contamination has been defined. Should residual contamination be identified, it would be "chased out" where appropriate until material exceeding the validation criteria has been removed. Soil sampling and handling of the collected samples will be as described in **Table 8-2**.

Table 8-1 Validation Sampling Design

Remediation Area	Sampling Density	Potential Contaminants
Remediated excavations	Linear – 1 sampling location per 10 m length of excavation wall. Vertical –1 sampling location per 0.5m depth of excavation. Base – 1 sample per 50 m^2.	Asbestos (bulk analysis methodology as described in NEPM (2013))
Final basement natural ground surface.	17.5 m grid (surface)	TRH, BTEX, PAHs, , heavy metals, OC/OP pesticides, PCBs, Asbestos (visual inspection to certify the presence of natural soils and the removal of fill materials
Stockpiled Material	As per requirements specified in **Section 6.2.5**	TRH, BTEX, PAHs, heavy metals, OC/OP pesticides, PCBs, asbestos
Imported Fill Material	If material is required to be sourced from off-site to reinstate the sites, it should be certified suitable for the intended use. If the material is not Virgin Natural Excavated Material (VENM) or if no suitable certification can be supplied by the source then the material should be sampled at a rate of one per 100 m^3.	TRH, BTEX, PAHs, heavy metals, OC/OP pesticides, PCBs, asbestos

Excavation of contaminated material shall continue until the analytical results indicate compliance with the criteria (i.e. either the concentrations of all contaminants are within the criteria, or the 95% UCL average contaminant concentration for each detected parameter is within the criteria). If results indicate that additional excavation is necessary, the excavation shall be extended until the excavation surface samples indicate that the location is validated as meeting the criteria for each respective contaminant.

Table 8-2 Validation Sample Collection and Handling Procedures

Action	Description
Sample Collection Handling, Transport and Tracking	Soil validation sampling will be directly from the exposed surface of excavation, or from the material brought to the surface by the backhoe/excavator bucket. Sampling data shall be recorded to comply with routine chain of custody requirements. The general sampling, handling, transport and tracking procedures shall comprise: • The use of stainless steel sampling equipment or direct sampling using gloved hand; • Washing of all sampling equipment, including hand tools or excavator parts in contact with the sample, in a 3 % solution of phosphate free detergent (Decon 90) then rinsing with potable water prior to each sample being collected; transfer of the sample into new glass jars or plastic bags, with each plastic bag individually sealed to eliminate cross contamination during transportation to the laboratory; • Labelling of the sample containers with individual and unique identification including Project No., Sample No., Sampling depth, date and time of sampling; • Placement of the containers into a chilled, enclosed and secure container for transport to the laboratory; and • Use of chain of custody documentation to ensure that sample tracking and custody can be cross-checked at any point in the transfer of samples from the field to ultimate hand-over to the environmental laboratory.
Sample Containers & Holding Times	• Metals - 250g glass jar / refrigeration 4^{o}C / 6 months (maximum holding period); TRH/BTEX, PAH, OCP/OPP, PCB - 250g glass jar / refrigeration 4^{o}C / 14 days (maximum holding period); and • Asbestos – up to a 10 Litre resealable plastic (polyethylene) bag / no refrigeration / indefinite holding time.
Field QA/QC	Quality assurance (QA) and quality control (QC) procedures will be adopted throughout the field sampling programme to ensure sampling precision and accuracy, which will be assessed through the analysis of 10% field duplicate/replicate samples. Appropriate sampling procedures will be undertaken to prevent cross contamination, in accordance with EI's Standard Operating Procedures Manual. This will ensure: • Standard operating procedures are followed; • Site safety plans are developed prior to works commencement; • Split duplicate field samples are collected and analysed; • Samples are stored under secure, temperature controlled conditions; • Chain of custody documentation is employed for the handling, transport and delivery of samples to the contracted environmental laboratory; and • Contaminated soil, fill or groundwater originating from the site area is disposed in accordance with relevant regulatory guidelines. In total, field QA/QC will include one in 10 samples to be tested as blind field duplicates, one in 20 samples to be tested as inter-laboratory duplicates (ILD), as well as one VOC trip blank (intra-lab) sample and one equipment wash blank sample per sample batch. No QAQC samples will be collected for asbestos sampling.
Laboratory Quality Assurance and Quality Control	The contract laboratory will conduct in-house QA/QC procedures involving the routine analysis of: • Reagent blanks; • Spike recoveries; • Laboratory duplicates; • Calibration standards and blanks; • QC statistical data; and • Control standards and recovery plots.

Action	Description
Achievement of Data Quality Objectives	Based on the analysis of quality control samples (i.e. duplicates/replicates and in-house laboratory QA/QC procedures), the following data quality objectives are required to be achieved: • conformance with specified holding times; • accuracy of spiked samples will be in the range of 70-130%; and • field and laboratory duplicates and replicates samples will have a precision average of +/- 30% relative percent difference (RPD). An assessment of the overall data quality should be presented in the final validation report, in accordance with the DEC (2006) *Guidelines for the NSW Site Auditor Scheme*.

8.2 VALIDATION REPORTING

All fieldwork, chemical analysis, discussions, conclusions and recommendations will be documented in a validation report for the site. The validation report will be prepared in general accordance with requirements of the NSW EPA (2011) *Guidelines for Consultants Reporting on Contaminated Sites* and NSW DEC (2006) *Guidelines for the NSW Site Auditor Scheme* and will confirm the site has been remediated to a suitable standard for the proposed development.

The Validation Report will be submitted for Council review at the completion of the remediation works programme.

9 CONCLUSIONS

Based on the information available from previous investigations at the site, this RAP has been prepared to inform the remediation works at 26 Shepherd Street, Liverpool NSW.

It is envisaged that the remediation works will be implemented in stages, as follows:

- **Stage 1** – Site preparation;
- **Stage 2** – Prior to site demolition, carry out a Hazardous Materials Survey;
- **Stage 3** - Post site demolition and removal of the hardstand pavement;
  - A site walkover to assess any visual signs of supplementary asbestos contamination and buried building waste;
- **Stage 4** – Additional investigations to close data gaps;
  - The quality of soils to be retained at the site for deep soil landscaping and characterise soils within the footprint of the warehouse building;
  - Groundwater assessment including, installation of an additional groundwater monitoring well in the footprint of the warehouse building, and one round of groundwater sampling from the existing groundwater monitoring well field; and
- **Stage 5** – Remedial excavation of fill soils, waste classification, and offsite disposal;
  - Classification of the fill material within the basement excavation and deep soil landscape area for offsite disposal in accordance with the EPA (2014) *Waste Classification Guidelines*.

In summary, EI considers that the site can be made suitable for residential use with minimal access to soils, through the implementation of the works described in this RAP.

10 STATEMENT OF LIMITATIONS

This report has been prepared for the exclusive use of Coronation Pty Ltd, who is the only intended beneficiary of our work. The scope of the investigations carried out for the purpose of this report is limited to those agreed with Coronation Pty Ltd.

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

EI has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the environmental industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The conclusions presented in this report are based on a limited investigation of conditions, with specific sampling locations chosen to be as representative as possible under the given circumstances.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during remedial activities. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

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ABBREVIATIONS

ACM	Asbestos Containing Material
AF	Asbestos Fines
AHD	Australian Height Datum
AMP	Asbestos Management Plan
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASS	Acid Sulfate Soils
ASSMAC	Acid Sulfate Soils Management Advisory Committee
B(α)P	Benzo(α)pyrene
BGL	Below Ground Level
BH	Borehole
BTEX	Benzene, Toluene, Ethyl benzene, Xylene
CBD	Central Business District
CEMP	Construction Environmental Management Plan
CLM	Contaminated Land Management
CSM	Conceptual Site Model
CT	Contaminant Threshold
DA	Development Application
DCP	Development Control Plan
DEC	Department of Environment and Conservation, NSW
DECC	Department of Environment and Climate Change, NSW
DECCW	Department of Environment, Climate Change and Water, NSW
DP	Deposited Plan
DQI	Data Quality Indicators
DQO	Data Quality Objectives
DSI	Detailed Site Investigation
DPI	Department of Primary Industries
EI	EI Australia
EIL	Ecological Investigation Levels
ENM	Excavated Natural Material
EMP	Environmental Management Plan
EPA	Environment Protection Authority
ESL	Environmental Screening Levels
FA	Fibrous Asbestos
FCS	Fibre Cement Sheeting
GIL	Groundwater Investigation Level
GME	Groundwater monitoring event
HIL	Health-based Investigation Level
HSL	Health-based Screening Level
m	Metres
mAHD	Metres relative to Australian Height Datum
mBGL	Metres below ground level
NATA	National Association of Testing Authorities
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measure
NSW	New South Wales
OCP	Organochlorine Pesticides
OEH	Office of Environment and Heritage, NSW (formerly DEC, DECC, DECCW)
OPP	Organophosphorous Pesticides
PAHs	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PID	Photo-ionisation Detector

POEO	Protection of Environmental Operations
PPE	Personal Protective Equipment
ppm	Parts Per Million
PSI	Preliminary Site Investigation
QA	Quality Assurance
QC	Quality Control
RAP	Remedial Action Plan
RMS	Roads and Maritime Service
SCC	Specific Contamination Concentration
SEPP	State Environment Protection Policy
SIL	Soil Investigation Level
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
UCL	Upper Confidence Limit
UPSS	Underground Petroleum Storage System
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VENM	Virgin Excavated Natural Material
VOC	Volatile Organic Compounds
WADOH	Western Australia Department of Health
WHS	Work Health and Safety

FIGURES

eiaustralia Contamination | Remediation | Geotechnical Suite 6.01, 55 Miller Street, PYRMONT 2009 Ph (02) 9516 0722 Fax (02) 9518 5088	Drawn:	D.R.	**Coronation Pty Ltd** Remediation Action Plan 26 Shepherd Street, Liverpool NSW Site Locality Plan
	Approved:	G.B.	
	Date:	29-09-16	
	Scale:	Not To Scale	

Figure: 1

Project: E23125 AC_Rev0

Map Source: SDG Land Development Solution, Ref No. 6683, Dated 12-02-2016

LEGEND

- Approximate Site Boundary
- Approximate Deep Soil Landscaping (Outside Basement Excavation
- Approximate Borehole Location
- Approximate Borehole/Monitoring Well Location

eiaustralia
Contamination | Remediation | Geotechnical
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

