NORTHERN SYDNEY HEALTH

PRELIMINARY CONTAMINATION ASSESSMENT
ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT
ST LEONARDS

S21855/4-AM

13 September 2004

S21855/4-AM EW
13 September 2004

Northern Sydney Health
Redevelopment Project Office
Level 5 Vindin House
Royal North Shore Hospital
ST LEAONARDS NSW 2065

Attention: Mr John Machon

Dear Sir,

RE: PRELIMINARY CONTAMINATION ASSESSMENT
ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT
ST LEONARDS

Coffey Geosciences Pty Ltd (Coffey) is pleased to provide our Preliminary Contamination Assessment report for the proposed redevelopment of the Royal North Shore Hospital at St Leonards.

This assessment was carried out in conjunction with a Preliminary Geotechnical Investigation. The results of the geotechnical investigation are reported in a separate report (Ref: S21855/3-AC).

We draw your attention to the enclosed sheet entitled "Important Information About Your Coffey Environmental Site Assessment" which should be read in conjunction with the report.

We trust that our report meets with your requirements. If you require any further information regarding our report, please do not hesitate to contact either of the undersigned on 9911 1000.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

JOSHUA LASKY	**EDWARD WU**
Senior Environmental Engineer	**Environmental Engineer**

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EXECUTIVE SUMMARY

This report presents the findings of a Preliminary Contamination Assessment undertaken by Coffey Geosciences Pty Ltd (Coffey) at the Royal North Shore Hospital (RNSH), St Leonards. The objective of the assessment was to provide preliminary information with respect to contamination to assist with master planning and initial design of the redevelopment of RNSH. We understood that additional investigations would be carried out at the detailed design stage. Based on the information provided in the Project Brief, the investigation area for the contamination assessment generally includes the main Hospital area, but excludes areas to the west of Reserve Road. The investigation area covers an area of approximately 8ha.

The main issues, which the Project Brief called for preliminary assessment of, are listed in the following bullet points along with the sections of this report in which they are addressed:

- Subsurface and groundwater conditions – Section 7.1;
- Likely suitability of the investigation area for the proposed development – Section 8.2;
- Likely waste classification of site soils – Section 8.3;
- The contamination status in the groundwater – Section 8.4;
- Requirements for further investigations – Section 8.5;
- Likely remediation measures which may be required during construction phase – Section 8.6; and
- Waste management issues with respect to excavations – Section 8.7.

The scope of work for the Preliminary Contamination Assessment included:

- A site history review and site visit to identify potential areas of environmental concern (AECs) and chemicals of concern (CoCs);
- Limited field investigations;
- Limited laboratory testing for chemicals of concern;
- Data assessment; and
- Reporting.

A site history review was undertaken which included a site walkover, a review of previous ownership, interviews, a review of WorkCover records, a search of council development application records, a review of historical aerial photographs, a search of Hospital's engineering plan room and a check of NSW EPA records for notices.

The site history review indicated that hospital related activities have been undertaken on the site for at least the past 100 years. Based on the site history review and a limited site walkover, a number of potential areas of environmental concern (AECs) have been identified within the investigation area (refer to Table 1 in Section 4), including:

- The potential presence of fill material (including fill for levelling, sub-base underneath pavements, potential ash deposits and reworked site soils);
- The presence of underground and aboveground diesel tanks and generators to the south of Building 22 and to the west of Building 9;
- Boiler and incineration related activities in the vicinity of Building 21;

- Potential heavy metal or asbestos contamination of soil as a result of weathering or leaching from building materials or demolition of former buildings;
- The engineering and maintenance works and chemical storage in the vicinity of Buildings 21 and 22, in particular the presence of a waste collection bay in the southern part of Building 22.

A limited field investigation program was undertaken to undertake an initial screening of the investigation area. The limited field investigation program included drilling of twelve boreholes (BH1 to BH12), installation of groundwater monitoring wells (BH4, BH5 and BH9) into three of the boreholes and collection of soil and groundwater samples from the boreholes. Selected soil and groundwater samples were sent to laboratories for analysis of a range of potential chemicals of concern.

Overall, the chemicals of concern analysed were generally detected below the adopted investigation levels with a number of minor exceedances at some locations.

Based on the site history review, field observations and the laboratory results, a preliminary assessment was undertaken of the issues required to be addressed by the Project Brief as listed above. A summary of the assessment/discussion of each of these issues is presented below.

Subsurface and Groundwater Conditions (see Section 7.1 for more details)

Fill material was generally encountered in most boreholes to depths ranging from about 0.3m to 2m but mainly less than 1m. Fill material can include either imported soil or reworked site soils. Fill material was observed to mainly consist of clayey soil but included a mixture of sand, clay, silt and gravel in some locations. Coal fragments were encountered at BH1 and some ash was encountered at BH12. Significant amount of anthropogenic material was not observed in the fill material. Asbestos containing materials such as fibro cement sheeting were not observed in the boreholes. Odours indicative of hydrocarbon contamination were not encountered. The fill material was observed to be underlain by residual clay which in turn underlain by shale and sandstone bedrock.

Groundwater was encountered approximately 4m to 9m below the ground surface within the bedrock.

Likely Suitability for the Proposed Development with Respect to Contamination (see Section 8.2 for more details)

Overall, based on the limited available data and the discussion presented above, it is considered that widespread soil contamination is unlikely to be present at the investigation area that would pose a major constraint to development of the investigation area as a hospital.

However, polycyclic aromatic hydrocarbons (PAHs) were detected within fill material at one location exceeding the health based investigation levels (HILs) for commercial/industrial land use while heavy metals were detected at three locations in fill material exceeding the phytotoxicity based environmental investigation levels (EILs). Given the limited nature of the investigations undertaken to date, it is considered that further investigations would be required to assess if additional contamination was present.

It is considered likely, based on the site history, the limited sampling and analysis undertaken to date and our experience on similar sites, that the investigation area would be capable of being remediated for hospital (ie commercial/industrial) use. The extent of remediation required would need to be assessed based on additional investigations.

