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DETAILED SITE INVESTIGATION (DSI)

39-41 Chertsey Avenue, Bankstown NSW

prepared for

JPH Urban Pty Ltd

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ABBREVIATIONS

AIP	*Australian Institute of Petroleum Ltd*	**QA/QC**	*Quality Assurance, Quality Control*
ANZECC	*Australian and New Zealand Environment and Conservation Council*	**RAC**	*Remediation Acceptance Criteria*
AST	*Aboveground Storage Tank*	**RAP**	*Remediation Action Plan*
BGL	*Below Ground Level*	**RPD**	*Relative Percentage Difference*
BTEX	*Benzene, Toluene, Ethyl benzene and Xylene*	**SAC**	*Site Assessment Criteria*
COC	*Chain of Custody*	**SVC**	*Site Validation Criteria*
DA	*Development Approval*	**TCLP**	*Toxicity Characteristics Leaching Procedure*
DP	*Deposited Plan*	**TPH**	*Total Petroleum Hydrocarbons*
DQOs	*Data Quality Objectives*	**UCL**	*Upper Confidence Limit*
EPA	*Environment Protection Authority*	**UST**	*Underground Storage Tank*
ESA	*Environmental Site Assessment*	**VHC**	*Volatile Halogenated Compounds*
HIL	*Health-Based Soil Investigation Level*	**VOC**	*Volatile Organic Compounds*
LGA	*Local Government Area*		
NEHF	*National Environmental Health Forum*		
NEPC	*National Environmental Protection Council*		
NHMRC	*National Health and Medical Research Council*		
OCP	*Organochlorine Pesticides*		
OPP	*Organophosphate Pesticides*		
PAH	*Polycyclic Aromatic Hydrocarbon*		
PCB	*Polychlorinated Biphenyl*		
PID	*Photo Ionisation Detector*		
PQL	*Practical Quantitation Limit*		

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EXECUTIVE SUMMARY

Benviron Group was appointed by JPH Urban to undertake a Detailed Site Investigation (DSI) for the property situated at 39-41 Chertsey Avenue, Bankstown NSW ("the site").

Refer to **Figure 1** - Site Location and **Figure 2** - Site Plan

The site is currently occupied by a medium density residential development and a driveway area exist at the side of the building. The site is proposed to be redeveloped into high density residential building with up to a 3 level basement. The Site Assessment forms part of SEPP 55 Guideline (Remediation of Land) with a proposed redevelopment to determine the end land-use suitability of the property.

Soils sampled across the Site were assessed against the Site Acceptance Criteria (SAC) provided by the National Environment Protection (Assessment of Site Contamination) Measure (NEPM 2013) Table 1A - Residential B.

The project objectives of this Supplementary Contamination Assessment are to satisfy the stated OEH Detailed Site Investigation requirements in accordance with *NSW EPA Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites, 2000.* Specifically this investigation will consider the potential for suspected historical activities to have caused contamination at the Site and determine land use suitability for the proposed land use.

A number of potential areas of environmental concerns were identified at the site, particularly:

- Historical uses;

- Carpark areas / driveways where leaks and spills from cars may have occurred;
- Vicinity of degrading building features

Laboratory Results for the soil samples were below detection limits or the relevant guideline criteria.

Laboratory Results for the groundwater samples were below detection limits and the relevant guideline criteria with the exception of Copper in GW1-GW3. This is not seen as cause for concern because concentrations are consistent in upgradient and downgradient wells and is most likely attributed to background concentrations.

Sources of this material are most likely associated with the fill materials which may have been present within this site.

Off-site impacts of contaminants in soil are generally governed by the transport media available and likely receptor(s). The most common transport medium is water, whilst receptors include uncontaminated soils, groundwater, surface water bodies, humans, flora & fauna.

Surface water run-off from within the site would generally be deposited in the stormwater drainage pits and the potential for migration of contamination is low and any infiltration of contaminants is also expected to be low-moderate based on the underlying geology. The potential for significant impact of site soils, if contaminated, on the water bodies collecting surface water run-off from the region is considered low.

Based on the results of this investigation it is considered that the risks to human health and the environment associated with soil contamination at the site are low in the

context of the proposed use of the site. The site therefore ***is suitable*** for the proposed development, subject to the following recommendations:

- Any soils proposed for removal from the site should initially be classified in accordance with the "*Waste Classification Guidelines, Part 1: Classifying Waste"* NSW DECC (2014).

If during any potential site works, significant odours and / or evidence of gross contamination (including asbestos) not previously detected are encountered, or any other significant unexpected occurrence, site works should cease in that area, at least temporarily, and the environmental consultant should be notified immediately to set up a response to this unexpected occurrence

Thank you for the opportunity of undertaking this work. We would be pleased to provide further information on any aspects of this report.

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1.0 INTRODUCTION

Benviron Group was appointed by JPH Urban to undertake a Detailed Site Investigation (DSI) for the property situated at 39-41 Chertsey Avenue, Bankstown NSW ("the site").

Refer to **Figure 1** - Site Location and **Figure 2** - Site Plan

The site is currently occupied by a medium density residential development and a driveway area exist at the side of the building. The site is proposed to be redeveloped into high density residential building with up to a 3 level basement. The Site Assessment forms part of SEPP 55 Guideline (Remediation of Land) with a proposed redevelopment to determine the end land-use suitability of the property.

Soils sampled across the Site were assessed against the Site Acceptance Criteria (SAC) provided by the National Environment Protection (Assessment of Site Contamination) Measure (NEPM 2013) Table 1A - Residential B.

2.0 OBJECTIVE

The NSW Office of Environment and Heritage (OEH) indicate that a Detailed Site Environmental Investigation should provide comprehensive information on:

- Any issues raised in preliminary investigations;
- The type, extent and level of contamination;
- Contaminant dispersal in the air, surface water, soil and dust;
- The potential effects of contaminants on public health and the environment;
- Where applicable, off-site impacts on soil, sediment and biota; and
- The adequacy and completeness of all information available to be used in making decisions on remediation.

The project objectives of this Detailed Site Investigation (DSI) are to satisfy the stated OEH Detailed Site Investigation requirements in accordance with *NSW EPA Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites, 2000.* Specifically this investigation will consider the potential for suspected historical activities to have caused contamination at the Site and determine land use suitability for the proposed land use.

The proposed investigation program and the Detailed Site Investigation are designed to assess the presence of any unacceptable on site or off site risk to human health or the environment. The report will draw conclusions regarding the land use suitability of the Site for the current commercial land use or provide recommendations to enable such conclusions and determine the need for a further assessment.

3.0 SCOPE OF WORKS

The scope of works for this Detailed Site Investigation (DSI) included:

- Collecting site information, review of historical information and past site practices, (site surveys, site records on waste management practices, NSW Land Titles Office records of ownership, aerial photographs obtained from the NSW Department of Lands, WorkCover NSW records and site interviews);
- A site inspection to identify areas of environmental concern, on-site waste disposal practices and location of sewers, drains, holding tanks, Underground Storage Tanks, Aboveground Storage Tanks and pits, spills and ground discolouration etc.;
- A targeted soil boring/sampling investigative study – formulating and conducting a sampling plan and borehole investigation; the soil samples are taken and submitted for analysis on particular contaminants;
- Laboratory analysis and results from sample analysis – findings and comparison to regulatory guidelines;
- Quality Assurance/Quality Control (QA/QC) – all QA/QC procedures were undertaken in accordance with the Benviron Group Quality Assurance/Quality Control manual;
- Interpretation of results and findings; and
- Recommendations and final conclusions drawn from interpretation of the results.

4.0 SITE IDENTIFICATION AND SITE HISTORY REVIEW

4.1 Site identification

The site is identified as follows:

Table 1: Site Identification Review

Site Identifier	Site Details	
Site Location	39-41 Chertsey Avenue, Bankstown NSW	
Lot/DP	Lots 140 in DP1211528	
Parish	Bankstown	
County	Cumberland	
Nearest Survey Marker	SS118125	
Site Area	4000m^2	
Local Government Area (LGA)	Marrickville Council	
Zoning	B4 Mixed Use Local Centre	
Surrounding Land Uses	*North*	Medium Density Residential
	South	Medium Density Residential
	East	High Density Residential
	West	Medium Density Residential

Refer to **Figure 1 and Figure 2** – Site Locality Map and Site Plan

4.2 Review of Historical Maps

A review of the Burwood Map originally produced by Higinbotham & Robinson between 1885-1890 was undertaken. The map revealed that the site had no distinguishable features nor was it occupied by any major industry at the time of development.

4.3 Review of aerial photographs

A number of aerial photographs obtained from the NSW Department of Lands were reviewed as part of this PESA. Copies of the aerial photographs are kept in the offices of Benviron Group and are available for examination upon request. The results of this review are presented in the following table:

Table 2 Review of Aerial Photographs

Year	Site		Surrounding areas
1943	Residential	The site is occupied by a Residential Building.	The surrounding area is mostly residential.
1961	Residential	No major changes	No major changes
1980	Residential	No major changes	The surrounding area is becoming more densely populated.
2003	Residential	No major changes.	No major changes
Current	As per inspection	The site is as inspected (section 5.2)	As per inspection

In summary, the aerial photographs reveal that the site has been residential since at least 1943. The site remains residential in use to this day.

4.4 Title search

A review of historical documents held at the NSW Department of Lands offices was undertaken to characterise the previous land use and occupiers of the site.