Drawn:	D.R.
Approved:	N.F.
Date:	22-11-16

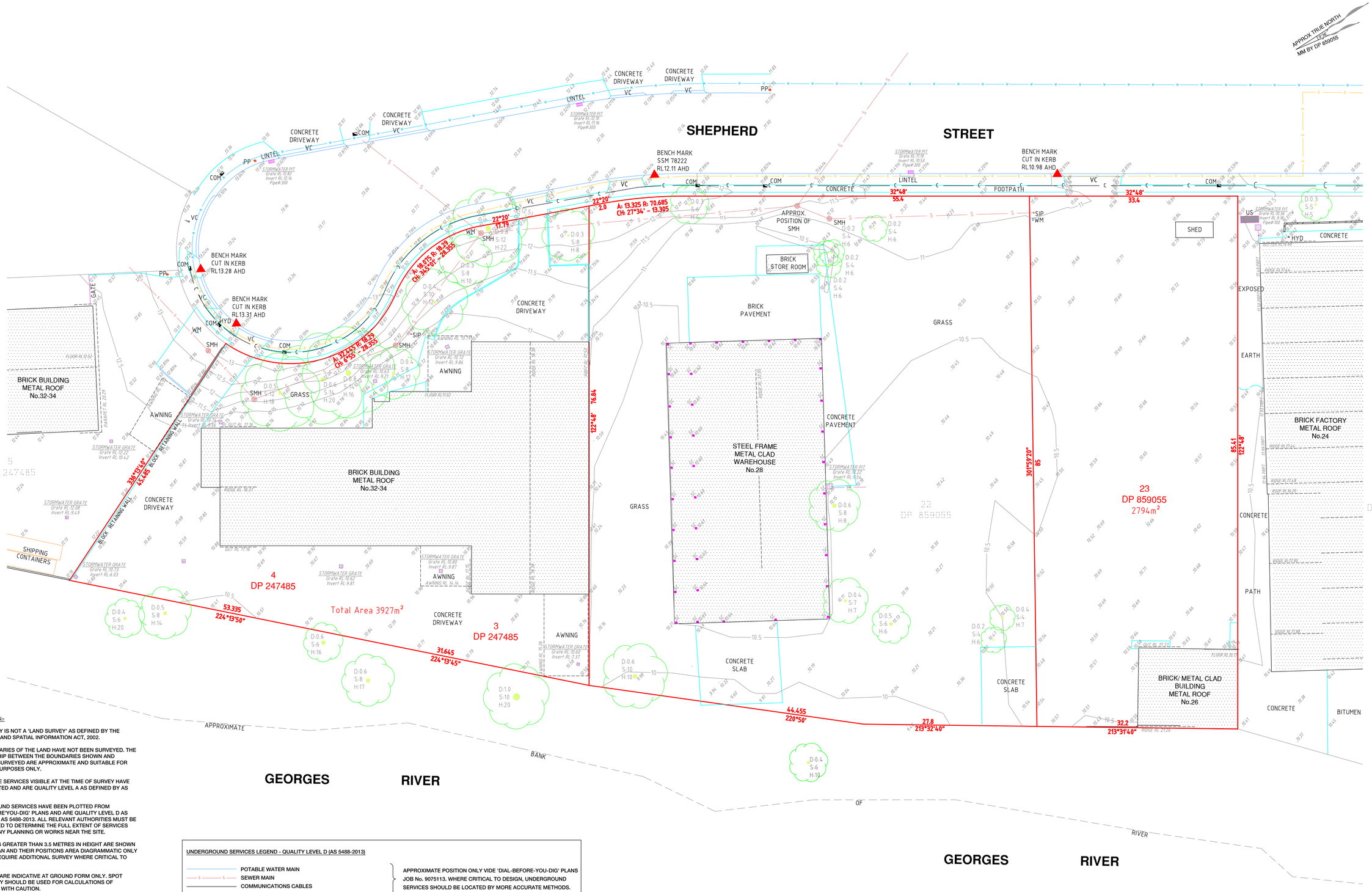
Coronation Pty Ltd
Remediation Action Plan
26 Shepherd Street, Liverpool NSW

Former Borehole Location Plan

Figure: 2

Project: E23125 AC_Rev0

APPENDIX A
PROPOSED DEVELOPMENT PLANS



GENERAL NOTES:-

1. THIS SURVEY IS NOT A 'LAND SURVEY' AS DEFINED BY THE SURVEYING AND SPATIAL INFORMATION ACT, 2002.
2. THE BOUNDARIES OF THE LAND HAVE NOT BEEN SURVEYED. THE RELATIONSHIP BETWEEN THE BOUNDARIES SHOWN AND FEATURES SURVEYED ARE APPROXIMATE AND SUITABLE FOR PLOTTING PURPOSES ONLY.
3. ONLY THOSE SERVICES VISIBLE AT THE TIME OF SURVEY HAVE BEEN LOCATED AND ARE QUALITY LEVEL A AS DEFINED BY AS 5488-2013.
4. UNDERGROUND SERVICES HAVE BEEN PLOTTED FROM 'DIAL-BEFORE'YOU-DIG' PLANS AND ARE QUALITY LEVEL D AS DEFINED BY AS 5488-2013. ALL RELEVANT AUTHORITIES MUST BE CONTRACTED TO DETERMINE THE FULL EXTENT OF SERVICES PRIOR TO ANY PLANNING OR WORKS NEAR THE SITE.
5. ONLY TREES GREATER THAN 3.5 METRES IN HEIGHT ARE SHOWN ON THIS PLAN AND THEIR POSITIONS AREA DIAGRAMMATIC ONLY AND MAY REQUIRE ADDITIONAL SURVEY WHERE CRITICAL TO DESIGN.
6. CONTOURS ARE INDICATIVE AT GROUND FORM ONLY. SPOT LEVELS ONLY SHOULD BE USED FOR CALCULATIONS OF QUANTITIES WITH CAUTION.
7. CONTOUR INTERVAL 0.5 m.
8. ALL SETOUT LEVELS MUST BE REFERRED TO THE BENCH MARK.
9. THE ORIENTATION OF THIS PLAN IS APPROXIMATE TRUE NORTH BASED ON THE ASSUMPTION THAT THE VARIATION OF TRUE NORTH TO MAGNETIC NORTH IS 9°36'. THIS HAS NOT BEEN VERIFIED AS PART OF THIS PLAN AND SHOULD YOU REQUIRE MORE ACCURATE DETERMINATION OF TRUE NORTH A FURTHER SURVEY IS REQUIRED.
10. THE LAND IS AFFECTED BY:
    - EASEMENT FOR DRAINAGE 1 WIDE (DP 123456) SHOWN 'A'
    - COVENANT (123456)
    - RESTRICTION ON THE USED OF LAND (A123456)

UNDERGROUND SERVICES LEGEND - QUALITY LEVEL D (AS 5488-2013)

- POTABLE WATER MAIN
- SEWER MAIN
- COMMUNICATIONS CABLES
- GAS MAIN

APPROXIMATE POSITION ONLY VIDE 'DIAL-BEFORE-YOU-DIG' PLANS JOB No. 9075113. WHERE CRITICAL TO DESIGN, UNDERGROUND SERVICES SHOULD BE LOCATED BY MORE ACCURATE METHODS.

CAUTION: FIBRE OPTIC CABLES ARE PRESENT IN THIS AREA

SERVICES NOTES:-

1. ONLY THOSE SERVICES VISIBLE AT THE TIME OF SURVEY HAVE BEEN LOCATED AND IF SHOWN AS '+ 89.67' ARE QUALITY LEVEL A AS DEFINED BY AS 5488-2013. LEVELS SHOWN ARE SURFACE LEVELS UNLESS NOTED OTHERWISE.
2. UNDERGROUND SERVICES HAVE BEEN PLOTTED FROM 'DIAL-BEFORE'YOU-DIG' PLANS AND ARE QUALITY LEVEL D AS DEFINED BY AS 5488-2013. ALL RELEVANT AUTHORITIES MUST BE CONTRACTED TO DETERMINE THE FULL EXTENT OF SERVICES PRIOR TO ANY PLANNING OR WORKS NEAR THE SITE.

LEGEND:-

VC denotes VEHICLE CROSSING
TK denotes TOP OF KERB
COM denotes COMMUNICATIONS PIT
GAS denotes GAS MARKER/LID
PP denotes POWER POLE
HYD denotes HYDRANT
WM denotes POTABLE WATER METER
SMH denotes SEWER MANHOLE
SIP denotes SEWER INSPECTION PIT
D:S:H denote DIAMETER, SPREAD and HEIGHT of TREE

2 4 6 8 10 20 30
1:300

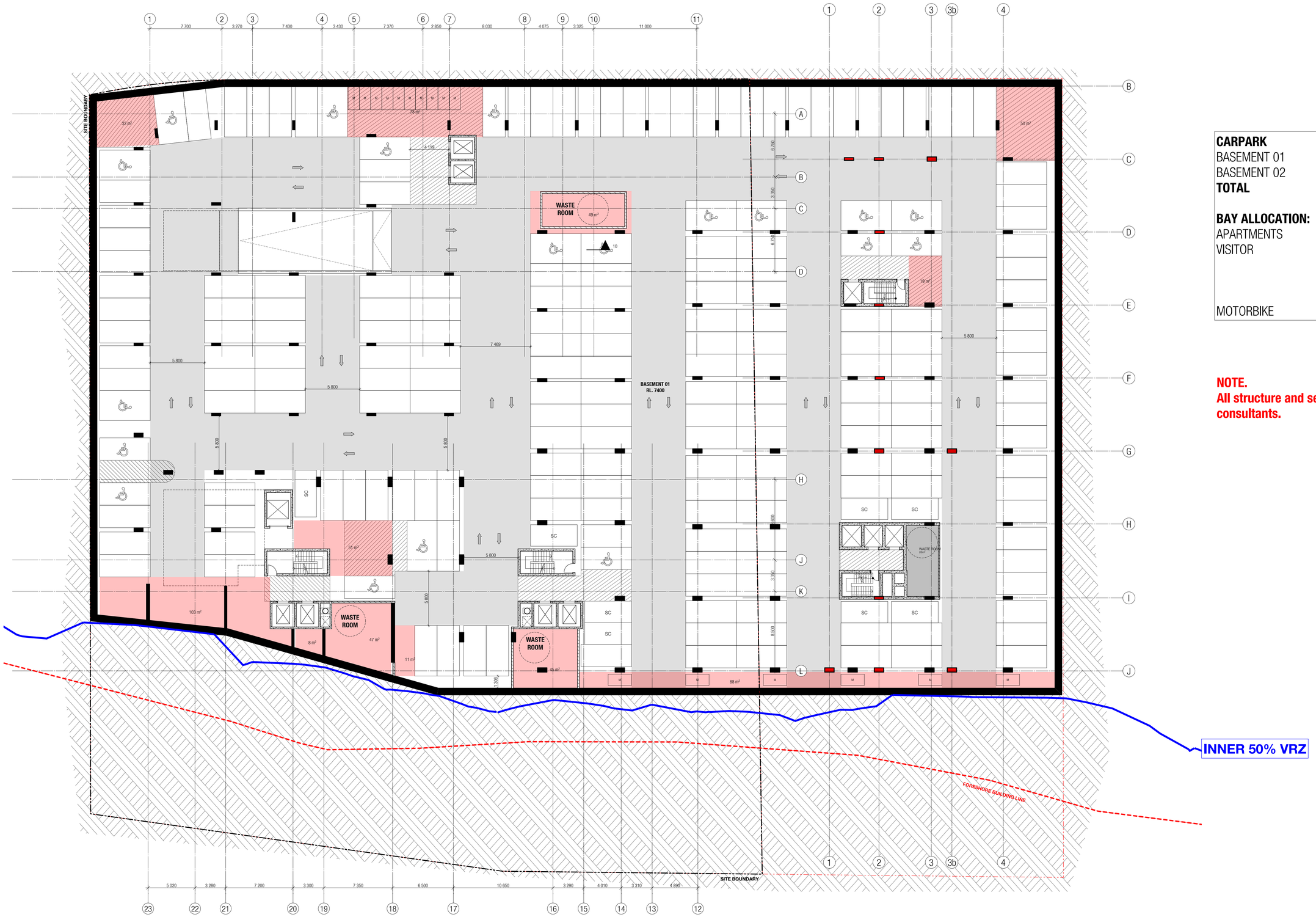
ISSUE	DATE	AMENDMENT
A	12/02/16	ORIGINAL ISSUE

CLIENT: CORONATION PTY LTD

SCALE 1:300
ORIGIN OF LEVELS: PM 61502 RL 10.196
DATUM: A.H.D.
REF.: 6683
DATE: 12/02/16
SURV/CHK: JR/ GE
SHEET 1 OF 1 SHEETS
PLAN A1
ISSUE A

DETAIL AND LEVEL SURVEY OF
LOT 3 & 4 IN DP 247485 & LOT 23 IN DP 859055
32-34 & 26 SHEPHERD STREET
LIVERPOOL NSW

SDG LAND DEVELOPMENT SOLUTIONS
A.B.N. 85 213 623 621
Suite 1 3 Railway Street
BAULKHAM HILLS 2153
P.O.Box 2572
NORTH PARRAMATTA 1750
t: (02) 9630 7955
e: office@sdg.net.au
w: www.sdg.net.au



CARPARK	
BASEMENT 01	207- 19 DDA
BASEMENT 02	215 - 22 DDA
TOTAL	**422 - 39 DDA**
BAY ALLOCATION:	
APARTMENTS	372 (38 DDA)
VISITOR	38 (2 DDA)
MOTORBIKE	22

NOTE.
All structure and services to be reviewed by consultants.