Likely Waste Classification (see Section 8.3 for more details)

Soil required to be disposed of offsite will need to be classified in accordance with the NSW EPA (1999) Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes prior to offsite disposal. A preliminary assessment of the results suggests the following classifications of the various soil units identified at the site:

- The majority of fill material is likely to classify as either inert or solid waste. Although considered relatively unlikely, there could be pockets of industrial or hazardous waste.
- The majority of underlying residual soil and bedrock is likely to classify as virgin excavated natural material (VENM). However there may be some localised areas where the underlying soil/bedrock has been impacted by contaminants (eg around the underground diesel tank) and may classify differently.

It is important to note that the waste classification assessment is preliminary only based on limited sampling and analysis. The waste classification of soils will need to be confirmed by additional sampling and analysis.

Contamination Status in Groundwater (see Section 8.4 for more details)

Given the available laboratory results, the relatively low permeability subsurface and the relatively deep groundwater table, it is considered that widespread groundwater contamination attributable to site activities is unlikely to be present at the investigation area. Industrial areas are located to the north of the investigation area. However, given the topography and the expected groundwater flow direction, it is considered that groundwater from the industrial areas is unlikely to migrate onto the site.

Groundwater disposal options would need to be assessed if basement dewatering were to be required.

Additional Investigations (see Section 8.5 for more details)

It is considered that additional investigations are required to further assess the suitability of the investigation area with respect to contamination for the proposed hospital development, as well as to assess the waste classification of soils for offsite disposal.

It is important to note that the extent of additional investigations required will depend to a large extent on the details of the proposed development and the preferred remedial strategy. For example, in areas where basement excavations are proposed, any contaminated soil would likely be removed during the basement excavations and therefore in these area the investigation would only need to focus on the waste classification of soils for offsite disposal. Another example is in future unpaved areas, detailed sampling for heavy metals is likely to be required whereas in future paved areas, heavy metals are unlikely to be a significant issue.

A preliminary recommendation on scope for additional investigations is presented in the following table. Further delineation of contamination beyond the recommended investigations may be required if further contamination is identified during the additional investigations. Further check sampling may also be required beneath building footprints following demolition of site buildings.

PRELIMINARY RECOMMENDATION ON ADDITIONAL INVESTIGATIONS

Potential AEC	Approx Area for Further Investigation	Number of Additional Sampling Locations	Depth of Investigation Below Ground	Chemicals of Concern
1. Fill material – entire site, particularly area to the north of Building 5, area to the south and southeast of Building 22, areas underneath buildings, vicinity of Westborune Street but also on approx grid across site	~8ha	30 Note that the EPA Sampling Design Guidelines require around 80 locations for a site of 8ha. Additional sampling may need to be undertaken at a later stage to bring the sampling density to comply with the Sampling Design Guidelines.	To below the base of fill (typically 0.5m to 2m).	Analysis should mainly focus on PAH and metals which were detected at elevated concentrations in this assessment. Selected samples should also be analysed for TPH, BTEX, OCP, PCB and asbestos.
2. Existing and previous underground and aboveground diesel tanks – area to the south and southeast of Building 22, area to the west of Building 9	~200m^2 and ~100m^2 respectively	7	Locations targeting the underground tank should be extended to at least 4m. Locations targeting the aboveground tank can be shallower.	TPH, BTEX, PAH, Metals.
3. Boiler and incinerator – vicinity of Building 21	~1500m^2	5	Generally near surface sampling as top down contamination.	Metals, TPH, PAH. Selected samples also for dioxin.
4. Asbestos, lead and zinc in near surface soil – around existing and previous buildings/sheds/pipes	~1ha (say)	30 around selected buildings.	Generally near surface sampling as top down contamination.	Asbestos, lead, zinc.
5. Engineering/maintenance workshop and waste collection bay – vicinity of Building 22	~2000m^2	6	Generally near surface sampling as top down contamination Selected deeper samples	Metals, TPH, BTEX, PAH, Phenol, VOC, SVOC
6. Waste classification – basement excavation	~1.2ha	Likely to be covered by above sampling locations.	As per above samples.	Additional TCLP analysis.
7. Groundwater – entire site	~8ha	Re-sampling of existing wells.	Shallow groundwater.	Ultra trace PAH.

Metals - Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc
TPH – Total Petroleum Hydrocarbons
PAH – Polycyclic Aromatic Hydrocarbons
BTEX – Benzene, Toluene, Ethylbenzene, Xylenes
OCP – Organo-chlorine Pesticides
PCB – Poly-chlorinated Biphenyls
VOC – Volatile Organic Compounds
SVOC – Semi-volatile Organic Compounds

Likely Remediation Options (see Section 8.6 for more details)

Given that the proposed development will likely involve excavations of a basement and therefore soil will in any case need to be excavated and disposed offsite, it is considered that excavation and disposal to landfill would likely be the main remediation strategy for the site.

Capping could also be considered where basements were not proposed providing NSH were willing to accept the resulting conditions on the site (eg notice on 149 certificate, EMP etc), particularly if large volumes of contaminated soil were identified or contamination were to be identified in inaccessible areas.

If large volumes of petroleum hydrocarbon contaminated soil are identified (eg around the underground tanks) landfarming or bioremediation may be adopted to lower the level of the contamination in the soil for reuse or offsite disposal.

Soil containing contamination exceeding the EILs but not the HILs only needs to be remediated or managed in proposed landscaped areas. Where such soil is found to be present in proposed landscaped areas, an alternative option may be to strip the impacted material and replace it in an area where no landscaping is proposed.

It is important that the above assessment is preliminary only. The remediation options should be reconsidered once the extent of contamination has been assessed and the development layout is known.

Waste Management Associated with Contamination (see Section 8.7 for more details)

During demolition and construction, soil will require offsite disposal. Soil classifying as solid waste should be disposed of to an appropriately licensed landfill. Soil classifying as inert waste can either be disposed of to a landfill licensed to accept inert waste or also could potentially be reused on sites that receive no more than 20,000 tonnes of inert waste and only if the disposal of the waste is ancillary to the land being used for a purpose other than as a landfill site (eg the construction of buildings or roads or other similar types of infrastructure development). Soil classifying as virgin excavated natural material (VENM) can be reused onsite or offsite. Asbestos waste should be disposed of to a licensed asbestos waste landfill. The asbestos handling should be undertaken by a licensed contractor in accordance with WorkCover requirements

Groundwater disposal options would need to be assessed if basement dewatering were to be required.