Refer to **Appendix A** – Land Titles.

Table 3 Historical land title data

Year	Owner	Company/Personal Occupation
Current	JPH Urban	-
1950	Peter Cherrell	Furniture Removalist
1948	Charles Thomas Heywood	Carrier
1924	William and Harold Gould	Produce Merchant

In summary, the site has been owned and used for commercial purposes since the early 1920s.

Refer to **Appendix A** – *Land Title Information*

4.5 Anecdotal Evidence

No Anecdotal Evidence was available at the time of the investigation.

4.6 NSW OEH records

The NSW OEH publishes records of contaminated sites under Section 58 of the Contaminated Land Management (CLM) Act 1997. The notices relate to investigation and/or remediation of site contamination considered to pose a significant risk of harm under the definition in the CLM Act.

A search of the database revealed that the subject site is not listed, and has no listed properties within the Strathfield area.

It should be noted that the OEH record of Notices for Contaminated Land does not provide a record of all contaminated land in NSW.

Refer to **Appendix B** – NSW EPA Notice Summary.

4.7 Previous Reports

No previous reports could be located as part of this assessment

4.8 Summary of site history

In summary:

- Land title information shows that the site has been owned and used for residential purposes since the early 1920s.
- The aerial photographs reveal that the site has been was previously residential since at least 1943. The site remains residential in use to this day.

4.9 Integrity Assessment

The information found in the historical sources has been found to be in general concurrence. It is therefore considered that accuracy of this data is acceptable for this investigation.

5.0 REVIEW OF ENVIRONMENTAL INFORMATION

Table 4: Site Condition and Surrounding Environment Review

Site Information	Descriptions
Sensitive Receivers within 500m	No sensitive receivers were identified within 500m of the site.
Topography (1:25,000)	After review of the topographical maps provided by the Land and Property information service (LPI) it was determined that the site area is generally flat with a slight slope of 5^{o} to the north.
Geological Profile	The Geological Map of Sydney (Geological Series Sheet 9130, Scale 1:100,000, 1983), published by the Department of Mineral Resources indicates the residual soils within the site to be underlain by Triassic Age Shale of the Wianamatta Group, comprising black to dark grey shale and laminate.
Presence of Acid Sulphate Soils **(Review of NSW Department of Land & Water Conservation (DLWC)** ***Acid Sulphate Soil Risk Maps*** **(Edition Two, December 1997, Scale 1:250,000).**	A review of the aforementioned map indicated that there is a "No Known Occurrence " of acid sulphate soil materials within the soil profile During site investigations no indicators of acid sulphate soils were identified.

Site Information	Descriptions				
Localised Hydrogeology	**Number**	**Location**	**Depth**	**SWL**	**Use**
	GW112803	2km N	6m	-	Monitoring
	-	-	-	-	-
	-	-	-	-	-
Nearest Surface Water Body	Powells Creek – 1km NW				
Nearest Active Service Station	Approx 800m from the site				

6.0 REVIEW OF CONSTRUCTION AND SERVICE INFORMATION

6.1 Proposed Development

Table 5: Proposed Development Review

Item	Description
Proposed Development	Construction of a multistorey residential unit complex
Proposed Basements (if any)	Three
Proposed Use	High Density Residential Building
Density of Development	High
Types of End Users	Residents, Workers
DA Approval Number (if applicable)	N/A

Refer to **Appendix D** - *Proposed Development Plans*

7.0 SITE VISIT

7.1 General

The site was visited on 29th May 2016 by Benviron Group Environmental Scientists to inspect the site for any potential sources of contamination.

The following items were considered as part of the site visit:

- Description of the building structures;
- Site surroundings;
- Present and past industrial processes and operations at the site;
- Surface water, groundwater, stormwater and sewer;
- Present and past storage of chemicals and wastes associated with site use and their on-site location;
- Waste management practices and management of hazardous materials;
- Presence of Underground Storage Tanks or Above Ground Storage Tanks;
- Odour; and
- Occupational health and safety.

7.2 Site observations

At the time of the site visit the following observations were made as per the following table:

Table 6: Site Inspection Review

Factors Considered	Description
Buildings & Structures on Site	The sites were occupied were mostly rectangular in shape was occupied by a brick residential property with tile roofing. A shed at the rear of the site was also noted
Percentage Concrete Covered	70%
Concrete Condition	Very good
Chemical Storage	None was noted on site.
Above and Underground Storage Tanks	USTs and ASTs were not identified within the site inspection.
Trade Waste Pits	No trade waste agreements or pits were identified for the building.
Nearby Electrical Transformers	No electrical transformers were identified within the site
Asbestos	Asbestos sheeting was identified within the building structures on site. The sheeting was in good condition.
Site Vegetation	Vegetation was apparent within the site and appeared healthy and free of stress.
Soil Staining and Odours	No odours were identified within the property. No significant soil staining was noted within the soil profile.
Stormwater and Sewer	Stormwater and sewage were connected to the local utilities.

Refer to **Figure 2** - Site Plans

8.0 CONCEPTUAL SITE MODEL (CSM)

Based on the above information, site history and site walkover, the areas of potential concern and associated contaminants for the site CSM were identified. These are summarised in the following table.

Areas and Contaminants of Concern

Known and potential contamination source	Associated Contaminants
Historical Site Uses	Heavy Metals, TRH, BTEX, PAH, OCP, PCB
Imported Fill	Heavy Metals, TRH, BTEX, PAH, OCP, PCB
Carparking Areas	TRH, BTEX, PAH
Building degradation/ Demolition	Heavy Metals

Potentially Contaminated Media

Potentially contaminated media present at the site may include:

Known and potential contamination source	Associated Contaminants
Fill Material	There is the potential for contamination to be present in the upper clay/sand fill material.
Groundwater	There is the potential for the leaching of contaminants into groundwater onsite and also migration of the contaminants.

Potential for Migration

Contaminants generally migrate from site via a combination of windblown dusts, rainwater infiltration, groundwater migration and surface water runoff. The potential for contaminants to migrate is a combination of:

- The nature of the contaminants (solid/liquid and mobility characteristics);
- The extent of the contaminants (isolated or widespread);
- The location of the contaminants (surface soils or at depth); and
- The site topography, geology, hydrology and hydrogeology.

The potential contaminants identified as part of the site history review, site inspection and previous report are present in solid (e.g. impacted fill, asbestos), liquid (e.g. dissolved in water) and gaseous/vapour forms.

Aerial photography has indicated that there are no unsealed ground surfaces and therefore, while there is the potential for migration of contaminants via wind-blown dust is unlikely.

Rainfall infiltration at the site is expected to occur in unsealed areas. There is therefore the potential that soil contamination could result in impacts to shallow groundwater.

Potential Exposure Pathways

Potential exposure pathways include:

- Dermal;
- Ingestion; and
- Inhalation.

Due to the presence of exposed potentially impacted soil/fill on ground surfaces, dermal exposure is considered a potential exposure pathway.

The potential for ingestion of soil is considered as a potential exposure pathway. Although groundwater is not used at the site, there is the potential, for ingestion of contaminants via groundwater removed from monitoring wells.

There is the potential for vapour to be present in the underlying profile within the site. As such, these gases potentially pose a risk to human health via the inhalation pathway.

The proposed development concerns the construction and development of a multistorey unit development with a triple basement approximately. Because of this dermal and inhalation exposure pathways by potentially contaminated groundwater may occur.

Receptors

Potential receptors of environmental impact present within the site which will be required to be addressed with respect to the suitability of the site for the proposed use include:

- Excavation/construction/maintenance workers conducting activities at the site, who may potentially be exposed to COPCs through direct contact with impacted soils, Vapour Intrusion and/or groundwater present within excavations and/or inhalation of dusts/fibres associated with impacted soils;
- Future occupants/users of the site may potentially be exposed to COPCs through direct contact with impacted soils and/or ingestion of impacted soils and/or inhalation of dusts/fibres associated with impacted soils and/or exposure to vapour; and/or
- Offsite sensitive receptors of groundwater; and/or
- Flora species to be established on vegetated areas of the site.

Preferential Pathways

For the purpose of this assessment, preferential pathways have been identified as natural and/or man-made pathways that result in the preferential migration of COPCs as either liquids or gases.

Man-made preferential pathways are present throughout the site, generally associated with fill materials and services present beneath existing ground surface. Fill materials and service lines are anticipated to have a higher permeability than the underlying natural soil and/or bedrock.

9.0 REVIEW OF DATA QUALITY OBJECTIVES

The DQOs were also prepared using Appendix IV of the Site Auditor Guidelines. These require 7 steps. The steps being

a. State the problem
b. Identify the decisions
c. Identify inputs to decision
d. Define the study boundaries
e. Develop a decision rule
f. Specify limits on decision errors
g. Optimise the design for obtaining data

9.1 State the Problem

The site requires to be confirmed suitable for the proposed development. The site is proposed to be redeveloped and has had some areas of potential concern, those being possible areas of imported fill of unknown origin, historical commercial uses, possible spraying of pesticides, degradation of the building materials and leakages from vehicles on site.

Technically defensible evidence needs to be provided so that the identified Site does not present an unacceptable risk to human health or the environment and is suitable for the intended land use.

9.2 Identify the Decisions

The decisions to be made on the contamination and the new environmental data required includes considering relevant site contamination criteria for each medium (fill, soil and sediment). A proposed use of the 95% UCL on the mean concentrations for all soil chemicals of potential concern must be less than the site criteria identified for the relevant land use suitability.