DRAFT

Notes
CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK OR PREPARING SHOP DRAWINGS. DO NOT SCALE DRAWING.

Rev	Description	Date	App'd

Rev	Description	Date	App'd

Rev	Description	Date	App'd

Project
26/28 SHEPHERD ST

28 SHEPHERD ST
LIVERPOOL NSW

Client
CORONATION PROPERTY CO

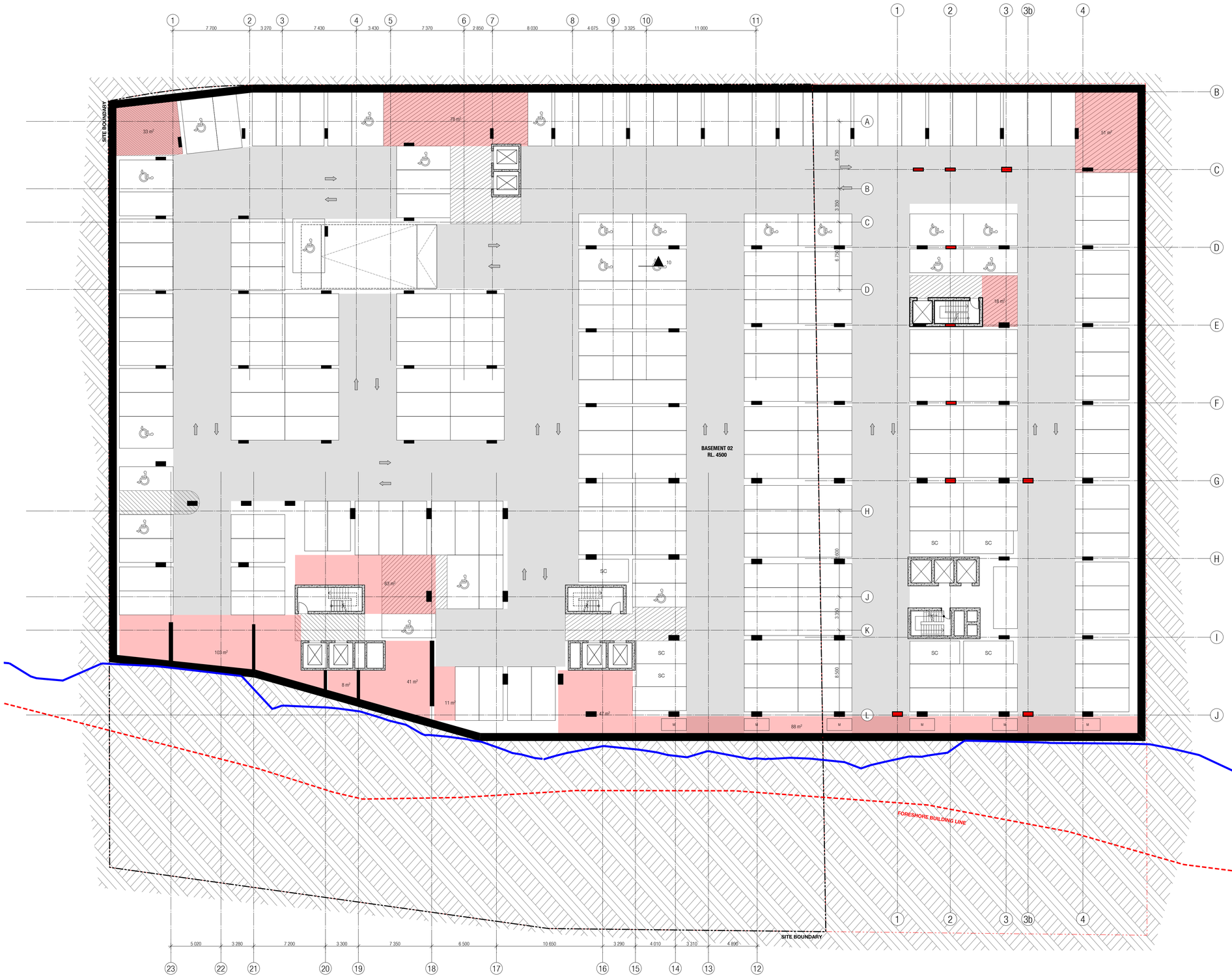
Coronation Property Co Pty Ltd
9-25 Commonwealth Street

Drawing title
BASEMENT LEVEL 01

Date generated 12-12-16
Checked
Approved
Scale 1:200 @ A1 sheet size
50mm on original

WOODS BAGOT
AUSTRALIA
ASIA
MIDDLE EAST
EUROPE
NORTH AMERICA

Project number 120597/120809
Drawing number A022B1
Revision
Status
FOR INFORMATION



CARPARK	
BASEMENT 01	207- 19 DDA
BASEMENT 02	215 - 22 DDA
TOTAL	**422 - 39 DDA**
BAY ALLOCATION:	
APARTMENTS	372 (38 DDA)
VISITOR	38 (2 DDA)
MOTORBIKE	22

NOTE.
All structure and services to be reviewed by consultants.

DRAFT

Notes
CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK OR PREPARING SHOP DRAWINGS. DO NOT SCALE DRAWING.

Rev	Description	Date	App'd

Rev	Description	Date	App'd

Rev	Description	Date	App'd

Project
26/28 SHEPHERD ST

28 SHEPHERD ST
LIVERPOOL NSW

Client
CORONATION PROPERTY CO

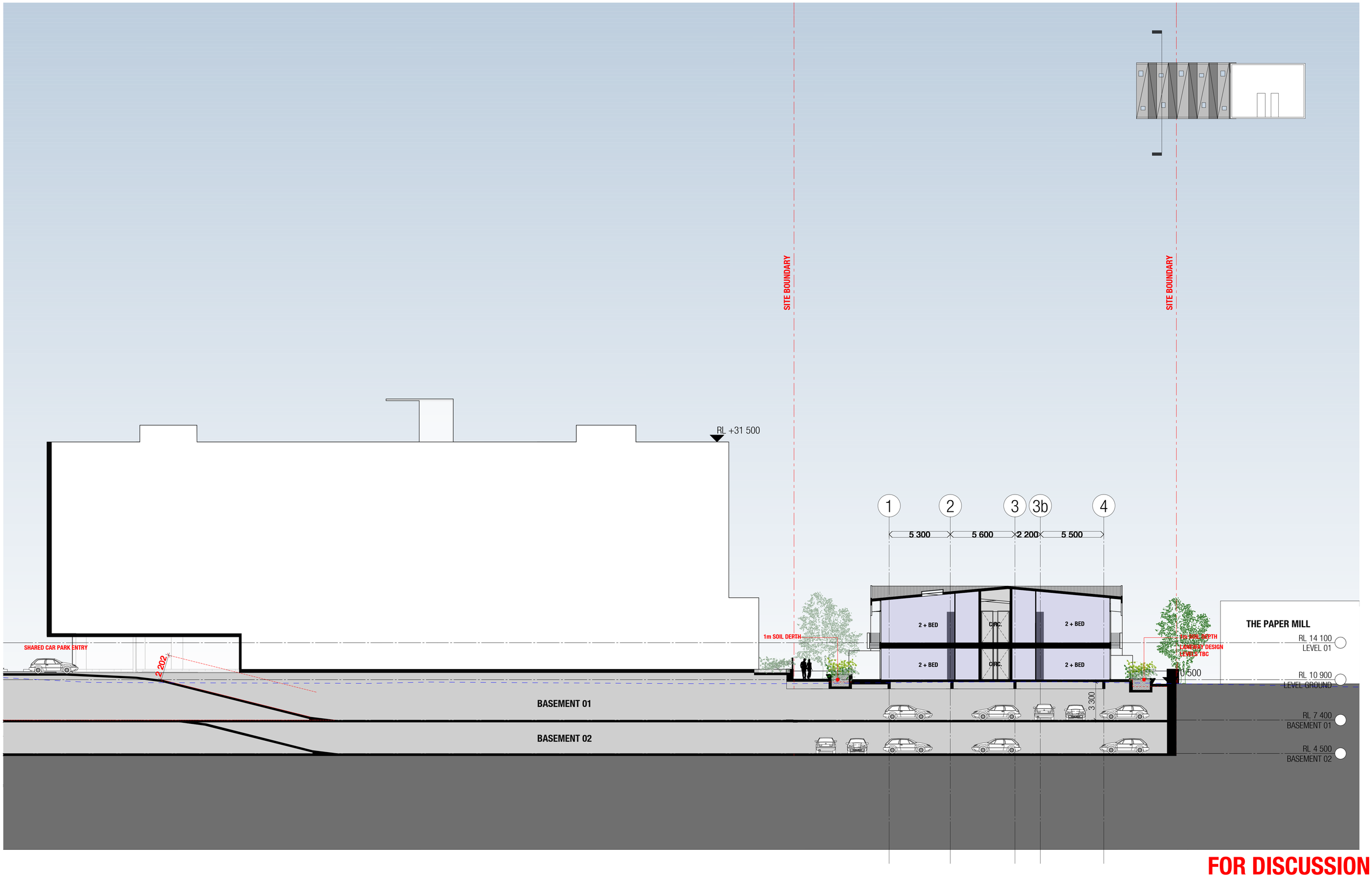
Coronation Property Co Pty Ltd
9-25 Commonwealth Street

Drawing title
BASEMENT LEVEL 02

Date generated 12-12-16
Checked
Approved
Scale 1:200 @ A1 sheet size
50mm on original

WOODS BAGOT
AUSTRALIA
ASIA
MIDDLE EAST
EUROPE
NORTH AMERICA

Project number 120597/120809
Drawing number A022B2
Revision
Status
FOR INFORMATION



FOR DISCUSSION

Notes
CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK OR PREPARING SHOP DRAWINGS. DO NOT SCALE DRAWING.