Conclusion

Overall, based on the limited available data and the discussion presented above, it is considered that widespread soil contamination is unlikely to be present at the investigation area that would pose a major constraint to development as a hospital.

However, PAHs were detected within fill material at one location exceeding the HIL for commercial/industrial landuse while heavy metals were detected at three locations in fill material exceeding the phytotoxicity based EILs. Given the limited nature of the investigations undertaken to date, it is considered that further investigations would be required to assess if additional contamination was present.

It is considered likely, based on the site history, the limited sampling and analysis undertaken to date and our experience on similar sites, that the investigation area would be capable of being remediated for hospital (ie commercial/industrial) use. The extent of remediation required would need to be assessed based on additional investigations.

It is recommended that additional investigations be undertaken to further assess the suitability of the investigation area with respect to contamination for the proposed hospital development, as well as to assess the extent of remediation required and the waste classification of soils for offsite disposal. The extent of additional investigations required will depend to a large extent on the details of the proposed development and the preferred remedial strategy. A preliminary recommendation on scope for additional investigations is presented in Section 8.5 of this report. It is considered that these investigations could potentially be undertaken at a later stage in the planning process.

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1. INTRODUCTION

1.1 General

This report presents the findings of a Preliminary Contamination Assessment undertaken by Coffey Geosciences Pty Ltd (Coffey) at the Royal North Shore Hospital (RNSH), St Leonards. The work was commissioned by Northern Sydney Health (NSH) in a letter dated 12 May 2004. The investigation was generally carried out in accordance with our proposal, reference S21855/1-AC, dated 5 May 2004, with variations based on discussions and agreement with NSH.

We understand that a redevelopment is being considered for a substantial proportion of the Royal North Shore Hospital Site, generally bounded by Herbert Street, Pacific Highway, Reserve Road, and the former Westbourne Street, St Leonards (Figure 1). This area generally contains older sections of the hospital complex, with buildings typically comprising multi storey brick construction. Details of the proposed redevelopment were not known at the time of the contamination assessment. However, we have assumed that redevelopment is likely to comprise demolition of existing buildings, excavation of basements, and construction of multi storey concrete frame hospital and community health services buildings. Bridges may link new buildings with the main hospital buildings to the west of the older section.

1.2 Objectives and Scope of Work

The objective of the Preliminary Contamination Assessment was to provide preliminary information with respect to contamination to assist with master planning and initial design. We understood that additional investigations would be carried out at the detailed design stage.

As requested, the Preliminary Contamination Assessment was required to:

- Identify potentially contaminating activities that are currently being performed on the site and that may have been performed on the site in the past;
- Make a preliminary assessment, with respect to contamination, of likely suitability of the site for the proposed development;
- Make a preliminary assessment of likely waste classification of site soils;
- Make an assessment of requirements for further investigations to render the site suitable for the proposed development;
- Make a preliminary assessment of remediation measures which may be required during construction phase;
- Make a preliminary assessment of the contamination status in the groundwater; and
- Make a preliminary assessment of waste management issues with respect to excavations.

The scope of work for the Preliminary Contamination Assessment included:

- A site history review and site visit to identify potential areas of environmental concern (AECs) and chemicals of concern (CoCs);
- Limited field investigations;
- Limited laboratory testing for chemicals of concern;
- Data assessment; and
- Reporting.

A Preliminary Geotechnical investigation and a Preliminary Hazardous Building Materials Walkover Audit were carried out concurrently with the Preliminary Contamination Assessment by Coffey and IT Environmental and are presented in separate reports.

2. SITE DESCRIPTION

2.1 Location and Site Features

Royal North Shore Hospital is located on the Pacific Highway in St Leonards. It is also identified as Lot 21 DP 863329 within the Willoughby City Council municipality. The Hospital is generally bounded by Herbert Street to the east, Reserve Road to the west, Pacific Highway to the south and Westbourne Street to the north. It contains some 50 buildings of various sizes, ages and condition.

Based on the information provided in the Brief, the investigation area for the contamination assessment generally includes the main Hospital area, but excludes areas to the west of Reserve Road. The investigation area covers an area of approximately 8ha.

The main features of the investigation area observed during a limited walkover of accessible areas by a Coffey engineer are shown in the figure in Appendix A and include:

- The investigation area generally contains brick buildings for community healthcare, medical research and accommodation purposes;
- The remaining area of the site is landscaped with a network of concrete or asphalt paved access roads and footpaths covering the site;
- The landscaped areas appeared to be well maintained;
- The site generally slopes down towards the southeast and is characterised by numerous natural and manmade surfaces;
- Two generators were observed; one to the west of Building 9 and one to the southwest of Building 22;
- The generator near Building 9 is fuelled from an aboveground diesel tank and the generator near Building 22 is fuelled from an underground diesel tank;

- A number of small chemical storages were observed across the investigation area, including liquid oxygen and sodium hypochlorite in various parts of the site;
- Building 22 contains an engineering/maintenance workshop and a waste collection bay on concrete;
- A small quantity of various chemicals including lubricants was stored in small containers in various sizes and condition at the engineering/maintenance workshop;
- The waste collection bay located at the south-western corner of Building 22 contains various types of general waste including chemical containers, car batteries and rusted metals; and evidence of staining on the concrete and in the vicinity of the bay was observed;
- A boiler installation is located at Building 21 which contains basement levels;
- Evidence of significant fill (such as significant raised mounds and areas) was not identified during the site walkover;
- Areas which appeared to contain localised fill include areas to the north of Building 5, areas to the south and southeast of Building 22 behind a retaining wall and areas underneath some buildings;
- Localised ground modifications comprising cut and fill for building foundations were evident at the investigation area;
- An east-west oriented underground walkway tunnel is present near the centre of the site;
- Various inspection pits, tunnels and control valves were observed across the investigation area suggesting that networks of underground services including asbestos steampipes are present;
- The exterior of most buildings are generally unpainted brick and galvanised iron roofs are present on a number of buildings;
- Information displayed outside and inside Building 31 suggests that Building 31 was the original hospital building built in 1902, which contains a basement level;
- Evidence of additional underground storage tanks (USTs) other then that described above and evidence of significant contamination such as widespread staining, stressed vegetation was not observed (although it is understood that an additional UST was previously located to the south of Building 22); and
- Stormwater on the site flows into a network of drains and stormwater pipes before discharging to the local stormwater system.