The decisions made in completing this assessment are as follows:

- Does the site or is the site likely to present a risk of harm to humans or the environment
- Is the site currently suitable for the proposed land use being residential with minimal access
- Is there a potential for soil and groundwater contamination
- Is there a potential for offsite migration issues
- Does the sampling results meet the site criteria proposed
- If not, does the site require remediation works

9.3 Identify Inputs to Decision

This step requires the identification of the environmental variables/characteristics that need measuring, identification of which media (fill, soil etc.) need to be collected, identification of the site criteria for each medium of concern and appropriate analytical testing. Inputs include:

- Existing site information

- Site history
- Regional geology, topography and hydrogeology
- Potential contaminants
- Proposed Land Use
- Site assessment criteria
- Results as measured against criteria

9.4 Define the Study Boundaries

Specific spatial and temporal aspects must be provided to identify the boundaries of the investigation and to identify any restrictions that may hinder the assessment process. The site is located at 39-41 Chertsey Avenue, Bankstown NSW and is currently registered The site is approximately 4000m^2 in area.

Refer to **Figure 1** - Site Locality and **Figure 2** – Site Layout Plan.

9.5 Develop a Decision Rule

The information obtained through this assessment will be used to characterise the soils and the groundwater on the site in terms of contamination issues and risks to human health and the environment. The decision rule in characterising the site will be as follows:

- Laboratory test results will be measured against the criteria provided within this report
- The site will be deemed suitable for the proposed use if the following criteria are fulfilled:

- Soil and groundwater concentrations are within background levels
- QA/QC shows data can be relied upon
- Results generally meet regulatory criteria
- Results are from NATA accredited laboratories
- Detection limits are below assessment criteria
- Results can be shown to be of minimal concern

9.6 Specify Limits on Decision Errors

The limits on decision errors for this assessment are as follows:

- The assessment criteria adopted from the guidelines within this report have risk probabilities already incorporated.
- The acceptable limits for inter/intra laboratory duplicate sample comparisons are laid out within our protocols.
- The acceptable limits for laboratory QA/QC parameters are based upon the laboratory reported acceptable limits and those stated within the NEPM 1999 Guidelines (2013 Amendment)

9.7 Optimise the Design for Obtaining Data

A resource-effective sampling and analysis design was undertaken for data collection that satisfies the DQO's. The sampling and analytical plan is designed to avoid Type 1 and Type 2 errors and includes defining minimum sample numbers required to detect contamination as determined with procedures provided in the NSW EPA 1995 Sampling Design Guidelines and AS 4482.1 - 2005 and appropriate quality control procedures.

Furthermore, only laboratories accredited by NATA for the analysis undertaken were used. The laboratory data was assessed from quality data calculated during this assessment. Field QA/QC protocols adopted and incorporate traceable documentation of procedures used in the sampling and analytical program and in data verification procedures.

10.0 SAMPLING PLAN AND FIELD SAMPLING QA/QC

During the supplementary contamination assessment the integrity of data collected is considered vital. With the assessment of the site, a number of measures were taken to ensure the quality of the data. These are as follows:

10.1 Sample Containers

Soil samples collected during the investigation were placed immediately into laboratory prepared glass jars with Teflon lid inserts. Standard identification labels were adhered to each individual container and labelled according to depth, date, sampling team and media collected.

10.2 Decontamination

All equipment used in the sampling program which includes a hand auger, spades and mixing bowl was decontaminated prior to use and between samples to prevent cross contamination. Decontamination of equipment involved the following procedures:

- Cleaning equipment in potable water to remove gross contamination;
- Cleaning in a solution of Decon 90;
- Rinsing in clean demineralised water then wiping with clean lint free cloths;

Water sampling equipment consisted of single use disposable bailer and Low Flow Peristaltic pump with replaceable Teflon tubing.

Benviron Group also adopted a sampling gradient of lowest to highest potential contamination to minimise the impact of cross contamination. This gradient was determined from the historical review and the on-site inspection that was carried out prior to sampling.

Although Benviron Group maintains consistent sampling procedures, a rinsate sample is obtained to ensure false positive samples are not generated and that decontamination procedures are effective in preventing cross contamination. The Rinsate water is collected after being in contact generally with the trowel used for sampling. Analytical results that target the contaminants of concern are compared to a blank sample, which is taken directly from the rinsate water container supplied by the laboratory.

A rinsate sample was not collected as the samples were taken from each borehole using a push tube sampler which were replaced at each sample location and therefore the chance for cross-contamination was minimal.

10.3 Sample Tracking, Identification and Holding Times

All samples were forwarded to Eurofins MGT and Envirolab under recognised chain of custodies with clear identification outlining the date, location, sampler and sample ID. All samples were recorded by the laboratory as meeting their respective holding times. The sample tracking system is considered adequate for the purposes of sample collection.

10.4 Sample Transport

All samples were packed into an esky with ice from the time of collection. A trip blank and trip spike are collected where appropriate. These were transported under chain of

custody from the site to Eurofins MGT Pty Ltd a NATA registered laboratory located in Lane Cove. During the project, the laboratory reported that all the samples arrived intact and were analysed within holding times for the respective analytes.

Samples were kept below 4°C at all times, soil samples submitted for asbestos analysis are not required to be kept below 4°C.

10.5 Trip Spike

Trip Spike samples were obtained from the laboratory prior to conducting field sampling where volatile substances are suspected. Benviron Group QA/QC procedures for the collection of environmental samples involves the collection of trip blanks, trip spikes and duplicate samples both intra and inter laboratory.

Trip Spike samples were not collected as part of this investigation. Results indicate that no volatile hydrocarbons were present within the samples and therefore losses most likely would not have occurred.

10.6 Trip Blank

A trip blank accompanied the sampling for the sampling process and is not separated from the sample collection and transportation process. The purpose of the trip blank is to identify whether cross-contamination is occurring during the sample collection and transport process.

Trip Blank samples were not collected as part of this investigation. Results indicate that no volatile hydrocarbons were present within the samples and therefore cross contamination most likely would not have occurred.

10.7 Field Duplicate Samples

Field duplicate samples for soil were prepared in the field through the following process:

- A larger than normal quantity of soil is recovered from the sample location selected for duplication.
- The sample is placed in a decontaminated stainless bowl and mixed as thoroughly as practicable before being divided into equal parts.
- Two Portions of the sub-sample are immediately transferred, one for an intra-laboratory duplicate and another as a sample.
- Samples are placed into a labelled, laboratory supplied 250ml glass jar and sealed with an airtight, Teflon screw top lid. The fully filled jars are labelled as the sample and duplicate and immediately placed in a chilled esky.

Intra-Laboratory duplicate samples were not collected as part of this assessment due to damage to the samples during transport.

Intra Laboratory Duplicate

Two intra-laboratory duplicate sample (1 soil and 1 groundwater) was collected and analysed in order to assess the variation in analyte concentration between samples collected from the same sampling point. The duplicate sample frequency was computed using the total number of samples analysed as part of this assessment.

The duplicate sample frequencies computed are presented in the following table.

Table 7: Intra Laboratory Duplicate Frequencies

Analyte – Discrete Soil	Samples Analysed	Duplicate Samples	Frequency
Heavy Metals	12	1	8.3%
TPH/BTEX	12	1	8.3%
PAH	12	1	8.3%
OCP/PCB	6	1	16.6%
Analyte – Discrete Groundwater	**Samples Analysed**	**Duplicate Samples**	**Frequency**
Heavy Metals	3	1	33%
TPH/BTEX	3	1	33%
PAH	3	1	33%

The duplicate frequency for the analytical suite adopted complies with the NEPM, which recommends a duplicate frequency of at least 5%.

It is considered that the number of duplicate samples collected is adequate to assess the variation in analyte concentration between samples collected from the same sampling

point. A summary of the test results with the Relative Percentage Difference (RPD) is presented in the following tables.

Inter Laboratory Duplicate

Two inter-laboratory duplicate sample (1 soil and 1 groundwater) was collected and analysed in order to assess the variation in analyte concentration between laboratories in samples collected from the same sampling point. The duplicate sample frequency was computed using the total number of samples analysed as part of this assessment.

The duplicate sample frequencies computed are presented in the following table.

Table 8: Inter Laboratory Duplicate Frequencies

Analyte – Discrete Soil	Samples Analysed	Duplicate Samples	Frequency
Heavy Metals	12	1	8.3%
TPH/BTEX	12	1	8.3%
PAH	12	1	8.3%
OCP/PCB	6	1	16.6%
Analyte – Discrete Groundwater	**Samples Analysed**	**Duplicate Samples**	**Frequency**
Heavy Metals	3	1	33%
TPH/BTEX	3	1	33%
PAH	3	1	33%

The duplicate frequency for the analytical suite adopted complies with the NEPM, which recommends a duplicate frequency of at least 5%.

It is considered that the number of split samples collected is adequate to assess the variation in analyte concentration between samples collected from the same sampling point. A summary of the test results with the Relative Percentage Difference (RPD) is presented in the following tables.

The comparisons between the duplicates and original samples indicate acceptable RPDs when they comply with criteria which are commonly set at:

- less than 30% for inorganics and 50% for organics
- greater than five (5) times the laboratory limit of recording (LOR)
- greater than 5% of the relevant health investigation level (HIL) concentration.