Rev	Description	Date	App'd

Rev	Description	Date	App'd

Rev	Description	Date	App'd

Project
26/28 SHEPHERD ST

28 SHEPHERD ST
LIVERPOOL NSW

Client
CORONATION PROPERTY CO

Coronation Property Co Pty Ltd
9-25 Commonwealth Street

Drawing title
COMBINED DA/STAGE 2 DA
SECTION BB

Date generated
14-12-16

Checked

Approved

Scale
NTS
@ A1 sheet size

50mm on original

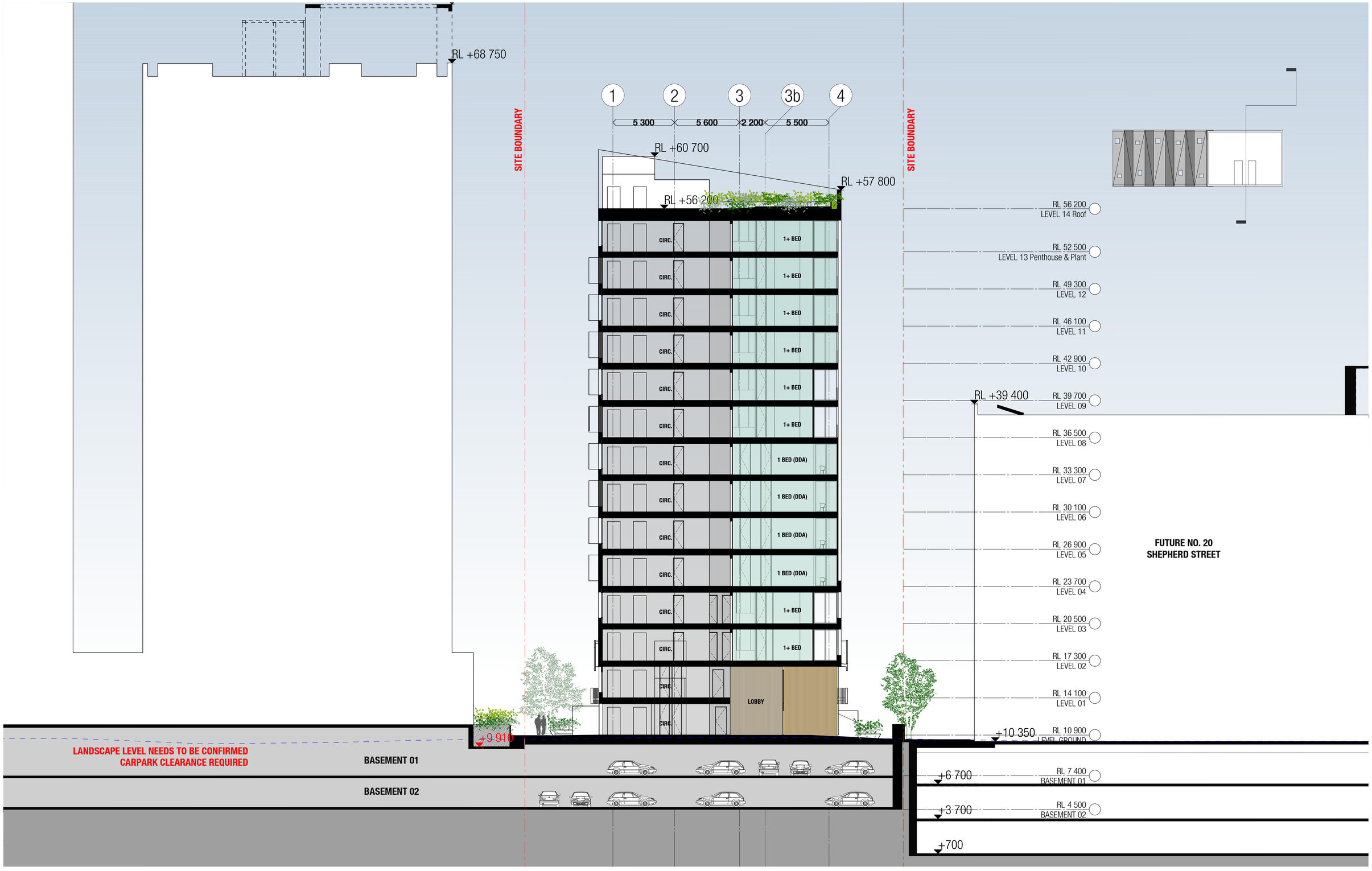
WOODS BAGOT
AUSTRALIA
ASIA
MIDDLE EAST
EUROPE
NORTH AMERICA

Project number
120597/120809

Drawing number
A23202

Revision
P13

Status
DEVELOPEMENT APPLICATION



FOR DISCUSSION

Notes
CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK OR PREPARING SHOP DRAWINGS. DO NOT SCALE DRAWING.

Rev	Description	Date	App'd

Rev	Description	Date	App'd

Rev	Description	Date	App'd

Project
26/28 SHEPHERD ST

28 SHEPHERD ST
LIVERPOOL NSW

Client
CORONATION PROPERTY CO

Coronation Property Co Pty Ltd
9-25 Commonwealth Street

Drawing title
COMBINED DA/STAGE 2 DA
SECTION CC

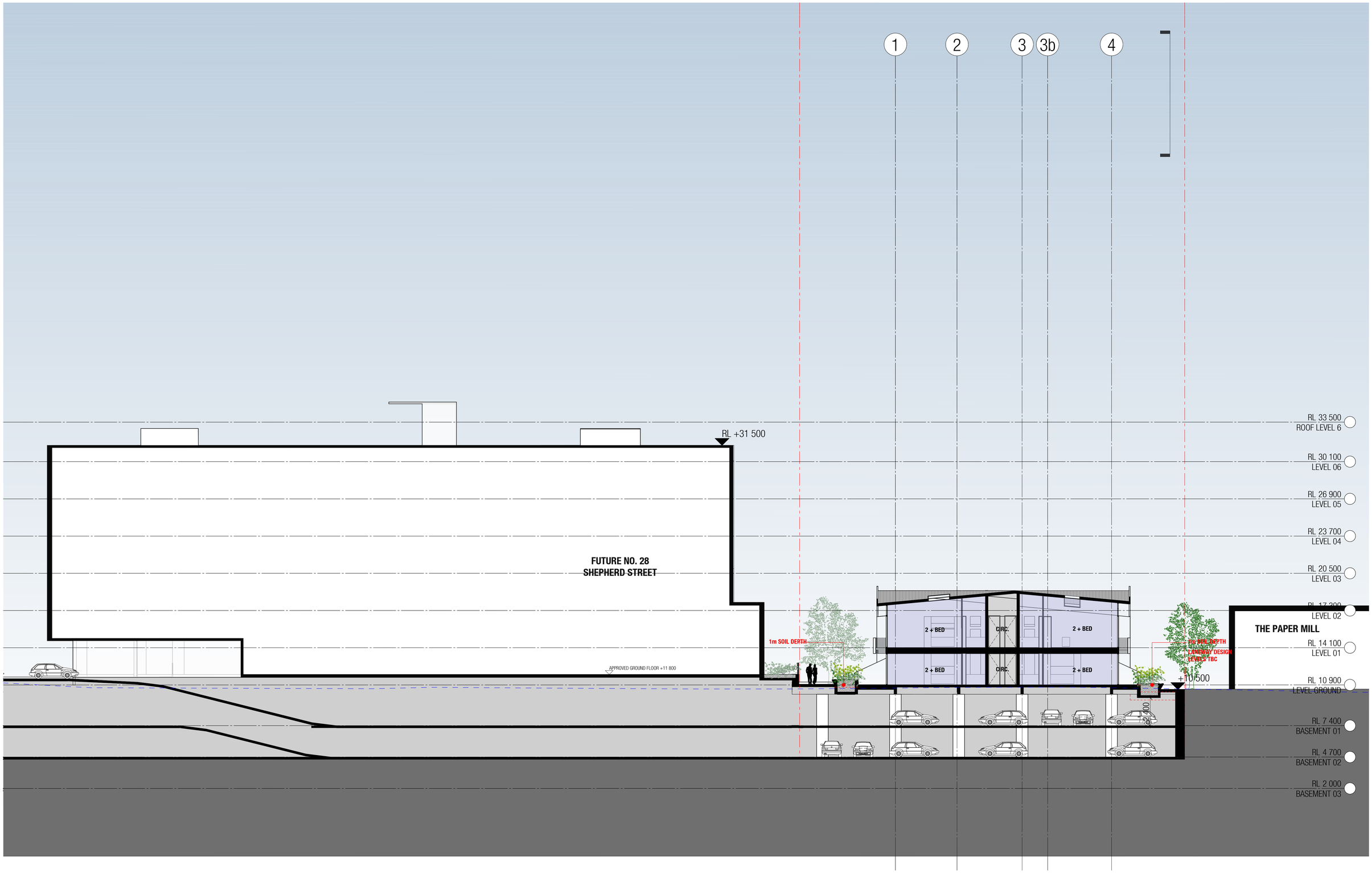
Date generated 14-12-16
Checked
Approved

Scale
NTS
@ A1 sheet size
50mm on original

WOODS BAGOT
AUSTRALIA
ASIA
MIDDLE EAST
EUROPE
NORTH AMERICA

Project number 120597/120809
Drawing number **A23203**
Revision P13

Status
DEVELOPEMENT APPLICATION



Notes
CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK OR PREPARING SHOP DRAWINGS. DO NOT SCALE DRAWING.

DRAFT

Rev	Description	Date	App'd

Rev	Description	Date	App'd

Rev	Description	Date	App'd

Project
26 SHEPHERD ST

28 SHEPHERD ST
LIVERPOOL NSW

Client
CORONATION PROPERTY CO

Coronation Property Co Pty Ltd
9-25 Commonwealth Street

Drawing title
DA
SECTION BB

Date generated 22-07-16
Checked
Approved
Scale NTS
@ A1 sheet size 50mm on original

WOODS BAGOT
AUSTRALIA
ASIA
MIDDLE EAST
EUROPE
NORTH AMERICA

Project number 120809
Drawing number **DA019**
Revision P8
Status
FOR INFORMATION

APPENDIX B
SUMMARY LABORATORY RESULTS (EI 2016)