The emergency unit, operation theatres, general and intensive care wards are located within Buildings 1 and 2, outside the investigation area. ·Land immediately to the north of Westbourne Street is significantly lower in elevation and appeared to have been excavated.

2.2 Current Surrounding Land Use

The observed surrounding land use were:

- High-rise residential and commercial/retail to the east and south;
- Commercial and industrial to the north; and
- A sport oval, a cemetery, a private hospital and some educational buildings to the west.

2.3 Local Geology and Hydrogeology

The Sydney 1:100,000 Geological Sheet produced by the Geological Survey of NSW, Department of Minerals and Energy (1983) indicates that the site locality is underlain by Ashfield Shale described as black to dark grey, shale and laminite. Hawkesbury Sandstone described as medium to coarse grained quartz sandstone with very minor shale and laminite lenses underlies the shale. There is also an intermediate unit known as the Mittagong Formation, which is found between the Hawkesbury Sandstone and Ashfield Shale in some locations, which is described as interbedded shale, laminite, and medium grained quartz sandstone.

The Ashfield Shale is likely to be of considerable thickness at higher elevations of St Leonards such as the northern part of the investigation area within RNSH. At lower elevations, the shale is likely to be less thick until the underlying Mittagong Formation (if present) and Hawkesbury is encountered.

The shale and sandstone are expected to be overlain by residual soils derived from weathering of the bedrock which in turn may be overlain by fill material at some locations.

Regional groundwater is expected to occur:

- Within joints and bedding partings in the bedrock; and potentially
- Perched within fill or natural soil above the bedrock.

It is anticipated that the regional groundwater flows in the area would be to the south towards Sydney Harbour or would approximately follow the topography towards the southeast.

3. SITE HISTORY REVIEW

The site history review undertaken by Coffey included:

- A site walkover by a Coffey environmental engineer;
- A review of previous site ownership;
- An interview with the Hospital's Senior Engineer; and
- A review of WorkCover NSW records for dangerous good storage (such as underground storage tanks);
- A search of council development application (DA) records on the site;
- A review of historical aerial photographs over the past 40-50 years;
- A search of Hospital's engineering plan room;
- A check of NSW EPA records for notices on the site.

Results of the site history review undertaken by Coffey are discussed in the following sections.

3.1 Site Visit

A Coffey environmental engineer undertook a limited walkover of the site to accessible areas during this assessment. Observations made during the site walkover are summarised in Section 2.

3.2 Title Search

A search of historical title records held at the Land and Property Information NSW was undertaken on 18 May 2004. The search revealed that the investigation area comprised various lots prior to 1991:

- Part Lots 1 to 11 DP 5872;
- Lot 1 DP 40487;
- Lots 1 and 2 DP 114124;
- Lot 1 DP 241826;
- Lot 1 DP 252323;
- Lots A and B DP 316223;
- Lot 1 DP 316516;
- Lot 1 DP 572275; and
- Portions 572, 573, 574 and 868 and part Portion 709 Parish Willoughby – CT Vol 15205 Fol 161.

These lots were consolidated into the one lot identified as Lot 2 DP 811372 in 1991, and subsequently re-identified as Lot 21 DP 863329 (ie current title) in 1996.

Details of the title records are unclear for the majority of the site. These records could only be identified up to 1975 and 1942 which suggest that the majority of the site was owned by RNSH and the Minister of Public Works. However, it is possible that the majority of the site has been owned by RNSH prior to 1942. The earliest available land title registered as RNSH dated to 1930.

Based on the available information, it appears that the majority of the site has been owned by RNSH (or related government departments) for at least the past 100 years. Part of the north-eastern corner of the investigation area was owned by a brick manufacturing company prior to 1965.

Lists of past registered proprietors lots are summarised in Appendix B along with copies of the current title and the cadastral plan.

3.3 Interview

An interview was undertaken on 26 May 2004 with the Senior Engineer for RNSH, Mr Bill Gerritsen, who has been working at RNSH as an engineer for over 30 years. Mr Gerritsen provided the following information with respect to the investigation area:

- The boiler at Building 21 was installed in 1957 and was originally coal fire powered. The boiler installation was extended in 1973. The boiler was switched to natural gas powered from 1995 until present.
- The ash generated from the boiler was generally disposed of offsite to a landfill or reused by a commercial nursery.
- Significant amount of ash are unlikely to be present around the boiler house or in other parts of the investigation area with the exceptions of the vicinity of Westbourne Street, and the vicinity of the access road between Buildings 11 and 24.
- Significant amount of imported fill is unlikely to be present within the investigation area.
- Most buildings were built prior to World War II. There have been various additions of buildings but they have never demolished hospital buildings.
- Asbestos, lead based paint and galvanised iron had been widely used in buildings and are still present in buildings across the investigation area.
- Asbestos materials were present in the old boiler house (Building 21) and the area surrounding the old boiler house was unpaved. However significant amount of surface soil around the boiler house had been excavated during the boiler house extension.
- Wastes generated from the hospital have been generally disposed of offsite. The investigation area is not known to have waste burial areas. It is unlikely that clinical waste was disposed of within the investigation area.
- One underground diesel tank of around 5000L and a generator are present to the south of Building 22. One aboveground diesel tank of 1000L and a generator are present to the west of Building 9. These storage tanks and generators are tested and maintained regularly, and used for emergency power supply purposes.
- One underground diesel tank of 3000L was previously present at the south-western corner of Building 22 where an engineering workshop is currently located. The tank was removed approximately 25 years ago.
- Two aboveground sodium hypochlorite storage tanks are present adjacent to swimming pools on the site. One is located to the south of Building 6 (understood to be 500L) and one is located to the north of Building 28 (understood to be 1050L).
- Significant contamination issues such as oil spill and waste burial are not known to be present within the investigation area.

Additional information was provided by Mr John Machon who is currently the Project Consultant for the redevelopment of RNSH. Mr Machon has been associated with RNSH for approximately 18 months. Mr Machon provided the following additional information:

- Laundry activities are generally undertaken by a contractor outside RNSH using conventional washing technique plus steam sterilisation. No dry cleaning activities are undertaken in RNSH.
- A brick pit and a brick factory was previously located to the north of the investigation area.
- Septic tanks are not known to be present in the investigation area.