The tables, below, give details of intra laboratory and inter laboratory duplicates.

Table 9: Intralab Soil Sample D1 RPDs

ANALYTE	GW2 2.5 mg/kg	INTRALAB D1 mg/kg	RELATIVE PERCENTAGE DIFFERENCE %
HEAVY METALS			
Arsenic	2.2	< 2	-
Cadmium	< 0.4	< 0.4	-
Chromium	6.7	5.6	18
Copper	11	10	10
Lead	21	15	33
Mercury	< 0.05	< 0.05	-
Nickel	< 5	< 5	-
Zinc	< 5	< 5	-
TPH			
C6-C9	<25	<25	-
C10-C14	<50	<50	-
C15-C28	<100	<100	-
C29-C36	<100	<100	-
BTEX			
Benzene	<0.2	<0.2	-
Toulene	<0.5	<0.5	-
Ethylbenzene	<2	<2	-
Xylenes - Total	<3	<3	-

Table 10: Intralab Groundwater Sample D1 RPDs

ANALYTE	GW1 ug/l	DUPLICATE D1 ug/l	RELATIVE PERCENTAGE DIFFERENCE %
HEAVY METALS			
Arsenic	<1	<1	-
Cadmium	0.1	0.1	-
Chromium	<1	<1	-
Copper	5	5	0
Lead	<1	<1	-
Mercury	0.1	0.1	0
Nickel	5	5	0
Zinc	6	6.2	3
TPH			
C6-C10 (F1)	<20	<20	-
C10-C16 (F2)	<50	<50	-
C16-C34	<50	<50	-
C34-C40	<100	<100	-
BTEX			
Benzene	<1	<1	-
Toulene	<1	<1	-
Ethylbenzene	<1	<1	-
Xylenes - Total	<3	<3	-
POLYCYCLIC HYDROCARBONS (PAH)			
Benzo(a)pyrene	<1	<1	-
Naphthalene	<1	<1	-

The comparisons between the inter-laboratory duplicates and corresponding original samples for soil indicated generally acceptable RPD overall.

Table 11: Interlab Soil Sample SS1 RPDs

ANALYTE	GW2 2.5 mg/kg	INTERLAB SS1 mg/kg	RELATIVE PERCENTAGE DIFFERENCE %
HEAVY METALS			
Arsenic	2.2	<4	-
Cadmium	< 0.4	<0.4	-
Chromium	6.7	9	29
Copper	11	15	31
Lead	21	22	5
Mercury	< 0.05	<0.1	-
Nickel	< 5	<1	-
Zinc	< 5	3	-
TPH			
C6-C9	<25	<20	-
C10-C14	<50	<20	-
C15-C28	<100	<50	-
C29-C36	<100	<50	-
BTEX			
Benzene	<0.2	<0.1	-
Toulene	<0.5	<0.1	-
Ethylbenzene	<2	<0.1	-
Xylenes - Total	<3	<0.3	-
POLYCYCLIC HYDROCARBONS (PAH)			
Benzo(a)pyrene	-	<0.05	-
Total PAH	-	<1	-
ORGANOCHLORINE PESTICIDES (OCP)			
Total OCP	-	<1	-
POLYCHLORINATED BIPHENYLS (PCB)			
Total PCB	-	<1	-

Table 12: Interlab Groundwater Sample SS1 RPDs

ANALYTE	GW1 ug/l	SPLIT SS1 ug/l	RELATIVE PERCENTAGE DIFFERENCE %
HEAVY METALS			
Arsenic	<1	<1	-
Cadmium	0.1	<0.1	-
Chromium	<1	<1	-
Copper	5	5	0
Lead	<1	<1	-
Mercury	0.1	<0.05	-
Nickel	5	4	22
Zinc	6	66	**167**
TPH			
C6-C10 (F1)	<20	<20	-
C10-C16 (F2)	<50	<50	-
C16-C34	<50	<50	-
C34-C40	<100	<100	-
BTEX			
Benzene	<1	<1	-
Toulene	<1	<1	-
Ethylbenzene	<1	<1	-
Xylenes - Total	<3	<3	-
POLYCYCLIC HYDROCARBONS (PAH)			
Benzo(a)pyrene	<1	<1	-
Naphthalene	<1	1	-

The comparisons between the inter-laboratory duplicates and corresponding original samples for soil indicated generally acceptable RPD overall, with the exception of concentrations of Zinc which exceed the DQOs for this project, however this exceedance is not considered significant because the concentrations are low and most likely due to the heterogeneous soils which were sampled.

Field duplicates provide an indication of the whole investigation process, including the sampling process, sample preparation and analysis. The accuracy of the data is considered to be adequate due to the effect on confidence intervals with low concentrations in the samples and their duplicates.

11.0 LABORATORY QA/QC

The integrity of analytical data provides the second step in the QA/QC process for total data compliance. The data validation techniques adopted by Benviron Group are based upon techniques published by the US EPA and in line with methods and guidelines adopted by the NSW EPA and outlined in the NEPM, 2013.

Descriptions are provided of the specific mechanisms used in the assessment of accuracy, precision and useability of analytical data within the project.

Refer to **Appendix C**- *NATA Accredited Analytical Results*

11.1 Blanks

Blanks were used for the identification of false positive data. Laboratory blank samples were analysed.

No cross contamination of samples is said to have occurred as a result of laboratory techniques provided all blanks show concentrations below the levels of detection. No results on blank samples were above the level of reporting for any determination during the project.

11.2 Spikes and Control Samples

Control sample spikes were utilised for determination of matrix recovery analysis. This involves analysis of spiked control samples and their duplicates, spiked with a known concentration of relative analyte.

Accuracy was assessed by calculation of the percent recovery (%R). The duplicate sample spikes were used to assess the precision of the methods used. The recoveries for all matrix spike analysis were within the acceptance criteria of 60-140%.

11.3 Duplicates

Laboratory Duplicates are tested to ensure the results meet the requirements of QA/QC. The samples from the Site showed a percent recovery for all analytes not exceeding the respective laboratory criteria.

11.4 Surrogates

To assess the performance of individual organic analysis the laboratory used surrogates. Recoveries were calculated for each surrogate providing an indication of analytical accuracy. Surrogate recoveries for soil samples were all within recommended control limits, indicating that there was an acceptable degree of accuracy in analysing for organic compounds.

11.5 Laboratory Detection Limits

Laboratory detection limits for soil and water analyses by Eurofins MGT are outlined in the results table in section 13 below.

12.0 SITE ASSESSMENT CRITERIA

12.1 Health Investigation Levels (HIL)s and Health Screening Levels (HSLs)

To assess the contamination status of soils at a site, the NSW EPA refers to the document entitled National Environmental Protection Council (1999) *National Environmental Protection (Assessment of Site Contamination) Measure* (NEPM) (Amendment 2013).

The site is to be redeveloped for a residential unit/townhouse development, so the site will be assessed against the NEPM exposure scenario 'Residential B' health investigation levels (HIL) of the above mentioned guidelines for *'residential land use with minimal soil access*.

For assessing TRH and BTEX contamination at sites used for sensitive land use, such as residential, the NEPM refers to the Health Screening Levels (HSLs) "*HSL A and HSLB*".

For standard residential sites, the NSW DEC (2006) "*Guidelines for the NSW Site Auditor Scheme*" notes that concentrations at the site should also be assessed against the ecological investigation levels (EIL) if some parts of the site are used for growing plants or grass.

The soil regulatory guidelines are presented in the Table below.

Table 7: Health Investigation Levels (HIL) Criteria for Soil Contaminants

	Residential B	Reference
Heavy Metals		
Arsenic	500	NEPM 2013 - Table 1(A)1 HILs
Beryllium	90	NEPM 2013 - Table 1(A)1 HILs
Boron	40000	NEPM 2013 - Table 1(A)1 HILs
Cadmium	150	NEPM 2013 - Table 1(A)1 HILs
Chromium (VI)	500	NEPM 2013 - Table 1(A)1 HILs
Cobalt	600	NEPM 2013 - Table 1(A)1 HILs
Copper	30000	NEPM 2013 - Table 1(A)1 HILs
Lead	1200	NEPM 2013 - Table 1(A)1 HILs
Manganese	14000	NEPM 2013 - Table 1(A)1 HILs
Mercury (Inorganic)	120	NEPM 2013 - Table 1(A)1 HILs
Methyl Mercury	30	NEPM 2013 - Table 1(A)1 HILs
Nickel	1200	NEPM 2013 - Table 1(A)1 HILs
Selenium	1400	NEPM 2013 - Table 1(A)1 HILs
Zinc	60000	NEPM 2013 - Table 1(A)1 HILs
Cyanide (Free)	300	NEPM 2013 - Table 1(A)1 HILs
Polycyclic Aromatic Hydrocarbons (PAHs)		
Carcinogenic PAHs (as Bap TEQ)	4	NEPM 2013 - Table 1(A)1 HILs
Total PAHs	400	NEPM 2013 - Table 1(A)1 HILs
Organochlorine Pesticides		
DDT + DDE + DDD	600	NEPM 2013 - Table 1(A)1 HILs
Aldrin + Dieldrin	10	NEPM 2013 - Table 1(A)1 HILs
Chlordane	90	NEPM 2013 - Table 1(A)1 HILs
Endosulfan	400	NEPM 2013 - Table 1(A)1 HILs
Heptachlor	10	NEPM 2013 - Table 1(A)1 HILs
HCB	15	NEPM 2013 - Table 1(A)1 HILs
Phenols		
Phenols	45000	NEPM 2013 - Table 1(A)1 HILs
Pentachlorophenol	130	NEPM 2013 - Table 1(A)1 HILs
Cresols	4700	NEPM 2013 - Table 1(A)1 HILs
Polychlorinated Biphenyls (PCBs)		
PCBs	1200	NEPM 2013 - Table 1(A)1 HILs
Other Pesticides		
Atrazine	470	NEPM 2013 - Table 1(A)1 HILs
Chlorpyrifos	340	NEPM 2013 - Table 1(A)1 HILs
Bifenthrin	840	NEPM 2013 - Table 1(A)1 HILs
Herbicides		
2,4,5-T	900	NEPM 2013 - Table 1(A)1 HILs
2,4-D	1600	NEPM 2013 - Table 1(A)1 HILs
MCPA	900	NEPM 2013 - Table 1(A)1 HILs
MCPB	900	NEPM 2013 - Table 1(A)1 HILs
Mecoprop	900	NEPM 2013 - Table 1(A)1 HILs
Picloram	6600	NEPM 2013 - Table 1(A)1 HILs
Other Organics		
PDBE (Br1-Br9)	2	NEPM 2013 - Table 1(A)1 HILs