Table T1 - Summary of Soil Analytical results

Sample ID	Sampling Depth (@ m BGL)	Sampling Date	Heavy Metals								PAHs				BTEX				TRHs				OCPs		Total OPPs	Total PCBs	Asbestos
			As	Cd	$Cr^{\#}$	Cu	Pb	Hg	Ni	Zn	Carcinogenic PAHs (as B(a)P TEQ)	Benzo(a)pyrene	Total PAHs	Naphthalene	Benzene	Toluene	Ethylbenzene	Total Xylenes	F1	F2	F3	F4	Other OCPs	Dieldrin + Aldrin			
Development Footprint - HIL-B																											
BH102	0.2-0.3	21-23 September 2016	4	0.4	17	23	500	<0.05	6.1	230	<0.2	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<0.3	2.1	<3.4	<1	No
BH102	1.2-1.3		8	<0.3	16	18	88	<0.05	6.5	94	<0.2	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	86	97	<120	-	-	<3.4	-	-
BH103	0.2-0.3		14	0.4	25	31	250	0.06	26	160	<0.2	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<0.3	<0.3	<3.4	<1	Yes (>0.01%)
BH105	0.2-0.3		11	1.4	70	700	900	0.30	72	5600	<0.2	<0.1	1.1	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	400	<120	<0.3	<0.3	<3.4	<1	Yes (<0.01%)
BH105	0.8-1.0		8	<0.3	10	44	220	0.48	5.5	190	<0.2	<0.1	1.2	<0.1	<0.1	<0.1	<0.1	<0.3	<25	30	150	<120	-	-	-	-	-
BH106	0.3-0.5		<3	<0.3	18	87	28	0.07	18	120	<0.2	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<0.3	<0.3	<3.4	<1	No
BH107	0.3-0.5		10	0.4	6.9	22	14	0.06	15	61	<0.2	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<0.3	<0.3	<3.4	<1	No
BH108	0.3-0.5		4	<0.3	15	38	160	0.10	10	100	0.3	0.1	1.7	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<0.3	0.5	<3.4	<1	No
BH108	0.8-1.0		3	<0.3	9.0	53	38	0.11	4.3	58	<0.2	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	-	-	-	-	-
BH109	0.3-0.5		4	<0.3	8.6	10	170	0.06	4.0	250	<0.2	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<0.3	<0.3	<3.4	<1	No
BH109	1.0-1.2		4	<0.3	8.8	10	13	<0.05	6.6	44	<0.2	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	-	-	-	-	-
Openspace and Landscaped Area - HIL-C																											
BH101	0.2-0.3	21-23 September 2016	5	0.7	31	73	100	0.19	30	190	<0.2	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<0.3	<0.3	<3.4	<1	Yes (>0.01%)
BH101	1.0-1.2		6	<0.3	7.3	13	28	0.06	19	87	<0.2	<0.1	1.9	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	-	-	-	-	-
BH104	1.2-1.5		8	<0.3	11	26	82	0.11	5.2	52	<0.2	<0.1	1.2	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	-	-	-	-	-
BH104	0.2-0.3		6	<0.3	9.4	20	18	<0.05	15	110	<0.2	<0.1	<0.8	<0.1	<0.1	<0.1	<0.1	<0.3	<25	<25	<90	<120	<0.3	<0.3	<3.4	<1	No
SILs																											
HIL B - *Residential with minimal opportunities for soil access*			500	150	500 Cr(VI)	30,000	1,200	120	1,200	60,000	4		400										600	10	NR	1	
HIL C - *Public Open Space*			300	90	300	17,000	600	80	1,200	30,000	3		300										400	10	NR	1	
Soil texture classification –Sand [1]			Source depths (0 m to <1 m. BGL)											3	0.5	160	55	40	45	110							
			Source depths (1 m to <2 m. BGL)											NL	0.5	220	NL	60	70	240							
EILs / ESLs - *urban residential and public open space* [1 4]			100		198	80	1,200		35	145		0.7		170	50	85	70	105	180	120	300	2,800					
Management Limits – *Residential, parkland and public open space* Coarse grained soil texture[1]																			700	1000	2500	10000					
Asbestos HSL - Presence / Absence																											Yes / No

Notes: All results are recorded in mg/kg

Highlighted values indicates concentration exceeds Human Helath Based Soil Criteria

Highlighted values indicates concentration exceeds EIL / ESL.

HIL B	NEPC 1999 Amendment 2013 'HIL B" Health Based Investigation Levels applicable for residential exposure settings with minimal opportunities for soil access, including dwellings with fully and permanently paved yard space such as high rise buildings and apartments.
#	Thresholds are for Chromium VI.
NR	No current published criterion.
NL	Not Limiting' If the derived soil vapour limit exceeds the soil concentration at which the pore water phase cannot dissolve any more of the individual chemical
-	'Not Tested' i.e. the sample as not analysed.
1	Coarse Grained soil values were applied, being the most conservative of the material types.
2	The NEPM 2013 HIL-B criterion value for phenol is 45000 mg/kg
F1	TPH C_6-C_{10} less the sum concentration of BTEX.
F2	TPH $C_{>10}$-C_{16} less the concentration of Naphthalene.
F3	TPH $C_{>16}$-C_{34}
F4	TPH $C_{>34}$-C_{40}

Table T2 - Summary of Acid Sulfate Soil Results

Sample ID	Sampling Depth (@ m BGL)	Sampling Date	pH $_{KCL}$ [1]	pH $_{Ox}$ [2]	Total Actual Acidity moles H+/tonne	Total Potential Acidity moles H+/tonne	Total Sulfur Acidity moles H+/tonne	Sulphur (S_{KCl}) %w/w	Sulphur (S_p) %w/w	Peroxide Oxidisable Sulphur (S_{pos}) %w/w
BH102	2.0-2.2	21-23 September 2016	4.7	5.4	30	35	<5	0.060	0.058	<0.005
BH102	2.9-3.0		4.5	5.0	40	30	<5	0.024	0.027	<0.005
BH102	3.9-4.0		8.9	7.3	<5	<5	<5	0.015	0.014	<0.005
BH102	4.9-5.0		4.9	6.2	12	12	<5	0.014	0.016	<0.005
BH102	5.8-6.0		5.1	6.3	12	12	<5	0.011	0.012	<0.005
BH104	1.8-2.0		6.5	7.6	<5	<5	<5	<0.005	0.007	<0.005
BH104	2.8-3.0		4.1	5.0	42	25	<5	0.010	0.015	<0.005
BH104	3.8-4.0		4.5	5.5	22	15	<5	0.010	0.012	<0.005
BH104	4.8-5.0		5.6	7.3	7	<5	<5	0.007	0.010	<0.005
BH104	5.8-6.0		6.0	7.9	<5	<5	<5	<0.005	0.005	<0.005
BH104	6.8-7.0		6.2	6.8	<5	<5	<5	<0.005	0.005	<0.005
BH104	7.8-8.0		6.2	6.3	<5	<5	<5	<0.005	<0.005	<0.005
BH104	8.5-9.0		6.7	8.2	<5	<5	<5	<0.005	0.005	<0.005
Assessment Criteria										
ASSMAC (1998) - Fine Textures (> 1,000 t disturbed material)			-	-	-	18	18	-	-	0.03

Notes:

Highlighted values indicates value exceeds of ASSMAC (1998) criteria

Table T3 – Summary of Groundwater Investigation Results

Sample Identification	Heavy Metals								PAHs		Total Phenols	BTEX					TPHs			
	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Benzo(a)pyrene	Naphthalene		Benzene	Toluene	Ethylbenzene	o-xylene	m/p-xylene	F1	F2	F3	F4
BH101M	Dry																			
BH102M	<1	0.1	<1	2	<1	<0.0001	10	33	<0.1	<0.1	<0.01	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500
BH104M	<1	<0.1	<1	2	<1	<0.0001	1	18	<0.1	<0.1	<0.01	<0.5	<0.5	<0.5	<0.5	<1	<50	<60	<500	<500
GILs																				
HSL - A & B *Residential 1*										NL		800	NL	NL	NL	NL	1,000	1,000		
GIL[1] Fresh Water	24-AsIII 13-As (V)	0.2	3.3 (Cr III)	1.4	3.4	0.06	11	8	0.02 [4]	16		950	300 [3]	150 [4]	350	200	50 [5]	60 [5]	500 [5]	500 [5]
Drinking Water	100	2	50	2,000	100	1	20		0.01			1	800	300	600					

Notes:

All values are µg/L unless stated otherwise ND = Non Detect NL = Non Limiting

F1 = TPH C6-C10 less the sum concentration of BTEX

F2 = TPH C>10-C16 less the concentration of Naphthalene

F3 = TPH C>16-C34

F4 = TPH C>34-C40

1 =NEPC (2013) Table 1A(4) Groundwater HSL A & B for vapour intrusion at the contaminant source depth ranges in sand 2m to <4m.

2 = NEPM (2013) Groundwater Investigation Levels for Fresh water quality, based on ANZECC & ARMCANZ (2000).

3 = NEPC (1999) Groundwater Investigation Levels for the protection of freshwater aquatic ecosystems, NEPM.

4 = ANZECC (2000) Low reliability data

5 = In lack of criteria the laboratory LOR has been used.

Highlighted indicates analyte concentration value exceeding the adopted criteria

Indicates the criteria exceeded

APPENDIX C
BOREHOLE LOGS

BOREHOLE: BH101M

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Project	Proposed Mixed Use Redevelopment	East	308064.1 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243382.2 m MGA94 Zone 56	Sheet	1 OF 2
Position	Refer to Figure 2	Surface RL	10.70 m AHD	Date Started	21/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	21/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 21/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
AD/T	E	28/09/16	0	10.70	BH101M_0.2-0.3 ES 0.20-0.30 m 0.20 m PID = 4.6 ppm			-	FILL; Sandy CLAY; low plasticity, dark brown-dark grey, sand is fine to coarse grained, with fine to medium grained gravel.			BH101M 6.30m
				0.70 10.00	SPT 0.50-0.70 m 5,5/50mm HB N=5				From 0.7 m, brick fragments.	M (<PL)	-	
			1		BH101M_0.5-0.7 BH101M_1.0-1.2 ES 1.00-1.20 m PID = 3.6 ppm							
					SPT 1.50-1.95 m 3,2,2 N=4 BH101M_1.5-1.95							
			2	2.00 8.70	BH101M_2.0-2.2 ES 2.00-2.20 m PID = 4.7 ppm			CL-CI	Sandy CLAY; low to medium plasticity, brown, sand is fine to medium grained.	M=PL	St	
			3		SPT 3.00-3.45 m 3,5,7 N=12 BH101M_3.0-3.45 PP =100-200 kPa							
			4	4.50 6.20	SPT 4.50-4.95 m 4,5,5 N=10 BH101M_4.5-4.95 ES 4.50-4.95 m BH101M_4.5-4.95 4.50 m PP =150-250 kPa			CL-CI	Sandy CLAY; low to medium plasticity, brown mottled grey, sand is fine to medium grained.	M (>PL)	St - VSt	
			5									
			6	6.00 4.70	SPT 6.00-6.45 m 6,4,5 N=9 BH101M_6.0-6.45 6.00 m PP =50-100 kPa			SC	Clayey SAND; fine to medium grained, light grey/ red/ orange-brown.		L	
			7							M		
			8		SPT 7.50-7.95 m 6,6,12 N=18 BH101M_7.5-7.95 7.50 m PP =30-50 kPa						MD	
			9	9.00	SPT 9.00-9.10 m 25/100mm HB N=SPT BH101M_9.0-9.1 C 9.10-11.61 m			-	SHALE; grey-brown, distinctly weathered, very low strength.	-	-	
NMLC		90-100% RETURN		1.60 9.53 1.17				-	SHALE; yellow-brown/ grey, with light grey laminations, very low to low strength.			
									From 9.53 m, dark grey, with light grey laminations, medium to high strength, with occasional low strength.			
			10	10.00								

Gatic Cover
Concrete
Cuttings
Bentonite
uPVC 50 mm Casing.
Sand
uPVC 50 mm Slotted Screen.
Bentonite

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH101M

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Project	Proposed Mixed Use Redevelopment	East	308064.1 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243382.2 m MGA94 Zone 56	Sheet	2 OF 2
Position	Refer to Figure 2	Surface RL	10.70 m AHD	Date Started	21/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	21/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 21/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
NMLC		90-100% RETURN	10	0.70	C 9.10-11.61 m 9.30 m 9.30 m 9.60 m 10.20 m			-	SHALE; dark grey-brown, with light grey laminations.			BH101M 6.30m
				10.90 -0.20	10.75 m				From 10.9 m, dark grey, with light grey laminations.			
			11		11.15 m							
					C 11.61-14.59 m 11.75 m							
			12		12.15 m							
					12.75 m							Sand
			13		13.30 m							
					13.80 m							
			14		14.25 m							
				14.60 -3.90	C 14.59-16.05 m				From 14.6 m, low to medium strength.			
					14.80 m							
			15		15.25 m							
					15.75 m							
			16	16.05					Hole Terminated at 16.05 m Monitoring well installed.			
			17									
			18									
			19									
			20									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH102M