3.4 WorkCover Records on Dangerous Goods

WorkCover NSW has maintained records of licenses for storage of dangerous goods including underground storage tanks (USTs) and aboveground storage tanks (ASTs) from 1983.

A search of WorkCover NSW records was undertaken on 28 May 2004. Records of licensed dangerous goods stored within the investigation area are included in Appendix C and are summarised as follows:

- One 1500L aboveground alkasol tank and one 1500L aboveground continuum tank, located at Depot LU01 immediately to the west of the laundry building (Building 19) – it is understood that the tanks have been removed;
- One 500L aboveground sour soft tank and one 500L aboveground sodium hypochlorite tank, located at Deport LU02 immediately to the west of the laundry building – it is understood that the tanks have been removed;
- One 5000L underground diesel tank, located at Depot UGT1 (where the generator is located) to the south of Building 22;
- One 1050L aboveground tank (Dangerous Goods Class 8, Packing Group III), located at Depot HP01 immediately to the north of Building 28 – it is understood that the tank is used to store sodium hypochlorite;
- One 250L aboveground tank (unknown chemical, Dangerous Goods Class 3, Packing Ground I, II and III), located at Deport IV01 inside Demountable Building DM1 – it is understood that this tank is actually a laboratory cabinet;
- One 250L aboveground tank (unknown chemical, Dangerous Goods Class 3, Packing Ground II and III), located at Deport OG01 inside Demountable Building DM2 – it is understood that this tank is actually a laboratory cabinet; and
- One aboveground liquid oxygen tank, located at Deport MT6 (previously BOC2) between Buildings 22 and 29 – it is understood that the tank has a capacity of about 3000L but licensed for 30000L.

A number of underground and aboveground chemical and fuel storage tanks are located outside the investigation area, mostly to the west of Buildings 1 and 2.

Based on the information provided by Mr John Machon, it is understood that the records provided by WorkCover NSW to Coffey were not the most recent. A copy of the current dangerous goods licence, dated 27 July 2004, was subsequently provided by Mr Machon. This licence confirms that the tanks at Depot LU01 and LU02 are no longer present. A copy of this licence is included in Appendix C.

3.5 Willoughby City Council Records

A check of computer records held by Willoughby City Council regarding Development Applications (DAs) and Building Applications (BAs) on the site was undertaken on 19 May 2004. A total of 54 records were identified on the computer database. Most DAs and BAs are related to addition, alternation or construction of buildings. No significant contaminating activities or developments were identified, with the potential exception of the construction of a boiler house in 1958.

A list of the council records is included in Appendix D.

3.6 Aerial Photograph Review

A review of available historical aerial photographs over the past 40 to 50 years was undertaken by a Coffey environmental engineer.

The aerial photograph review suggests that most of the existing hospital buildings have been built prior to the 1930s. Since the 1930s, a number of building additions and alternations have been undertaken. However, significant demolitions of buildings could not be identified from the aerial photographs. Based on the above, it is expected that most of the existing building have been used for hospital purposes for over 70 years.

The aerial photograph review also suggests that what appears to be residential houses had been present at the north-western corner of the investigation area (Buildings 42 to 44) since the 1930s and were demolished in the 1980s.

An excavation covering a significant area to the north of the investigation area was evident in the 1951 photograph. However, the 1970 photograph suggests that some warehouse buildings had been constructed over the excavation prior to 1970. The excavation is understood to be a brickpit. The brickworks did not appear to have extended into the investigation area.

3.7 Hospital's Engineering Plan Room

A review of engineering plans and drawings from the Hospital's engineering plan room was undertaken in June 2004.

Key features from the review include:

- Various extensions, additions, refurbishments, alternations and constructions of buildings had been undertaken over the years across the investigation area.
- Asbestos material had been commonly used in buildings.
- A plan dated 1971 suggests that the laundry was originally located at Building 22.
- A plan dated 1957 suggests that an old boiler house was located immediately to the south of the existing boiler house. A coal bunker was located to the north of the old boiler house and an ash bunker was located to the south of the old boiler house (ie at where a water tank is current located). An incinerator was located immediately to the southwest of the old boiler house. The area surrounding the old boiler house appeared to be unpaved but gravelled.
- A plan dated 1953 suggests that an underground oil tank had been proposed to be located immediately to the south of Building 22, in the vicinity of where the waste collection bay is currently located.

3.8 NSW EPA Notices

A search of the contaminated land record database at NSW EPA Website undertaken on 20 July 2004 revealed that no notices have been issued on the site under the Contaminated Land Management Act (1997).

3.9 Summary of Investigation Area History

The information obtained from the site history review and site walkover can be summarised as follows:

- Building 31 was the original hospital building built in 1902.
- It appears that the majority of the site has been owned by RNSH (or related government departments) for at least the past 100 years. Part of the north-eastern corner of the investigation area was owned by a brick manufacturing company prior to 1965.
- Various extensions, additions, refurbishments, alternations and constructions of buildings had been undertaken over the years across the investigation area. However, little evidence of building demolishment was identified.
- Most buildings were built prior to World War II.
- Asbestos, lead based paint and galvanised iron had been widely used in buildings and are still present in buildings across the investigation area.
- Significant amount of imported fill is unlikely to be present within the investigation area. Areas which appeared to contain localised fill include area to the north of Building 5, area to the south and southeast of Building 22 behind a retaining wall and areas underneath some buildings.
- Networks of underground services including asbestos steampipes are present across the investigation area. An east-west oriented underground walkway tunnel is present near the centre of the investigation area.
- A boiler is located at Building 21 which was originally coal fire powered. The boiler was installed in about 1957 and was extended in 1973. The boiler was switched to natural gas powered from 1995 until present. An old boiler house was located immediately to the south of the existing boiler house. A coal bunker, an ash bunker and an incinerator was located around the old boiler house. The ash generated from the boiler was generally disposed of offsite to a landfill or reused by a commercial nursery. Significant amount of ash is unlikely to be present around the boiler house or in other parts of the investigation area with the exceptions of the vicinity of Westbourne Street, and the vicinity of the access road between Buildings 11 and 24.