Note - All values are in mg/kg

For selection of the health screening criteria an assessment of the in-situ soil profile should be undertaken. The soil criteria indicates that the upper soil profile is more consistent with clay.

Table 8: Health Screening Levels (HSL) Criteria

	HSL A & HSL B	HSL A & HSL B	HSL A & HSL B	HSL A & HSL B	Soil Saturation Concentration (Csat)	Reference
	0m to <1m	1m to <2m	2m to <4m	4m+		
CLAY						
Toluene	480	NL	NL	NL	630	NEPM 2013 - Table 1(A) 3 HSLs
Ethylbenzene	NL	NL	NL	NL	68	NEPM 2013 - Table 1(A) 3 HSLs
Xylenes	110	310	NL	NL	330	NEPM 2013 - Table 1(A) 3 HSLs
Naphthalene	5	NL	NL	NL	10	NEPM 2013 - Table 1(A) 3 HSLs
Benzene	0.7	1	2	3	430	NEPM 2013 - Table 1(A) 3 HSLs
F1	50	90	150	290	850	NEPM 2013 - Table 1(A) 3 HSLs
F2	280	NL	NL	NL	560	NEPM 2013 - Table 1(A) 3 HSLs

Note - All values are in mg/kg

The EPA guidelines indicate that the assessment of soil test results and comparison with defined soil criteria should include consideration of a number of factors such as:

1. Land uses, e.g. residential, agricultural/horticultural, recreation or commercial/industrial.
2. Potential child occupancy.
3. Potential environmental effects including leaching into groundwater.
4. Single or multiple contaminants.
5. Depth of contamination.
6. Level and distribution of contamination.
7. Bioavailability of contaminant(s), e.g. Related to speciation, route of exposure.

8. Toxicological assessment of the contaminant(s), e.g. Toxicokinetics, carcinogenicity, acute and chronic toxicity.
9. Physico-chemical properties of the contaminant(s).
10. State of the site surface, e.g. paved or grassed exposed.
11. Potential exposure pathways.
12. Uncertainties with the sampling methodology and toxicological assessment.

12.2 Ecological Investigation Levels (EIL)s and Ecological Screening Levels (ESLs)

Ecological Investigation Levels (EILs) -

The NEPM 2013 states that "Ecological investigation levels (EILs) for the protection of terrestrial ecosystems have been derived for common contaminants in soil based on a species sensitivity distribution (SSD) model developed for Australian conditions. EILs have been derived for As, Cu, CrIII, DDT, naphthalene, Ni, Pb and Zn

Insufficient data was available to derive ACLs for arsenic (As), DDT, lead (Pb) and naphthalene. As a result, the derived EILs are generic to all soils and are presented as total soil contaminant concentrations in Tables 1B(4) and 1B(5) within the NEPM 2013.

For the purposes of EIL derivation, a contaminant incorporated in soil for at least two years is considered to be aged for the purpose of EIL derivation. The majority of contaminated sites are likely to be affected by aged contamination. Fresh contamination is usually associated with current industrial activity and chemical spills".

The following process describes the method for calculation of site specific EILs.

A. EILs for Ni, Cr III, Cu, Zn and Pb aged contamination (>2 years)

Steps 1–4 below describe the process for deriving site-specific EILs for the above elements using Tables 1B(1) – 1B(4), which can be found at the end of the NEPM 2013.

1. Measure or analyse the soil properties relevant to the potential contaminant of concern (pH, CEC, organic carbon, clay content). Sufficient samples need to be taken for these determinations to obtain representative values for each soil type in which the contaminant occurs.

2. Establish the sample ACL for the appropriate land use and with consideration of the soil-specific pH, clay content or CEC. The ACL for Cu may be determined by pH or CEC and the lower of the determined values should be selected for EIL calculation. Note that the ACL for Pb is taken directly from Table 1(B)4.

3. Calculate the contaminant ABC in soil for the particular contaminant and location from a suitable reference site measurement or other appropriate method.

4. Calculate the EIL by summing the ACL and ABC:

$$EIL = ABC + ACL$$

B. EILs for As, DDT and naphthalene

EILs for aged contamination for DDT and naphthalene are not available and the adopted EIL is based on fresh contamination taken directly from Table 1B(5). The EILs for As, DDT and naphthalene are generic i.e. they are not dependent on soil type and are taken

directly from Table 1B(5). Only EILs for fresh contamination are available for As, DDT and naphthalene due to the absence of suitable data for aged contaminants.

Ecological Screening Levels (ESLs) -

Ecological screening levels (ESLs) are presented based on a review of Canadian guidance for petroleum hydrocarbons in soil and application of the Australian methodology (Schedule B5b) to derive Tier 1 ESLs for BTEX, benzo(a)pyrene and F1 and F2 (Warne 2010a, 2010b)

The Canadian Council of the Ministers of the Environment (CCME) has adopted risk-based TPH standards for human health and ecological aspects for various land uses in the *Canada-wide standard for petroleum hydrocarbons (PHC) in soil* (CCME 2008) (CWS PHC). The standards established soil values including ecologically based criteria for sites affected by TPH contamination for coarse- and fine-grained soil types

Table 9: Ecological Investigation Levels (EIL) and Ecological Screening Levels (ESL) Criteria

Contaminant	Age/Soil Texture	National parks and areas of high conservation value	Urban residential and open public spaces	Commercial and industrial	Reference
Ecological Investigation Levels (EILs)					
Heavy Metals					
Arsenic	**Fresh**	20	50	80	NEPM 2013 - Table 1(B) 1-5 EILs
	Aged	40	100	160	NEPM 2013 - Table 1(B) 1-5 EILs
Chromium (III)	**Fresh**	Site Specific Calculation Required			NEPM 2013 - Table 1(B) 1-5 EILs
	Aged				NEPM 2013 - Table 1(B) 1-5 EILs
Copper	**Fresh**	Site Specific Calculation Required			NEPM 2013 - Table 1(B) 1-5 EILs
	Aged				NEPM 2013 - Table 1(B) 1-5 EILs
Lead	**Fresh**	110	270	440	NEPM 2013 - Table 1(B) 1-5 EILs
	Aged	470	1100	1800	NEPM 2013 - Table 1(B) 1-5 EILs
Nickel	**Fresh**	Site Specific Calculation Required			NEPM 2013 - Table 1(B) 1-5 EILs
	Aged				NEPM 2013 - Table 1(B) 1-5 EILs
Zinc	**Fresh**	Site Specific Calculation Required			NEPM 2013 - Table 1(B) 1-5 EILs
	Aged				NEPM 2013 - Table 1(B) 1-5 EILs
Polycyclic Aromatic Hydrocarbons (PAHs)					
Naphthalene	**Fresh**	10	170	370	NEPM 2013 - Table 1(B) 1-5 EILs
	Aged	10	170	370	NEPM 2013 - Table 1(B) 1-5 EILs
Organochlorine Pesticides					
DDT	**Fresh**	3	180	640	NEPM 2013 - Table 1(B) 1-5 EILs
	Aged	3	180	640	NEPM 2013 - Table 1(B) 1-5 EILs
Ecological Screening Levels (ESLs) and Management Limits					
F1 (C_6-C_{10})	**Coarse**				NEPM 2013 - Table 1(B) 6-7 EILs
	Fine	125*	180*	215*	NEPM 2013 - Table 1(B) 6-7 EILs
F1 (C_6-C_{10})	**Coarse**		700	700	NEPM 2013 - Table 1(B) 6-7 EILs
(Management Limits)	**Fine**	-	800	800	NEPM 2013 - Table 1(B) 6-7 EILs
F2 (>C_{10}-C_{16})	**Coarse**				NEPM 2013 - Table 1(B) 6-7 EILs
	Fine	25*	120*	170*	NEPM 2013 - Table 1(B) 6-7 EILs
F2 (>C_{10}-C_{16})	**Coarse**		1000	1000	NEPM 2013 - Table 1(B) 6-7 EILs
(Management Limits)	**Fine**	-	1000	1000	NEPM 2013 - Table 1(B) 6-7 EILs
F3 (>C_{16}-C_{34})	**Coarse**	-	300	1700	NEPM 2013 - Table 1(B) 6-7 EILs
	Fine	-	1300	2500	NEPM 2013 - Table 1(B) 6-7 EILs
F3 (>C_{16}-C_{34})	**Coarse**		2500	3500	NEPM 2013 - Table 1(B) 6-7 EILs
(Management Limits)	**Fine**	-	3500	5000	NEPM 2013 - Table 1(B) 6-7 EILs
F4 (>C_{34}-C_{40})	**Coarse**	-	2800	3300	NEPM 2013 - Table 1(B) 6-7 EILs
	Fine	-	5600	6600	NEPM 2013 - Table 1(B) 6-7 EILs
F4 (>C_{34}-C_{40})	**Coarse**		10000	10000	NEPM 2013 - Table 1(B) 6-7 EILs
(Management Limits)	**Fine**	-	10000	10000	NEPM 2013 - Table 1(B) 6-7 EILs
Benzene	**Coarse**	10	50	75	NEPM 2013 - Table 1(B) 6-7 EILs
	Fine	10	65	95	NEPM 2013 - Table 1(B) 6-7 EILs
Toluene	**Coarse**	10	85	135	NEPM 2013 - Table 1(B) 6-7 EILs
	Fine	65	105	135	NEPM 2013 - Table 1(B) 6-7 EILs
Ethylbenzene	**Coarse**	1.5	70	165	NEPM 2013 - Table 1(B) 6-7 EILs
	Fine	40	125	185	NEPM 2013 - Table 1(B) 6-7 EILs
Xylenes	**Coarse**	10	105	180	NEPM 2013 - Table 1(B) 6-7 EILs
	Fine	1.6	45	95	NEPM 2013 - Table 1(B) 6-7 EILs
Benzo(a)pyrene	**Coarse**	0.7	0.7	0.7	NEPM 2013 - Table 1(B) 6-7 EILs
	Fine	0.7	0.7	0.7	NEPM 2013 - Table 1(B) 6-7 EILs