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Project	Proposed Mixed Use Redevelopment	East	308019.6 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243411.2 m MGA94 Zone 56	Sheet	1 OF 2
Position	Refer to Figure 2	Surface RL	10.70 m AHD	Date Started	21/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	22/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 22/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
AD/T	E	23/09/16	0	10.70	BH102M_0.2-0.3 ES 0.20-0.30 m PID = 3.3 ppm SPT 0.50 m 1/0mm HB BH102M_0.5 BH102M_0.5-0.6 ES 0.50-0.60 m PID = 7.7 ppm BH102M_0.8-1.0 ES 0.80-1.00 m			-	FILL; Sandy CLAY; low plasticity, brown, sand is fine to coarse grained, with fine to medium grained gravel, with brick fragments and trace of sandstone gravel.			BH102M 5.20m
				0.50 10.20					From 0.5 m, concrete fragments, hydrocarbon odour.	M (<PL)	-	
			1									
				1.50 9.20	BH102M_1.2-1.3 ES 1.20-1.30 m PID = 15.8 ppm SPT 1.50-1.95 m 3,7,8 N=15 BH102M_1.5-1.95 1.50 m PP =250-300 kPa			CI-CH	Silty CLAY; medium to high plasticity, red-dark grey, trace of fine to medium grained sand.			
			2		BH102M_2.0-2.2 ES 2.00-2.20 m BH102M_2.5-2.6 ES 2.50-2.60 m PID = 5.9 ppm BH102M_2.9-3.0 ES 2.90-3.00 m SPT 3.00-3.45 m 3,5,6 N=11 BH102M_3.0-3.45 3.00 m PP =300-350 kPa					M (>PL)	St - VSt	
			3									
				4.00 6.70	BH102M_3.3-3.4 ES 3.30-3.40 m BH102M_3.9-4.0 ES 3.90-4.00 m			SC	Clayey SAND; fine to medium grained, brown/ grey/ red-brown.			
			4		BH102M_4.4-4.5 ES 4.40-4.50 m PID = 9.6 ppm SPT 4.50-4.95 m 5,10,10 N=20 BH102M_4.5-4.95 4.50 m PP =150-200 kPa BH102M_4.9-5.0 ES 4.90-5.00 m							
			5									
		28/09/16			BH102M_5.8-6.0 ES 5.80-6.00 m SPT 6.00-6.45 m 5,11,22 N=33 BH102M_6.0-6.2 ES 6.00-6.20 m BH102M_6.0-6.45 6.00 m PP =250-300 kPa					M (>PL)	St	
			6	6.20 4.50					From 6.2 m, grey mottled brown.			
WB			7	7.30 7.45				-	SHALE; grey, distinctly weathered, very low strength.	-	-	
NMLC		90-100% RETURN		3.25	C 7.45-10.11 m 7.60 m			-	SHALE; dark grey-brown, with light grey laminations.			
			8	8.00 2.70	8.10 m PP =250-300 kPa 8.80 m				From 8.0 m, dark grey with light grey laminations, medium to high strength.			
			9		9.20 m							
			10	10.00	9.75 m							

Gatic Cover
Bentonite
uPVC 50 mm Casing
Cuttings
Bentonite
uPVC 50 mm Slotted Screen
Sand
Bentonite

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH102M

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Project	Proposed Mixed Use Redevelopment	East	308019.6 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243411.2 m MGA94 Zone 56	Sheet	2 OF 2
Position	Refer to Figure 2	Surface RL	10.70 m AHD	Date Started	21/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	22/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 22/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
NMLC		90-100% RETURN	10	0.70	C 10.11-13.13 m 10.20 m 10.70 m 11.20 m 11.75 m 12.20 m 12.75 m			-	SHALE; dark grey, with light grey laminations.			BH102M 5.20m Sand
			11									
			12									
			13	13.13	13.10 m				Hole Terminated at 13.13 m Monitoring well installed.			
			14									
			15									
			16									
			17									
			18									
			19									
			20									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH103

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Project	Proposed Mixed Use Redevelopment	East	308029.3 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243377.8 m MGA94 Zone 56	Sheet	1 OF 2
Position	Refer to Figure 2	Surface RL	10.50 m AHD	Date Started	22/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	22/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 22/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	H	GW not observed due to rotary drilling	0	10.50	BH103_0.2-0.3 ES 0.20-0.30 m PID = 2.9 ppm			-	FILL; Gravelly SAND; fine to medium grained, dark grey/ dark brown/ red, fine to coarse, angular to sub-angular gravel, with clay and brick fragments.	M	-	FILL
			1									
			2	*2.30*								
WB	E			8.20	SPT 2.50-2.95 m 4,3,3 N=6 BH103_2.5-2.9 ES 2.50-2.90 m PID = 1.7 ppm BH103_2.5-2.95 PP =50-150 kPa			CL-CI	Sandy CLAY; low to medium plasticity, red-brown/ grey, sand is fine to medium grained.	M (>PL)	F - St	ALLUVIUM
			3									
			4	*4.20*	SPT 4.00-4.45 m 5,8,10 N=18 BH103_4.0-4.45 PP =100-200 kPa							
				6.30					From 4.2 m, grey.			
			5	*5.50*								
				5.00	SPT 5.50-5.95 m 6,8,11 N=19 BH103_5.5-5.95			SC	Clayey SAND; fine to medium grained, brown.	M	MD	
			6									
			7		SPT 7.00-7.45 m 13,15,13 N=28 BH103_7.0-7.45							
			8	*8.00*								
				8.12				-	SHALE; dark grey, distinctly weathered, very low strength.	-	-	WEATHERED ROCK
NMLC				2.38	C 8.12-10.29 m			-	SHALE; yellow-brown/ grey, with light grey laminations, very low to low strength.			
			9	*9.50*								
				1.00					From 9.5 m, medium strength.			
			10	*10.00*								

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH103

Project	Proposed Mixed Use Redevelopment	East	308029.3 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243377.8 m MGA94 Zone 56	Sheet	2 OF 2
Position	Refer to Figure 2	Surface RL	10.50 m AHD	Date Started	22/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	22/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 22/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
NMLC			10	0.50	C 8.12-10.29 m 8.30 m 8.30 m 9.30 m 9.75 m 10.25 m C 10.29-13.16 m 10.80 m			-	SHALE; dark grey, with light grey laminations, medium to high strength.			
			11		11.25 m							
					11.75 m							
			12		12.25 m							
					12.65 m							
			13		C 13.16-16.25 m 13.25 m							
					13.75 m							
			14		14.20 m							
					14.75 m							
			15		15.25 m							
					15.75 m							
			16	*16.25*	16.10 m				Hole Terminated at 16.25 m Backfilled with drilling spoil.			
			17									
			18									
			19									
			20									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH104M

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Project	Proposed Mixed Use Redevelopment	East	308056.6 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243361.1 m MGA94 Zone 56	Sheet	1 OF 1
Position	Refer to Figure 2	Surface RL	10.60 m AHD	Date Started	23/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	23/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 23/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS
AD/T	E	28/09/16	0	0.16				-	CONCRETE; 160 mm thick.	-	-	Gatic Cover; Concrete
				10.44	BH104M_0.2-0.3 ES 0.20-0.30 m PID = 2 ppm			-	FILL; Gravelly Sandy CLAY; medium plasticity, sand is fine to coarse grained, gravels are fine to coarse, with brick fragments.			
			1		BH104M_0.7-1.0 ES 0.70-1.00 m					M (>PL)	-	
					BH104M_1.2-1.5 ES 1.20-1.50 m							uPVC 50 mm Casing
				1.60								
				9.00	BH104M_1.7-1.8 ES 1.70-1.80 m			CL	Sandy CLAY; low plasticity, sand is fine to medium grained, brown mottled grey.			
			2		BH104M_1.8-2.0 ES 1.80-2.00 m					M (>PL)	-	Cuttings
					BH104M_2.5-2.6 ES 2.50-2.60 m PID = 4.4 ppm							
				3.00	BH104M_2.8-3.0 ES 2.80-3.00 m							
			3	7.60				CL-CI	Silty CLAY; low to medium plasticity, brown/ red-brown, with fine grained sand.			
					BH104M_3.5-3.6 ES 3.50-3.60 m PID = 3.3 ppm							
			4		BH104M_3.8-4.0 ES 3.80-4.00 m					-		Bentonite
					BH104M_4.8-5.0 ES 4.80-5.00 m							
			5	5.50								
				5.10				CL	Sandy CLAY; low plasticity, sand is fine grained, brown.		-	
			6		BH104M_5.8-6.0 ES 5.80-6.00 m							uPVC 50 mm Slotted Screen
					BH104M_6.8-7.0 ES 6.80-7.00 m					-		Sand
			7	7.80								
				2.80	BH104M_7.8-8.0 ES 7.80-8.00 m				From 7.8 m, grey-brown.			
			8	8.50								
	F-H			2.10	BH104M_8.5-9.0 ES 8.50-9.00 m			-	SHALE; dark grey-brown, extremely weathered, extremely low to very low strength.	-	-	
			9		BH104M_9.0-9.3 D 9.00-9.30 m							
				9.30								
									Hole Terminated at 9.30 m Monitoring well installed.			
			10									

PIEZOMETER DETAILS: ID BH104M, Static Water Level 6.90m

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH105

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Project	Proposed Mixed Use Redevelopment	East	308051.6 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243379.1 m MGA94 Zone 56	Sheet	1 OF 1
Position	Refer to Figure 2	Surface RL	10.70 m AHD	Date Started	23/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	23/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 23/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	E	▽	0	10.70	BH105_0.2-0.3 ES 0.20-0.30 m			-	FILL; Gravelly Sandy CLAY; low plasticity, sand is fine to coarse grained, gravels are fine to coarse, dark brown-dark grey, with brick fragments.			FILL
			1		BH105_0.8-1.0 ES 0.80-1.00 m					M (>PL)	-	
				1.50 9.20	BH105_1.5-1.6 ES 1.50-1.60 m				From 1.5 m, with roadbase.			
				1.80 8.90	BH105_1.7-1.8 ES 1.70-1.80 m			CI	Sandy Silty CLAY; medium plasticity, sand is fine to medium grained, brown.			ALLUVIUM
			2		BH105_2.0-2.2 ES 2.00-2.20 m					M (>PL)	-	
				2.50 8.20				CI-CH	Silty CLAY; medium to high plasticity, grey/ red-brown, with fine to medium grained sand.			
			3	*3.00*	BH105_2.8-3.0 ES 2.80-3.00 m				Hole Terminated at 3.00 m Backfilled with drilling spoil.			
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH106

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Project	Proposed Mixed Use Redevelopment	East	308041.9 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243379.6 m MGA94 Zone 56	Sheet	1 OF 1
Position	Refer to Figure 2	Surface RL	10.60 m AHD	Date Started	23/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	23/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 23/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	E		0	10.60	BH106_0.3-0.5 ES 0.30-0.50 m			-	FILL; Gravelly SAND; fine to coarse grained, dark brown-dark grey, with clay and brick fragments.	D	-	FILL
					BH106_0.8-1.0 ES 0.80-1.00 m							
			1	*1.20* 9.40	BH106_1.3-1.5 ES 1.30-1.50 m			-	FILL; Silty CLAY; medium to high plasticity, red-brown/ dark grey.	M (>PL)	-	
				1.70 8.90	BH106_1.8-2.0 ES 1.80-2.00 m			CL	Sandy CLAY; low plasticity, sand is fine to medium grained, grey.	-	-	ALLUVIUM
			2	*2.60* 8.00				CI-CH	Silty CLAY; medium to high plasticity, brown/ red-brown, with fine grained sand.			
			3	*3.00*	BH106_2.8-3.0 ES 2.80-3.00 m				Hole Terminated at 3.00 m Backfilled with drilling spoil.			
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH107