- Wastes generated from the hospital have been generally disposed of offsite. The site is not known to have waste burial areas. It is unlikely that clinical waste was disposed of on the site.
- One underground diesel tank of about 5000L and a generator are present to the south of Building 22. One aboveground diesel tank of 1000L and a generator are present to the west of Building 9. It is further understood that one additional underground diesel tank of about 3000L was previously located at the south-western corner of Building 22. The tank was removed about 25 years ago.
- A number of other chemical storages are also present across the investigation area, including liquid oxygen and sodium hypochlorite.
- Building 22 contains an engineering/maintenance workshop and a waste collection bay on concrete. A small quantity of various chemicals including lubricants was stored in containers at the engineering/maintenance workshop. The waste collection bay located at the south-western corner of Building 22 contains various types of general waste including chemical containers, car batteries and rusted metals. Evidence of staining on the concrete and in the vicinity of the bay was present.
- A brickpit, evident in the 1970 aerial photograph, was located to the north of the investigation area. The brickworks did not appear to have extended into the investigation area.
- No notices have been issued on the site under the Contaminated Land Management Act (1997).

4. POTENTIAL AREAS OF ENVIRONMENTAL CONCERN BASED ON SITE HISTORY REVIEW

Based on the observations of the limited site walkover and site history review, potential areas of environmental concern (AECs) within the investigation area were identified. These are summarised in Table 1.

It is important to note that these are only based on the limited site walkover and site history review and need to be confirmed through field investigations. Further assessment of the significance of the potential AECs is presented later in the report based on the limited field investigations undertaken.

TABLE 1: SUMMARY OF POTENTIAL AREAS OF ENVIRONMENTAL CONCERN

Potential Contaminating Activity	Chemicals of Concern	Likely Impacted Area	Remarks/Comments Based on Site History Review & Coffey's Previous Experience on Similar Sites
Importation of fill material	Metals TPH BTEX PAH OCP PCB Asbestos	• Area to the north of Building 5; • Area to the south and southeast of Building 22; • Areas underneath buildings; • Vicinity of Westbourne Street; • Vicinity of the access road between Buildings 11 and 24; • Other parts of the investigation area.	Fill is commonly used for levelling and providing a sub-base underneath pavements. The depth of fill (comprising imported fill and/or reworked site soils) across most parts of the investigation area is anticipated to be relatively shallow. It is considered that some filled areas may contain ash which can contain contaminants such as PAH and heavy metals. Other contaminants could also potentially be present within fill material.
Previous onsite use of ash from boilers	Metals TPH PAH	• Vicinity of Westbourne Street; • Vicinity of the access road between Buildings 11 and 24; • Possibly in the vicinity of the boiler house; • Possibly gardens and lawns.	The ash generated from the boiler was generally disposed of offsite to a landfill or reused by a commercial nursery. Evidence suggests that ash had been used in some parts of the investigation area. Ash from boilers typically contain high levels of contaminants such as PAH and heavy metals, although not necessarily exceeding the site criteria.
Underground and aboveground diesel tanks and generators	TPH BTEX PAH Lead	• South of Building 22; • West of Building 9.	One aboveground and one underground diesel tank (1000L and 5000L) have been identified within the investigation area. One additional underground diesel tank (3000L) was previously located at the south-western corner of Building 22, but was removed about 25 years ago. Although unlikely, additional underground storage tanks could be present given the long history of site use. Fuel tanks commonly leak contaminating surrounding soil. For this reason, it is possible that the tanks on the site may have leaked causing contamination of soil around the tanks. If the tanks have leaked, where perched groundwater intercepts the contaminated zone, it is possible that groundwater may have become contaminated although the clayey/shale subsurface conditions at the site would act to reduce the risk of migration through groundwater.
Chemical bulk storages	Various specific chemicals	• Various isolated locations.	A number of other minor chemical storages are also present across the investigation area. If contamination is present in these areas, it is likely to be localised. It is noted that many of these chemicals are considered to be relatively non-toxic to human health and the environment.

TABLE 1: SUMMARY OF POTENTIAL AREAS OF ENVIRONMENTAL CONCERN (CONTINUED)

Potential Contaminating Activity	Chemicals of Concern	Likely Impacted Area	Remarks/Comments Based on Site History Review & Coffey's Previous Experience on Similar Sites
Present and previous boiler and incineration activities	Metals TPH PAH Dioxin Asbestos	• Vicinity of the boiler house (Building 21)	The boiler related activities have been present before 1957. The boiler was originally coal fire powered. Boilers often produce ash related contamination. A coal bunker, an ash bunker and an incinerator had been present around the boiler house. Dioxin may be produced from the incinerator, although it is considered there is a relatively low likelihood of significant dioxin contamination being present.
Use of lead based paint and use of asbestos and zinc containing building materials	Lead Zinc Asbestos	• Areas around buildings/sheds across the investigation area; and • Vicinity of steampipes and other service pipes and trenches.	Given the age of the buildings, it is considered that localised contamination of surface soils around buildings/sheds/pipes at the site may have occurred as a result of: peeling/leaching of lead based paint; leaching of zinc from galvanised iron sheds/buildings/roofs; weathering or burial of asbestos from fibro buildings, roofs, insulation, service pipes etc. However, soil contamination, if present, is likely to be localised and shallow. Asbestos could also potentially have been introduced to the site through past demolition of buildings containing asbestos, however it is noted that the site history review suggests that no major demolition activities have been undertaken in the investigation area.
Engineering and maintenance works and waste collection	Metals TPH BTEX PAH Phenol VOC SVOC	• Vicinity of Building 22, particularly the southern parts; and • Possibly in the vicinity of Building 20.	Building 22 contains an engineering/maintenance workshop and a waste collection bay on concrete. A small quantity of various chemicals including lubricants was stored in containers at the engineering/maintenance workshop. The waste collection bay located at the south-western corner contains various types of general waste including chemical containers, car batteries and rusted metals. Evidence of staining on the concrete and in the vicinity of the bay was present. However, contamination resulting form engineering and maintenance, if present, is likely to be localised.
Remainder of the investigation area	Unknown	• Remainder of the investigation area.	Due to the age of RNSH, the possibility of other potentially contaminating activities having occurred within the investigation area cannot be ruled out.