Notes

1 Urban residential/public open space is broadly equivalent to the HIL-A, HIL-B and HIL-C land use scenarios in Table 1A(1) Footnote 1 and as described in Schedule B7.

2 Aged values are applicable to arsenic contamination present in soil for at least two years. For fresh contamination refer to Schedule B5c.

3 Insufficient data was available to calculate aged values for DDT and naphthalene, consequently the values for fresh contamination should be used.

4 Insufficient data was available to calculate ACLs for As, DDT and naphthalene. The EIL should be taken directly from Table 1B(5).

5 ESLs are of low reliability except where indicated by * which indicates that the ESL is of moderate reliability.

6 '-' indicates that insufficient data was available to derive a value.

7 To obtain F1, subtract the sum of BTEX concentrations from C6-C10 fraction and subtract naphthalene from >C10-C16 to obtain F2.

8 Management limits are applied after consideration of relevant ESLs and HSLs

9 Separate management limits for BTEX and naphthalene are not available hence these should not be subtracted from the relevant fractions to obtain F1 and F2.

Based on the proposed development the bulk of site soils >2m in depth are likely to be excavated and removed offsite. It is therefore unlikely that ecological receptors will be impacted and therefore no calculation of EILs or ESLs is required. It is also noted that future plans may change and that some soils may remain. If this is the case then further investigation for EIL and ESLs should be undertaken once design is completed.

12.3 Groundwater

The NSW DECC has endorsed the use of the Groundwater Investigation Levels (GILs) given in the 1999 NEPM '*Schedule B(1) Guideline on the Investigation Levels for Soil and Groundwater*' (Amendment 2013) and the water quality trigger levels given in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, 2000). These Guidelines provide criteria for:

- Aquatic ecosystems – both marine and fresh waters

The NEPM advises that '*when assessing groundwater contamination, the GILs are to be applied at the point of extraction and as response levels at the point of use, or where there is a likelihood of an adverse environmental effect at the point of discharge*'.

For assessing groundwater quality, it is first necessary to assess the potential uses of groundwater downgradient of the site being assessed.

Potential uses of groundwater downgradient of the site include:

- Discharge to water bodies sustaining aquatic ecosystems particularly Powells Creek.

The threshold concentrations presented in the ANZECC (2000) Fresh and Marine Waters Quality Guidelines are considered applicable for the protection of aquatic ecosystems of the receiving waters. As these guidelines apply to receiving waters, it is generally conservative to apply these to groundwater discharging to receiving waters. It is important to note that these are not threshold values at which an environmental problem is likely to occur if exceeded, rather, if the trigger values are exceeded, then further action is required which may include either further site-specific investigations to assess whether or not there is an actual problem or management / remedial action should be undertaken.

It is considered that fresh water trigger values are applicable for investigating chemical concentrations in groundwater at the site, as the receiving body, Powells Creek is a Estuarine water body .It is understood that the NSW EPA policy is that the trigger values for the protection of 95% of aquatic ecosystems should be used as groundwater assessment criteria when considering moderately or highly disturbed receiving environments. The receiving waters for groundwater at the site are considered to be moderately disturbed ecosystems and the ANZECC (2000) 95% protection values are therefore considered appropriate groundwater assessment criteria for the site.

13.0 SITE ASSESSMENT

Samples were recovered from five (5) locations across the site and were labelled GW1-GW3 & BH4-BH5. These locations were selected to detect any contamination that may have originated from past and present activities, and due to potential excavation and future development in these areas.

Table 10: Sampling Information - Soil

Analyte / Analyte Group / Sample	Depth (m)	SAMPLING DATE	DUPLICATE & SPLIT	HEAVY METALS	TRH	BTEX	PAH	OCP	PCB
BH1	0.5	29/03/2016		✔	✔	✔	✔	✔	✔
BH1	1	29/03/2016		✔	✔	✔	✔		
BH2	0.1	29/03/2016		✔	✔	✔	✔	✔	✔
BH2	0.4	29/03/2016		✔	✔	✔	✔		
BH3	0.2	29/03/2016		✔	✔	✔	✔	✔	✔
BH3	0.5	29/03/2016		✔	✔	✔	✔		
BH4	0.2	29/03/2016		✔	✔	✔	✔	✔	✔
BH4	0.5	29/03/2016		✔	✔	✔	✔		
BH5	0.5	29/03/2016	D1 & SS1	✔	✔	✔	✔	✔	✔
BH5	0.8	29/03/2016		✔	✔	✔	✔		
BH6	0.3	29/03/2016		✔	✔	✔	✔	✔	✔
BH6	0.9	29/03/2016		✔	✔	✔	✔		

The locations of the boreholes and samples are shown in **Figure 2** –Site Plans and details of the boreholes are presented in **Appendix E** – Borehole Logs.

Based on information from all boreholes, the surface and sub-surface profile across the site is generalised as follows:

- Fill Silty Sand, medium to fine grained, brown with some inert building materials
- Natural, Silty Clay, high plasticity, red/brown, moist.

14.0 RESULTS

14.1 Soils

The original laboratory test results certificates are presented in **Appendix C** – NATA Laboratory Test Results. A summary of the test results together with the assessment criteria adopted are discussed below.

Table 11: Heavy Metals Results

			Heavy Metals (mg/kg)							
			ARSENIC[2]	CADMIUM	CHROMIUM (VI)	COPPER	LEAD[3]	MERCURY (Inorganic)[5]	NICKEL	ZINC
Health Investigation Levels (HIL)										
Residential B[1]			500	150	500	30000	1200	120	1200	60000
Limit of Resolution (LOR)			2	0.4	5	5	5	0.05	5	5
Sample ID	**Date Sampled**	**Depth**								
GW1	12/01/2016	0.2	6.3	<0.4	18	18	590	<0.05	<5	37
GW1	12/01/2016	2.2	<2	<0.4	5.4	5.7	26	<0.05	<5	<5
GW2	12/01/2016	0.5	6.1	<0.4	6.7	7.4	65	<0.05	<5	100
GW2	12/01/2016	2.5	2.2	<0.4	6.7	11	21	<0.05	<5	<5
GW3	12/01/2016	0.4	4	<0.4	13	17	18	<0.05	6.7	53
GW3	12/01/2016	3.5	7	<0.4	6.9	7.2	10	<0.05	<5	<5
BH4	12/01/2016	0.2	7.3	<0.4	26	30	16	<0.05	5.1	27
BH4	12/01/2016	1.2	7.5	<0.4	14	<5	15	<0.05	<5	<5
BH5	12/01/2016	0.3	2.3	<0.4	7.1	79	14	<0.05	7.8	40
BH5	12/01/2016	1.8	2.4	<0.4	6.5	6.1	13	<0.05	<5	<5

Notes

1 **HIL A** - Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools

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

HIL C - Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. This does not include undeveloped public open space where the potential for exposure is lower and where a site-specific assessment may be more appropriate

HIL D - Commercial/industrial, includes premises such as shops, offices, factories and industrial sites

2 Arsenic: HIL assumes 70% oral bioavailability. Site specific bioavailability may be important and should be considered where appropriate (refer Schedule 7b)

3 Lead: HIL is based on blood lead models (IEUBK for HILs A, B and C and adult lead model for HIL D where 50% oral bioavailability has been considered. Site-specific bioavailability may be important and should be considered where appropriate.