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Project	Proposed Mixed Use Redevelopment	East	308042.2 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243394.0 m MGA94 Zone 56	Sheet	1 OF 1
Position	Refer to Figure 2	Surface RL	10.60 m AHD	Date Started	23/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	23/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 23/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	E		0	10.60	BH107_0.3-0.5 ES 0.30-0.50 m			-	FILL; Sandy CLAY; low plasticity, sand is fine to coarse grained, brown-dark grey, with fine to coarse gravel.	D	-	FILL
				0.70 9.90					From 0.7 m, with brick fragments.			
	H		1	*1.20*	BH107_0.8-1.0 ES 0.80-1.00 m				Hole Terminated at 1.20 m TC-Bit refusal on brick fill. Backfilled with drilling spoil.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH108

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Project	Proposed Mixed Use Redevelopment	East	308022.7 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243392.0 m MGA94 Zone 56	Sheet	1 OF 1
Position	Refer to Figure 2	Surface RL	10.70 m AHD	Date Started	23/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	23/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 23/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	E	GWNE	0	10.70	BH108_0.3-0.5 QD1/QT1 0.30-0.50 m			-	FILL; Gravelly SAND; fine to coarse grained, dark brown-dark grey, with clay.	D	-	FILL
				0.80								
			1	9.90	BH108_0.8-1.0 ES 0.80-1.00 m				From 0.8 m, with brick fragments.			
				1.20								
				9.50	BH108_1.3-1.5 ES 1.30-1.50 m			CI	Sandy CLAY; medium plasticity, sand is fine to medium grained, brown/ red-brown.			ALLUVIUM
			2		BH108_1.8-2.0 ES 1.80-2.00 m					M (>PL)	-	
					BH108_2.3-2.5 ES 2.30-2.50 m							
				2.60								
				8.10				CL	Sandy CLAY; low plasticity, sand is fine grained, brown.	M (>PL)	-	
			3	*3.00*	BH108_2.8-3.0 ES 2.80-3.00 m				Hole Terminated at 3.00 m Backfilled with drilling spoil.			
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

BOREHOLE: BH109

eiaustralia
Contamination | Remediation | Geotechnical

Project	Proposed Mixed Use Redevelopment	East	308003.1 m		
Location	26 Shepherd Street, Liverpool NSW	North	6243395.6 m MGA94 Zone 56	Sheet	1 OF 1
Position	Refer to Figure 2	Surface RL	10.70 m AHD	Date Started	23/9/16
Job No.	E23125	Contractor	Rockwell Drilling Pty Ltd	Date Completed	23/9/16
Client	Coronation (26 Shepherd Street) Pty Ltd	Drill Rig	Hanjin D&B	Logged JZ	Date: 23/9/16
		Inclination	-90°	Checked JP	Date: 10/11/16

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	E	GWNE	0	10.70				-	FILL; Sandy Silty CLAY; low plasticity, sand is fine to medium grained, dark brown-dark grey, with fine to coarse gravel.	M (<PL)		FILL
				0.60	BH109_0.3-0.5 ES 0.30-0.50 m	■						
				10.10				-	FILL; SAND; fine grained, brown.		-	
			1	*1.00*	BH109_0.8-1.0 ES 0.80-1.00 m	■				D		
				9.70 *1.20*				-	FILL; Clayey SAND; fine grained, brown-dark grey.			
									Hole Terminated at 1.20 m TC-Bit refusal on inferred concrete in fill. Backfilled with drilling spoil.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.

APPENDIX D
REMEDIATION CRITERIA

Table D-0-1 Soil Remediation Criteria

`Chemical	Unit	HIL A [1a]	HSL A&B [9,10]				Management limits[11]
			0 - <1 mBGL	1 - <2 mBGL	2 - <4 mBGL	>4 mBGL	
Metals							
Arsenic – As [2]	mg / kg	500 3	-	-	-	-	-
Cadmium - Cd	mg / kg	150	-	-	-	-	-
Chromium(VI) – Cr(VI)	mg / kg	500	-	-	-	-	-
Copper – Cu	mg / kg	30,000	-	-	-	-	-
Lead – Pb	mg / kg	1,200	-	-	-	-	-
Mercury – Hg (inorganic)	mg / kg	120	-	-	-	-	-
Nickel – Ni	mg / kg	1,200	-	-	-	-	-
Zinc – Zn	mg / kg	60,000	-	-	-	-	-
Petroleum Hydrocarbons							
F1 [3]	mg / kg	-	45	70	110	200	700
F2 [4]	mg / kg	-	110	240	440	NL	1,000
F3 [5]	mg / kg	-	-	-	-	-	2,500
F4 [6]	mg / kg	-	-	-	-	-	10,000
Polycyclic Aromatic Hydrocarbons (PAH)							
Naphthalene	mg / kg	-	3	NL	NL	NL	-
Benzo(α)pyrene	mg / kg	-	-	-	-	-	-
Carcinogenic PAHs (as B(α)P TEQ) [7]	TEQ	4	-	-	-	-	-
Total PAHs [8]	mg / kg	400	-	-	-	-	-
Monocyclic Aromatic Hydrocarbons (BTEX)							
Benzene	mg / kg	-	0.5	0.5	0.5	0.5	-
Toluene	mg / kg	-	160	220	310	540	-
Ethylbenzene	mg / kg	-	55	NL	NL	NL	-
Xylenes (total)	mg / kg	-	40	60	95	170	-
Organochlorine Pesticides (OCPs)							
DDT+DDE+DDD	mg / kg	600	-	-	-	-	-
Aldrin and Dieldrin	mg / kg	10	-	-	-	-	-
Chlordane	mg / kg	90	-	-	-	-	-
Endosulfan	mg / kg	400	-	-	-	-	-
Endrin	mg / kg	20	-	-	-	-	-
Heptachlor	mg / kg	10	-	-	-	-	-
HCB	mg / kg	15	-	-	-	-	-
Methoxychlor	mg / kg	500	-	-	-	-	-
Mirex	mg / kg	20	-	-	-	-	-
Toxaphane	mg / kg	30	-	-	-	-	-

Organophosphate Pesticides (OPPs)							
Total OPPs	mg / kg	-	-	-	-	-	-
Polychlorinated Biphenyls (PCBs)							
Total PCBs	mg / kg	1	-	-	-	-	-
Asbestos		HSL B					
Asbestos (friable or fines)	w / w	0.001%	-	-	-	-	-
Asbestos (bonded)	w / w	0.04%	-	-	-	-	-

Notes:

1. Health-based investigation levels:

a. HIL B - Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments, Ref. NEPM 2013, Schedule B1, Table 1A(1).

2. Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer Schedule B7).

3. F1: concentration of TPH C_6-C_{10} fraction minus the sum of BTEX concentrations.

4. F2: concentration of TPH >C_{10}-C_{16} fraction minus the concentration of Naphthalene.

5. F3: concentration of TPH >C_{16}-C_{34}.

6. F4: concentration of TPH >C_{34}-C_{40}.

7. Carcinogenic PAHs: HIL is based on the 8 carcinogenic PAHs and their TEFs (potency relative to B(a)P) adopted by CCME 2008 (refer Schedule B7). The B(a)P TEQ is calculated by multiplying the concentration of each carcinogenic PAH in the sample by its B(a)P TEF, given below, and summing these products.

8. Total PAHs: HIL is based on the sum of the 16 PAHs most commonly reported for contaminated sites (WHO 1998). The application of the total PAH HIL should consider the presence of carcinogenic PAHs and naphthalene (the most volatile PAH). Carcinogenic PAHs reported in the total PAHs should meet the B(a)P TEQ HIL. Naphthalene reported in the total PAHs should meet the relevant HSL.

9. Soil HSLs for vapour intrusion assuming coarse texture (sand) soils.

10. Coarse grained soil values were applied, being the most conservative of the material types.

11. Coarse grained management limits for recreational, parkland and public open space have been applied, being the most conservative.

12. NL = Not Limiting.

Table D-2 Waste Classification without Leachate Testing

Contaminant	Maximum Values of *Specific Contaminant Concentration* for Classification without TCLP	
	General Solid Waste CT1 (mg/kg)	Restricted Solid Waste CT2 (mg/kg)
Arsenic	100	400
Asbestos	"Special Waste - Asbestos Waste" if ANY Asbestos is present	
Benzene	10	40
Benzo(a)pyrene	0.8	3.2
Cadmium	20	80
Chromium (VI)	100	400
Cyanide (amenable)	70	280
Ethylbenzene	600	2,400
Lead	100	400
Mercury	4	16
Nickel	40	160
Petroleum hydrocarbons C_6-C_9	650	2,600
Petroleum hydrocarbons C_{10}-C_{36}	10,000	40,000
Polychlorinated biphenyls (PCB)	<50	<50
Polycyclic aromatic hydrocarbons (total PAH)	200	800
Tetrachloroethylene (PCE)	14	56
Toluene	288	1,152
Trichloroethylene (TCE)	10	40
Vinyl Chloride (VC)	4	16
Xylenes (total)	1,000	4,000

Note: N/A = not applicable (assessed using SCC1 and SCC2 values, only) see Table C-3

Table D-3 Waste Classification using TCLP and SCC Values

Contaminant	Maximum Values for *Leachable Concentration* and Specific Contaminant Concentration when used together			
	General Solid Waste		*Restricted Solid Waste*	
	Leachable Concentration	Specific Contaminant Concentration	Leachable Concentration	Specific Contaminant Concentration
	TCLP1 (mg/L)	SCC1 (mg/kg)	TCLP2 (mg/L)	SCC2 (mg/kg)
Arsenic	5.0	500	20	2,000
Asbestos	"Special Waste - Asbestos Waste" if ANY Asbestos is present			
Benzene	0.5	18	2	72
Benzo(a)pyrene	0.04	10	0.16	23
Cadmium	1.0	100	4	400
Chromium (VI)	5	1,900	20	7,600
Cyanide (amenable)	3.5	300	14	1,200
Ethylbenzene	30	1,080	120	4,320
Lead	5	1,500	20	6,000
Mercury	0.2	50	0.8	200
Nickel	2	1,050	8	4,200
Petroleum hydrocarbons C_6-C_9	N/A	650	N/A	2,600
Petroleum hydrocarbons C_{10}-C_{36}	N/A	10,000	N/A	40,000
Polychlorinated biphenyls (PCB)	N/A	<50	N/A	<50
Polycyclic aromatic hydrocarbons (total PAH)	N/A	200	N/A	800
Tetrachloroethylene (PCE)	0.7	25.2	2.8	100.8
Toluene	14.4	518	57.6	2,073
Trichloroethylene (TCE)	0.5	18	2	72
Vinyl Chloride (VC)	0.2	7.2	0.8	28.8
Xylenes	50	1,800	200	7,200

Note: N/A = not applicable (assessed using SCC1 and SCC2 values, only)

APPENDIX E
REVIEW OF REMEDIAL OPTIONS & TECHNOLOGIES

REVIEW OF REMEDIATION OPTIONS & TECHNOLOGIES

A number of soil remediation options were reviewed to examine the suitability of each method, in considering the remedial options available for the site, the surrounding lands and the geological and hydrogeological limitations, the following issues have been considered:

- Prioritisation of works in areas of most concern;
- Ability of remedial method to treat contamination with respect to natural and infrastructure limitations;
- Remedial timetable;
- Cost effectiveness;
- Defensible method to ensure the site is remediated to appropriate levels / validation criteria; and
- Regulatory compliance.