Metals - Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc
TPH – Total Petroleum Hydrocarbons
PAH – Polycyclic Aromatic Hydrocarbons
BTEX – Benzene, Toluene, Ethylbenzene, Xylenes
OCP – Organo-chlorine Pesticides
PCB – Poly-chlorinated Biphenyls
VOC – Volatile Organic Compounds
SVOC – Semi-volatile Organic Compounds

5. REGULATORY BACKGROUND AND APPLICABLE GUIDELINES

5.1 Soil

For assessing contamination levels in soil in urban settings, the NSW EPA (1998) Guidelines for the NSW Site Auditor Scheme present health based investigation levels for different land uses (eg industrial/commercial, residential, recreational etc) as well as phytotoxicity based investigation levels.

It is understood that the investigation area will remain as a hospital with landscaped areas. For hospital sites, the NSW EPA (1998) guidelines do not provide specific guidance on investigation and acceptance criteria to be adopted, however we consider that hospital land use is most consistent with commercial/industrial land use exposure scenario. While NSW EPA (1998) does not require phytotoxicity issues to be addressed for commercial/industrial sites, given that there is relatively large landscaped areas proposed, it is considered that phytotoxicity issues should be addressed in proposed landscaped areas.

Given the above, for future paved areas of the site, the human health based threshold levels listed in Column 4 of the table in the NSW EPA (1998) guidelines may be adopted as investigation or acceptance criteria for the respective contaminants of concern. For future unpaved/landscaped parts of the site, the lower of the human health based threshold levels listed in Column 4 and the provisional phytotoxicity based guidelines listed in Column 5 of the table in the NSW EPA (1998) guidelines should be adopted as investigation or acceptance criteria.

NSW EPA (1998) does not provide threshold levels for petroleum hydrocarbons. NSW EPA (1994) Guidelines for Assessing Service Station Sites, provide an indication of acceptable cleanup levels for petroleum hydrocarbons compounds at service station sites to be reused for sensitive land uses such as residential. In the absence of land use based criteria, the NSW EPA have advised that these should also be applied to less sensitive land uses such as commercial/industrial in the absence of additional site specific information.

The NSW EPA and the NSW Department of Health currently have no endorsed threshold levels for asbestos in soil. The NSW EPA has given advice to accredited site auditors (31 March 2000) that no asbestos in soil at the surface is permitted.

It is important to note that these criteria are presented as a guide only. Further site specific risk based investigation and acceptance criteria may need to be developed by undertaking human health and ecological risk assessments.

The health based investigation levels (HILs) and the environmental investigation levels (EILs) applicable to contaminants of concern at the site are summarised in Table 2.

TABLE 2: ADOPED SOIL INVESTIGATION LEVELS (HILs)

Chemical	Unpaved Areas Adopted Soil Investigation Levels (mg/kg)	Paved Areas Adopted Soil Investigation Levels (mg/kg)
Arsenic	20[2]	500[1]
Cadmium	3[2]	100[1]
Chromium (III)	400[2]	600,000[1]
Copper	100[2]	5,000[1]
Lead	600[2]	1,500[1]
Nickel	60[2]	3,000[1]
Zinc	200[2]	35,000[1]
Mercury (Inorganic)	1[2]	75[1]
Benzo(a)pyrene	5[1]	5[1]
Total PAH	100[1]	100[1]
Aldrin + Dieldrin	50[1]	50[1]
DDT	1,000[1]	1,000[1]
Heptachlor	50[1]	50[1]
Total PCB	50[1]	50[1]
TPH C6-C9	65[3]	65[3]
TPH C10-C36	1,000[3]	1,000[3]
Benzene	1[3]	1[3]
Toluene	1.4[3]	130[3]
Ethylbenzene	3.1[3]	50[3]
Total Xylenes	14[3]	25[3]
Asbestos	Not Detectable[4]	Not Detectable[4]

1. *Based on Health Based Soil Investigation Level (HILs) in Column 4 of the NSW EPA (1998) Auditor Guidelines*
2. *Based on Phytotoxicity Based Investigation Level (EILs) in Column 5 of the NSW EPA (1998) Auditor Guidelines*
3. *Based on NSW EPA (1994)*
4. *Interim policy advice from the NSW EPA (31 March 2000) states that no asbestos should be present in surface soils*

5.2 Groundwater

For assessing groundwater quality, it is first necessary to assess the beneficial uses of groundwater down gradient of the investigation area being assessed.

No registered groundwater bore search was undertaken. However, given that the investigation area and the surrounding down gradient areas are underlain by Ashfield Shale or Hawkesbury Sandstone, the shallow groundwater down gradient of the investigation area is considered to have little beneficial usage. It is therefore considered unlikely that the shallow groundwater down gradient of the investigation area would be used.

It is considered that the groundwater would eventually discharge to Sydney Harbour. Potential beneficial reuses of the Sydney Harbour water include:

- Sustaining aquatic ecosystems; and
- Recreational use.

The threshold concentrations presented in the ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality 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.

ANZECC (2000) advocates a site-specific approach to developing guideline trigger values based on such factors as local biological affects data, the current level of disturbance of the ecosystem etc. The guidelines present “low risk guidelines trigger values” which are defined as concentrations of key performance parameters below which there is a low risk that adverse biological effects will occur. 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.

Low risk trigger values are provided for the protection of 80-99% of species in marine waters (presented in Table 3.4.1 of the guidelines), with the trigger value depending on the health of the receiving waters.

It is considered that the marine water trigger values are applicable for investigating chemical concentrations in groundwater at the site, as the receiving body is a marine water body.

It is understood that the NSW EPA’s policy is that the trigger values for the protection of 95% of aquatic ecosystems should be used except where contaminants are potentially bioaccumulative in which case the trigger values for protection of 99% of species should be used. Therefore, we have selected trigger values for protection of 95% of marine water species for the majority of contaminants, and 99% of marine water species for bioaccumulative contaminants for initial comparison purposes.

ANZECC (2000) states that there is currently insufficient data to derive high reliability trigger values for various contaminants. For these contaminants, low reliability trigger values have been adopted when necessary.

ANZECC (2000) state that there is currently insufficient data to derive a high reliability trigger value for total petroleum hydrocarbons (TPH) but propose a low reliability trigger value for TPH of 7μg/L. This guideline is generally considered by industry to be overly conservative and is also well below the TPH detection limit that most laboratories can achieve. Another commonly internationally used guideline for TPH is contained in Dutch (1994), which present a target, and intervention values for mineral oils. The average of the target and intervention values (325μg/L) is commonly used as an intervention level for TPH and will be adopted as investigation criteria for this site.