4 Methyl mercury: assessment of methyl mercury should only occur where there is evidence of its potential source. It may be associated with inorganic mercury and anaerobic microorganism activity in aquatic environments. In addition the reliability and quality of sampling/analysis should be considered

5 Elemental mercury: HIL does not address elemental mercury. A site-specific assessment should be considered if elemental mercury is present, or suspected to be present,

* Concentrations in **YELLOW** exceed the "Residential B" Criteria

* NA = Not Applicable

* " - " Not Tested

Five (5) samples were analysed for the Priority Heavy Metals and no samples were found to exceed the relevant guidelines.

Table 12: BTEX and TRH Results

			Soil HSLs for Vapour Intrusion (mg/kg)							Management Limits (Urban and Recreational)			
			TOLUENE	ETHYLBENZENE	XYLENES	NAPHTHALENE	BENZENE	F1[9]	F2[10]	F1	F2	F3	F4
Health Screening Levels (HSL)			**SOIL PROFILE - CLAY (FINE SOILS)**										
HSL A & HSL B - 0m to <1m			480	NL	110	5	0.7	50	280				
HSL A & HSL B - 1m to <2m			NL	NL	310	NL	1	90	NL				
HSL A & HSL B - 2m to <4m			NL	NL	NL	NL	2	150	NL				
HSL A & HSL B - 4m+			NL	NL	NL	NL	3	290	NL	800	1000	3500	10000
Soil Saturation Concentration (Csat)			630	68	330	10	430	850	560				
Limit of Resolution (LOR)			0.5	1	3	0.5	0.2	25	50				
Sample ID	**Date Sampled**	**Depth**											
GW1	12/01/2016	0.2	<0.5	<1	<3	<0.5	<0.2	<20	<50	<20	<50	<100	<100
GW1	12/01/2016	2.2	<0.5	<1	<3	<0.5	<0.2	<20	<50	<20	<50	<100	<100
GW2	12/01/2016	0.5	<0.5	<1	<3	<0.5	<0.2	<20	<50	<20	<50	<100	<100
GW2	12/01/2016	2.5	<0.5	<1	<3	<0.5	<0.2	<20	<50	<20	<50	<100	<100
GW3	12/01/2016	0.4	<0.5	<1	<3	<0.5	<0.2	<20	<50	<20	<50	<100	<100
GW3	12/01/2016	3.5	<0.5	<1	<3	<0.5	<0.2	<20	<50	<20	<50	<100	<100
BH4	12/01/2016	0.2	<0.5	<1	<3	<0.5	<0.2	<20	<50	<20	<50	<100	<100
BH4	12/01/2016	1.2	<0.5	<1	<3	<0.5	<0.2	<20	<50	<20	<50	<100	<100
BH5	12/01/2016	0.3	<0.5	<1	<3	<0.5	<0.2	<20	71	<20	71	4600	1100
BH5	12/01/2016	1.8	<0.5	<1	<3	<0.5	<0.2	<20	<50	<20	<50	<100	<100

Notes

1 Land use settings are equivalent to those described in Table 1A(1) Footnote 1 and Schedule B7. HSLs for vapour intrusion for high density residential assume residential occupation of the ground floor. If communal car parks or commercial properties occupy the ground floor, HSL D should be used,

2 The key limitations of the HSLs should be referred to prior to application and are presented in Friebel and Nadebaum (2011b and 2011d).

3 Detailed assumptions in the derivation of the HSLs and information on how to apply the HSLs are presented in Friebel and Nadebaum (2011a and 2011b).

4 Soil HSLs for vapour inhalation incorporate an adjustment factor of 10 applied to the vapour phase partitioning to reflect the differences observed between theoretical estimates of soil vapour partitioning and field measurements. Refer Friebel & Nadebaum (2011a) for further information.

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

6 The HSLs for TPH C6-C10 in sandy soil are based on a finite source that depletes in less than seven years, and therefore consideration has been given to use of sub-chronic toxicity values. The >C8-C10 aliphatic toxicity has been adjusted to represent sub-chronic exposure, resulting in higher HSLs than if based on chronic toxicity. For further information refer to Section 8.2 and Appendix J in Friebel and Nadebaum (2011a).

7 The figures in the above table may be multiplied by a factor to account for biodegradation of vapour. A factor of 10 may apply for source depths from 2 m to <4 m or a factor of 100 for source depths of 4 m and deeper. To apply the attenuation factor for vapour degradation, a number of conditions must be satisfied. Firstly the maximum length of the shorter side of the concrete slab and surrounding pavement cannot exceed 15 m, as this would prevent oxygen penetrating to the centre of the slab. Secondly, measurement of oxygen in the subsurface is required to determine the potential for biodegradation. Oxygen must be confirmed to be present at >5% to use these factors.

8 For soil texture classification undertaken in accord with AS 1726, the classifications of sand, silt and clay may be applied as coarse, fine with liquid limit <50% and fine with liquid limit>50% respectively, as the underlying properties to develop the HSLs may reasonably be selected to be similar. Where there is uncertainty, either a conservative approach may be adopted or laboratory analysis should be carried out

9 To obtain F1 subtract the sum of BTEX concentrations from the C6-C10 fraction

10 To obtain F2 subtract naphthalene from the >C10-C16 fraction

* Concentrations in **GREEN** exceed the "HSL A & HSL B" Criteria

* NA = Not Applicable

* "-" Not Tested

Five (5) samples were analysed for Monocyclic Aromatic Hydrocarbons (BTEX fractions), associated with petrol contamination and Total Recoverable Hydrocarbons (TRH). There were no concentrations of BTEX fractions or TRH recorded above the relevant assessment criteria.

Table 13: PAH, OCP & PCB Results

			PAH (mg/kg)		OCP (mg/kg)									PCB (mg/kg)
			CARINOGENIC PAHs (as Bap TEQ)[6]	TOTAL PAHs[7]	DDT + DDE + DDD	ALDRIN + DIELDRIN	CHLORDANE	ENDOSULFAN	HEPTACHLOR	HCB	METHOXYCHLOR	MIREX	TOXAPHENE	PCBs[8]
Health Investigation Levels (HIL)														
Residential B[1]			4	400	600	10	90	400	10	15	500	20	30	1200
Limit of Resolution (LOR)			-	NA	0.05	0.05	0.1	0.05	0.05	0.05	0.2	-	1	0.5
Sample ID	**Date Sampled**	**Depth**												
GW1	12/01/2016	0.2	1.7	11	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.5
GW1	12/01/2016	2.2		-	-	-	-	-	-	-	-	-	-	-
GW2	12/01/2016	0.5	0.6	2.6	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.5
GW2	12/01/2016	2.5		-	-	-	-	-	-	-	-	-	-	-
GW3	12/01/2016	0.4	0.6	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.5
GW3	12/01/2016	3.5		-	-	-	-	-	-	-	-	-	-	-
BH4	12/01/2016	0.2	0.6	0.9	<0.05	0.13	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.5
BH4	12/01/2016	1.2		-	-	-	-	-	-	-	-	-	-	-
BH5	12/01/2016	0.3	**140**	**990**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.5
BH5	12/01/2016	1.8		-	-	-	-	-	-	-	-	-	-	-

Notes

1 **HIL A** - Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools

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

HIL C - Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. This does not include undeveloped public open space where the potential for exposure is lower and where a site-specific assessment may be more

HIL D - Commercial/industrial, includes premises such as shops, offices, factories and industrial sites

6 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, and summing these products (Refer to comment 6 in Table 1A(1) in schedule B1 p49).

7 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.

8 PCBs: HIL relates to non-dioxin-like PCBs only. Where a PCB source is known, or suspected, to be present at a site, a site-specific assessment of exposure to all PCBs (including dioxin-like PCBs) should be undertaken

* Concentrations in **YELLOW** exceed the "Residential B" Criteria

* NA = Not Applicable

* " - " Not Tested

Five (5) samples were analysed for PAH. There were no concentrations of PAH, above the relevant assessment criteria.

14.2 Groundwater

The original laboratory test results certificates are presented in **Appendix C** – NATA Laboratory Test Results. A summary of the test results together with the assessment criteria adopted are discussed below.

Table 14: Heavy Metals Results (Groundwater)

			HEAVY METALS (µg/L)							
			ARSENIC (As) - Total	CADMIUM (Cd)	CHROMIUM (Cr) - Total	COPPER (Cu)	LEAD (Pb)	MERCURY (Hg) - Total	NICKEL (Ni)	ZINC (Zn)
ANZ [a] Guidelines for Fresh and Marine Water Quality (2000)										
Aquatic Ecosystems (Trigger Values)										
Fresh Water			24[b] 13[c]	0.2	3.3[d, h] 1[e]	1.4	3.4	0.6[f] 0.4[g, h]	11	8
Marine Water			2.3[b, h] 4.5[c, h]	5.5	27.4[d] 4.4[e]	1.3	4.4	ID ID	70	15
Water for recreational purposes										
Trigger Values			**50**	**5**	**50**	**1000**	**50**	**1**	**100**	**5000**
Limit of Resolution			1	0.1	1	1	1	0.05	1	1
Sample ID	**Date Sampled**	**Depth**								
GW1	16/02/2016	-	<1	0.1	<1	5	<1	0.1	5	6
GW2	16/02/2016	-	<1	0.1	<1	3	<1	<0.1	1	5.3
GW3	16/02/2016	-	<1	<0.1	<1	4	<1	<0.1	8	8

Notes
a: ANZ = Australia and New Zealands
b: as As (III)
c: as As (V)
d: as Cr (III)
e: as Cr (VI)
f: as Hg (Inorganic)
g: as Hg (methyl)
h: Interim w orking values in the absence of reliable trigger values (Section 8.3.7)
ID: Insufficient Data to derive a reliable trigger value

Results highlighted green indicate exceedance above fresh w ater trigger values.