The following sections provide details on various remediation options for the material found on site.

E1 FILL, SOILS & RESIDUAL CLAYS

E1.1. BIOVENTING

Bioventing stimulates the natural in situ biodegradation of aerobically degradable compounds in soil by increasing oxygen flow to existing soil microorganisms. In contrast to soil vapour vacuum extraction, bioventing uses low air flow rates to provide only enough oxygen to sustain microbial activity. Oxygen is most commonly supplied through direct air injection into residual contamination in soil. In addition to degradation of adsorbed fuel residuals, volatile compounds are biodegraded as vapours move slowly through biologically active soil. Bioventing techniques have been successfully used to remediate soils contaminated by petroleum hydrocarbons, non-chlorinated solvents, some pesticides, wood preservatives, and other organic chemicals.

Factors that may limit the applicability and effectiveness of the process include:

- A high water table within 1-2 m of the surface, saturated soil lenses, or low permeability soils all may reduce bioventing performance.
- Vapours can build up in basements or underneath buildings within the radius of influence of air injection wells. This problem can be alleviated by extracting air near the structure of concern.
- Extremely low soil moisture content may limit biodegradation and the effectiveness of bioventing.
- Monitoring of off-gases at the soil surface may be required.
- Aerobic biodegradation of many chlorinated compounds may not be effective unless there is a co-metabolite present, or an anaerobic cycle.

E1.2 ENHANCED BIOREMEDIATION

Enhanced bioremediation is a process in which indigenous or inoculated micro-organisms (e.g., fungi, bacteria, and other microbes) degrade organic contaminants found in soil and/or ground water, converting them to harmless end products. Nutrients, oxygen, or other additives are used to enhance bioremediation and contaminant desorption from subsurface materials. In the presence of sufficient oxygen (aerobic conditions), and other nutrient elements, microorganisms will ultimately convert many organic contaminants to carbon dioxide, water, and microbial cell mass. In the absence of oxygen (anaerobic conditions), the organic contaminants will be ultimately metabolized to methane, limited amounts of carbon dioxide, and trace amounts of hydrogen gas. Under sulfate-reduction conditions, sulfate is converted to sulfide or elemental sulfur, and under nitrate-reduction conditions, nitrogen gas is ultimately produced.

Factors that may limit the applicability and effectiveness bio remediation of the process include:

- Interaction between the soil matrix and microorganisms influence the results;
- Contaminants may be subject to leaching requiring treatment of the underlying ground water;
- Preferential flow paths may severely decrease contact between injected fluids and contaminants throughout the contaminated zones. The system should not be used for clay, highly layered, or heterogeneous subsurface environments because of oxygen (or other electron acceptor) transfer limitations.
- High concentrations of heavy metals, highly chlorinated organics, long chain hydrocarbons, or inorganic salts may be toxic to microorganisms;
- A surface treatment system, such as air stripping or carbon adsorption, may be required to treat extracted groundwater prior to re-injection or disposal; and
- The length of time required for treatment can range from 6 months to 5 years and is dependent on many site-specific factors.

E1.3 CAPPING AND CONTAINMENT

The “cap and contain” method employs a risk minimisation approach similar to “ongoing management”, where impacted soils are managed on site so as not to pose an ongoing risk to the environment or human health. Impacted soils are contained by the placement of an impervious barrier or clean fill materials on top of the impacted material to prevent exposure to site occupiers, workers or the environment. The base of this “clean zone” would be clearly marked by a demarcation barrier to indicate that below this depth workers could potentially be exposed to contamination, which would then trigger additional health, safety and environmental controls.

Capping and containment may be an appropriate remedial option for soil containing both organic and inorganic contaminants that contain residual contamination, particularly if the mix of contaminants is not easily treated. The conditions for this remedial action alternative are:

- The contaminant is relatively non-mobile, including low volatility, insoluble and has low migration potential in a soil matrix;
- The primary exposure route to the contaminant and risk to human health is through direct dermal contact, dust inhalation or soil ingestion;
- The primary exposure route for the environment is mitigated through low leaching potential or migration to groundwater; and
- The contained area can be monitored and incorporated into any final land-use plans.

In the use of capping and containment, the focus of the response is to prevent contact with, or exposure to the contaminated soils by human receptors and/or eliminate transport by water to off-site receptors.

E1.4 CHEMICAL OXIDATION/INJECTION

Chemical oxidation remedial strategies involve the addition of an oxidising agent to the soil or groundwater. The rate and extent of degradation of a target chemical of concern is dependent on its susceptibility to oxidative degradation as well as the site conditions, such as pH, temperature, the concentration of oxidant, and the concentration of secondary oxidant-consuming substances such as natural organic matter.

Factors which may limit the applicability and effectiveness of chemical oxidation include:

- Requirement for handling large quantities of hazardous oxidizing chemicals due to the oxidant demand of the target organic chemicals and the unproductive oxidant consumption of the formation;
- Some chemicals of concern are resistant to oxidation; and
- There is a potential for process-induced detrimental effects.

E1.5 EXCAVATION AND OFF-SITE DISPOSAL

Excavation and disposal of contaminated wastes is a frequently used option, typically used when a rapid site remediation program is required or where significant subsurface contamination exists that is potentially impacting on sensitive off-site receptors. Wastes must be classified in accordance with the NSW EPA Guidelines.

Based on the required disposal of the landfill material, this option would adequately address the remediation goals through the removal of the contaminants from the site. Furthermore, with the removal of any identified contaminated fill soils, the long-term liability associated with soil contamination shall be minimised, along with substantial improvement of subsurface site conditions with regard to contamination of soil and groundwater.

E1.6 LAND FARMING

Ex situ land-farming is a proven treatment for petroleum hydrocarbon impacted soils. In general the higher the molecular weight or number of rings in a compound, the slower the degradation rate.

Factors that may limit the applicability and effectiveness of the land farming include:

- The large amount of space required;
- Conditions affecting biological degradation of contaminants (e.g., temperature, rain fall) are largely uncontrolled, which increases the length of time to complete remediation.
- Only suitable for organic contaminants.
- Volatile contaminants, such as solvents, must be pre-treated because they would volatilise into the atmosphere, causing air pollution.
- Dust control is an important consideration, especially during tilling and other material handling operations.
- Runoff collection facilities must be constructed and monitored.

E3 REMEDIATION OPTIONS

The various remediation options were reviewed in a technology matrix to assess their suitability against the various subsurface materials at the site and whether the option meets the primary objectives of the remediation works program, as discussed in **Section 5.3**.

APPENDIX F
GROUNDWATER ASSESSMENT METHODOLOGY

For groundwater investigation wells installed on-site, the methodology described in **Table F-1** is to be adopted.

Table F-1 Summary of Groundwater Investigation Methodology

Activity	Details
Fieldwork	Installation of a groundwater monitoring wells immediately on the down hydraulic gradient of the contaminated source / location.
Well Construction	Based on existing groundwater data, the groundwater monitoring well is to be installed to a maximum depth of 9.0 mBGL, and installed with a 3 m screening interval to assess for any potential PSH.
Well Development	Well construction will be in general accordance with the standards described in NUDLC, 2012 and involve the following: • 50 mm, Class 18 uPVC, threaded, machine-slotted screen and casing, with slotted intervals in shallow wells set to screen to at least 500 mm above the standing water level to allow sampling of phase-separated hydrocarbon product, if present; • Base and top of each well sealed with a uPVC cap; • Annular, graded sand filter used to approximately 300 mm above top of screen interval; • Granular bentonite applied above annular filter to seal the screened interval; • Drill cuttings used to backfill the bore annulus to just below ground level; and • Surface completion comprised a steel road box cover set in neat cement and finished flush with the concrete slab level. Well development is be conducted following installation. This will involve agitation of the full length of the water column using a dedicated, HDPE, disposable bailer, followed by removal of water and suspended sediment.
Well Gauging	Monitoring well will be gauged for standing water level (SWL) prior to well purging. A transparent HDPE bailer will be used to visually assess for the presence PSH prior to the commencement of well purging
Well Purging & Field Testing	Measurements of water quality parameters will be conducted repeatedly during well purging with a water quality meter (Hanna Multi Parameter 9829) positioned within an open flow-through cell. Groundwater parameters tested in the field will include Dissolved Oxygen (DO), Electrical Conductivity (EC), Redox, Temperature and pH. Measured parameters will be recorded onto a field data sheet along with the purged water volume at the time of measurement. Groundwater sampling will be performed when three consecutive readings of groundwater parameter indicate stabilisation; as per the specified ranges detailed below: • Electrical Conductivity: ± 3% of the read value; • Redox: ± 20 mV; • DO: ± 20% of the read value; and • pH: ± 0.2 pH unit.

Activity	Details
Groundwater sampling	The groundwater monitoring well will be purged and sampled using a low-flow/minimal drawdown sampling method with a MicroPurge kit (MP15) and a portable MicroPurge pump following well gauging. The MicroPurge system incorporates a low density poly-ethylene (LDPE) pump bladder, and a Teflon-lined LDPE sample delivery tube. The system used for this investigation will employ pressurised carbon dioxide gas to regulate groundwater flow. Pump pressure and pumping cycles will be adjusted accordingly to regulate extraction flow rate, and to avoid causing excessive drawdown of water level during the sampling process.
Decontamination Procedure	The water level probe, water quality kit probes, MicroPurge pump and HDPE bailers will be washed in a solution of potable water and Decon 90 and then rinsed with potable water between measurements/wells;
Sample Preservation	Sample containers will be supplied by the laboratory with the following preservatives: • One, 1 litre amber glass, acid-washed and solvent-rinsed bottle; • Two, 40ml glass vials, pre-preserved with dilute hydrochloric acid, Teflon-sealed; and • One, 250mL, HDPE bottle, pre-preserved with dilute nitric acid (1 mL). Samples for metals analysis will be field-filtered using 0.45 µm pore-size filters. All containers were filled with sample, capped and stored in ice-filled chests, until completion of the fieldwork and during sample transit to the laboratory.
Quality Control & Laboratory Analysis	All groundwater samples will be submitted for analysis of PCOC (**Section 3.2.3**) to NATA accredited testing laboratories. QA/QC testing comprised intra-laboratory duplicates ('field duplicates') will be tested blind by the primary laboratory and an inter-laboratory field duplicate tested blind by a secondary laboratory. All samples will be transported in refrigerated chests under strict Chain-of-Custody (COC) conditions. A Sample Receipt Advice (SRA) will be provided by each laboratory to document sample condition upon receipt.
Sample Transport	After sampling, refrigerated sample chests will transported to the primary analytical laboratory using strict Chain-of-Custody (COC) procedures. Inter-laboratory duplicate (ILD) samples will be forwarded to the secondary laboratory for QA/QC analysis. A Sample Receipt Advice (SRA) will be provided by each laboratory to document sample condition upon receipt.