Three (3) samples were analysed for the Priority Heavy Metals and no samples were found to exceed the relevant guidelines with the exception of Copper In GW1-GW3.

Table 15: BTEX and TRH Results (Groundwater)

			Groundwater HSLs for Vapour Intrusion (ug/L)						
			TOLUENE	ETHYL BENZENE	XYLENES	NAPHTHALENE	BENZENE	F1[9]	F2[10]
Health Screening Levels (HSL)			**SOIL PROFILE - CLAY**						
HSL A & HSL B - 2m to <4m			NL	NL	NL	NL	5	NL	NL
HSL A & HSL B - 4m to <8m			NL	NL	NL	NL	5	NL	NL
Solubility Limit			61	3.9	21	0.17	59	9	3
Limit of Resolution (LOR)			1	1	3	1	1	25	50
Sample ID	**Date Sampled**	**Depth**							
GW1	16/02/2016	-	<1	<1	<3	<1	<1	<20	<50
GW2	16/02/2016	-	<1	<1	<3	<1	<1	<20	<50
GW3	16/02/2016	-	<1	<1	<3	<1	<1	<20	<50

Notes

1 Land use settings are equivalent to those described in Table 1A(1) Footnote 1 and Schedule B7. HSLs for vapour intrusion for high density residential assume residential occupation of the ground floor. If communal car parks or commercial properties occupy the ground floor, HSL D should be used,

2 The key limitations of the HSLs should be referred to prior to application and are presented in Friebel and Nadebaum (2011b

3 Detailed assumptions in the derivation of the HSLs and information on how to apply the HSLs are presented in Friebel and Nadebaum (2011a and 2011b).

4 Soil HSLs for vapour inhalation incorporate an adjustment factor of 10 applied to the vapour phase partitioning to reflect the differences observed between theoretical estimates of soil vapour partitioning and field measurements. Refer Friebel & Nadebaum (2011a) for further information.

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

6 The HSLs for TPH C6-C10 in sandy soil are based on a finite source that depletes in less than seven years, and therefore consideration has been given to use of sub-chronic toxicity values. The >C8-C10 aliphatic toxicity has been adjusted to represent sub-chronic exposure, resulting in higher HSLs than if based on chronic toxicity. For further information refer to Section 8.2 and Appendix J in Friebel and Nadebaum (2011a).

7 The figures in the above table may be multiplied by a factor to account for biodegradation of vapour. A factor of 10 may apply for source depths from 2 m to <4 m or a factor of 100 for source depths of 4 m and deeper. To apply the attenuation factor for vapour degradation, a number of conditions must be satisfied. Firstly the maximum length of the shorter side of the concrete slab and surrounding pavement cannot exceed 15 m, as this would prevent oxygen penetrating to the centre of the slab. Secondly, measurement of oxygen in the subsurface is required to determine the potential for biodegradation. Oxygen must

8 For soil texture classification undertaken in accord with AS 1726, the classifications of sand, silt and clay may be applied as coarse, fine with liquid limit <50% and fine with liquid limit>50% respectively, as the underlying properties to develop the HSLs may reasonably be selected to be similar. Where there is uncertainty, either a conservative approach may be adopted or laboratory analysis should be carried out

9 To obtain F1 subtract the sum of BTEX concentrations from the C6-C10 fraction

10 To obtain F2 subtract naphthalene from the >C10-C16 fraction

* Concentrations in **GREEN** exceed the "HSL A & HSL B" Criteria

* NA = Not Applicable

* " - " Not Tested

Three (3) samples were analysed for Monocyclic Aromatic Hydrocarbons (BTEX fractions), associated with petrol contamination and Total Recoverable Hydrocarbons (TRH). There were no concentrations of BTEX fractions or TRH recorded above the relevant assessment criteria, however significant detections were observed in the underlying groundwater.

Table 16: PAH Results (Groundwater)

			PAH (ug/L)		OCP (ug/L)				PCB (ug/L)	
			NAPHTHALENE	BENZO(a)PYRENE	ENDRIN	ENDOSULFAN	HEPTACHLOR	DDT	AROCHOR 1242	AROCHLOR 1254
Health Investigation Levels (HIL)										
Fresh Water			16	-	0.01	0.03	0.01	0.06	0.3	0.01
Marine Water			50	-	0.004	0.005	-	-	-	-
Limit of Resolution (LOR)			1	1	0.2	0.2	0.2	0.2	2	2
Sample ID	**Date Sampled**	**Depth**								
GW1	16/02/2016	-	<1	<1	-	-	-	-	-	-
GW2	16/02/2016	-	<1	<1	-	-	-	-	-	-
GW3	16/02/2016	-	<1	<1	-	-	-	-	-	-

Notes 1 PCBs: HIL relates to non-dioxin-like PCBs only. Where a PCB source is known, or suspected, to be present at a site, a site-specific assessment of exposure to all PCBs (including dioxin-like PCBs) should be undertaken

* Concentrations in **BLUE** exceed the "Fresh Water" Criteria

* Concentrations in **GREEN** exceed the "Marine Water" Criteria

* NA = Not Applicable

* " - " Not Tested

Three (3) samples were analysed for PAH. There were no concentrations of PAH recorded above the relevant assessment criteria.

Refer to **Appendix C** – NATA Accredited Laboratory Results

15.0 DISCUSSION

A number of potential areas of environmental concerns were identified at the site, particularly:

- Historical uses;
- Carpark areas / driveways where leaks and spills from cars may have occurred;
- Vicinity of degrading building features

Laboratory Results for the soil samples were below detection limits or the relevant guideline criteria.

Laboratory Results for the groundwater samples were below detection limits and the relevant guideline criteria with the exception of Copper in GW1-GW3. This is not seen as cause for concern because concentrations are consistent in upgradient and downgradient wells and is most likely attributed to background concentrations.

Sources of this material are most likely associated with the fill materials which may have been present within this site.

Off-site impacts of contaminants in soil are generally governed by the transport media available and likely receptor(s). The most common transport medium is water, whilst receptors include uncontaminated soils, groundwater, surface water bodies, humans, flora & fauna.

Surface water run-off from within the site would generally be deposited in the stormwater drainage pits and the potential for migration of contamination is low and

any infiltration of contaminants is also expected to be low-moderate based on the underlying geology. The potential for significant impact of site soils, if contaminated, on the water bodies collecting surface water run-off from the region is considered low.

16.0 CONCLUSION AND RECOMENDATION

Based on the results of this investigation it is considered that the risks to human health and the environment associated with soil contamination at the site are low in the context of the proposed use of the site. The site therefore ***is suitable*** for the proposed development, subject to the following recommendations:

- Any soils proposed for removal from the site should initially be classified in accordance with the "*Waste Classification Guidelines, Part 1: Classifying Waste"* NSW DECC (2014).

If during any potential site works, significant odours and / or evidence of gross contamination (including asbestos) not previously detected are encountered, or any other significant unexpected occurrence, site works should cease in that area, at least temporarily, and the environmental consultant should be notified immediately to set up a response to this unexpected occurrence.

Thank you for the opportunity of undertaking this work. We would be pleased to provide further information on any aspects of this report.

17.0 LIMITATIONS

To the best of our knowledge information contained in this report is accurate at the date of issue, however, subsurface conditions, including groundwater levels and contaminant concentrations, can change in a limited time. This should be borne in mind if the report is used after a protracted delay.

There is always some disparity in subsurface conditions across a site that cannot be fully defined by investigation. Hence it is unlikely that measurements and values obtained from sampling and testing during environmental works carried out at a site will characterise the extremes of conditions that exist within the site.

There is no investigation that is thorough enough to preclude the presence of material that presently or in the future, may be considered hazardous at the site. Since regulatory criteria are constantly changing, concentrations of contaminants presently considered low may, in the future, fall under different regulatory standards that require remediation.

Opinions expressed herein are judgements and are based on our understanding and interpretation of current regulatory standards and should not be construed as legal opinions.

REFERENCES

- Australian and New Zealand Environment and Conservation Council (ANZECC) (1996) – *Drinking Water Guidelines*.
- Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) – *Guidelines for Fresh and Marine Waters*.
- Department of Urban Affairs and Planning – EPA (1998) "*Managing Land Contamination – Planning Guidelines – SEPP 55 – Remediation of Land*".
- National Environmental Protection Council (NEPC) (1999) – *National Environmental Protection (Assessment of Site Contamination) Measure. Amendment 2013*
- NSW EPA (2014) "*Technical Note: Investigation of Service Station Sites*".
- NSW EPA (1995) "*Sampling Design Guidelines*".
- NSW EPA (1997) "*Guidelines for Consultants Reporting on Contaminated Sites*".
- NSW DEC (2006) "*Guidelines for the NSW Site Auditor Scheme*".
- NSW EPA (2009) "*Guidelines on Significant Risk of Harm from contaminated land and the duty to report*".
- NSW DECC "Waste Classification Guidelines, Part 1: Classifying Waste" (2014). Department of Environment and Climate Change NSW, Sydney