Guidelines for the recreational water use are also presented in the ANZECC (2000) (Table 5.2.3 of the guidelines). These guidelines are generally less sensitive than the aquatic ecosystem guidelines.

6. FIELD INVESTIGATIONS AND LABORATORY ANALYSIS

6.1 General

As per our proposal, our field investigation program focused on:

- Assessing if widespread gross soil contamination is present which may significantly constrain the development, in particular the eastern part of the investigation area where the majority of the new development will be located;
- Assessing the likely waste classification of soils at a preliminary level to allow master planning and initial budgeting of likely soil removal costs; and
- Assessing if widespread groundwater contamination is likely to be present based on soil contamination results, subsurface conditions and groundwater sampling.

Prior to the commencement of the fieldwork at the site, Coffey prepared a Work Method Statement (Ref: S21855/4-AK) which outlined a work plan, environmental, health and safety controls for the work. The Work Method Statement was reviewed and approved by RNSH and the fieldwork was undertaken in general accordance with this document.

6.2 Field Investigations

Fieldwork was undertaken concurrently with the geotechnical investigation in June 2004.

A truck mounted drilling rig was used to drill twelve boreholes (identified as BH1 to BH12) to depths ranging from 10.4m to 20m.

The boreholes were located to target selected areas of environmental concern and to provide a reasonable coverage of the investigation area. The approximate borehole locations are shown on Figure 2.

The boreholes were drilled to refusal using solid flight augers fitted with a steel V shaped bit or tungsten carbide bit. A triple tube NMLC core barrel was used to obtain cores of the rock from each of the boreholes for geotechnical purposes. Soil samples from the boreholes were generally collected from a Standard Penetration Test (SPT) sampler using disposable gloves. Between two and four soil samples were collected from the boreholes.

Each sample was divided into two sub-samples. One of the sub-samples was placed into a laboratory-supplied, acid-rinsed glass jar and placed in a cooler box filled with ice. The other was bagged for field headspace screening.

A photo-ionisation detector (PID) was used to screen the headspace gases of the bagged soil samples. The PID provides a semi-quantitative indication of the presence of ionisable volatile organic compounds in the soil. The PID had a 10.6eV lamp, generally calibrated daily prior to use with isobutylene gas at 100ppm.

In addition, an additional surface soil sample (identified as BH2A) was collected immediately adjacent to BH2. This additional sample was collected as a result of an accidental breakage of a few sample jars during transportation to the laboratory.

Groundwater monitoring wells were installed into three of the twelve boreholes (BH4, BH5 and BH9). The groundwater wells were constructed with 6m of machine slotted 50mm diameter Class 18 PVC screen at the base and were extended above the ground surface with blank 50mm Class 18 PVC casing. The boreholes were backfilled with graded sand to above the top of the screen, sealed with bentonite pellets and subsequently backfilled with the drilling cuttings to near the ground surface. To protect the wells, they were completed approximately flush to surface and concreted with a steel cover.

The project surveyors, Frank M Mason & Co Pty Ltd, surveyed the locations and ground elevations of the boreholes. The levels of the top of casing of the wells were also surveyed.

The construction details, positions and levels of monitoring wells are shown on the engineering logs in Appendix E and records of field measurements in Appendix F.

Each monitoring well was developed after installation by pumping with a submersible pump until no further turbidity improvements were observed. Approximately six well volumes of water were removed.

Groundwater samples were collected from the monitoring wells on 22 June 2004, in accordance with the following protocols:

- Prior to purging, the groundwater levels were measured in each well and the water quality meter was calibrated;
- Purging of the wells prior to sampling using a submersible pump or a disposal bailer until temperature, pH and electrical conductivity (EC) readings were stabilised;
- Field measurement of pH, EC, temperature and redox potential following purging but prior to sampling;
- Use of a new, dedicated PVC bailer for sample collection from each well;
- Samples to be analysed for heavy metals were field filtered using a new, dedicated 0.45µm filter; and
- Samples were collected into appropriately preserved laboratory supplied containers and placed in a cooler box filled with ice.

The records of groundwater purging and sampling are presented in Appendix F.

Low flow purging technique for sampling petroleum volatiles was not employed as petroleum volatiles in groundwater were considered unlikely to be chemicals of concern. In addition, the results were only intended to be used for qualitative screening purposes.

6.3 Field Quality Assurance / Quality Control (QA/QC)

Sampling activities were based on procedures and protocols outlined in Coffey's Environmental Field Manual (QP15/5-E, June 1995, revised September 1997), which is based on industry accepted standard practice.

The augers were decontaminated between holes by scrubbing with a solution of Decon-90, a phosphate free detergent, followed by rinsing with pressurised potable water. Sampling equipment that came directly in contact with the samples (eg SPT sampler and hand auger) was decontaminated between samples by scrubbing with a solution of Decon-90 followed by rinsing with potable water. A clean pair of disposable gloves was used when handling each sample. A dedicated bailer was used for each monitoring well during collection of groundwater samples.

For soil, one intra-laboratory duplicate soil sample identified as DUP1 (duplicate of BH3 0-0.3) and one inter-laboratory duplicate soil sample identified as DUP6 (duplicate of BH8 0.1-0.3) were submitted for laboratory analysis. For groundwater, one intra-laboratory duplicate sample identified as DUP-GW1 (duplicate of BH5) was submitted for laboratory analysis. The duplicate samples were used to check whether the field sampling and laboratory procedures adequately reproduced results.

One wash blank sample identified as WB080604 was collected from soil sampling by running laboratory supplied water over the decontaminated SPT sampler. No wash blank sample was required for groundwater sampling as dedicated bailers were used. The wash blank sample was collected to check the efficiency of field decontamination procedures.

One trip spike sample identified as TS070604 and one trip blank sample identified as TB040604 were collected from soil sampling. For groundwater sampling, one trip spike sample identified as TS220604 and one trip blank sample identified as TB220604 were also collected. These samples were collected to check the effect of sample handling and transportation procedures on volatile concentrations.

In addition, during transportation of the first batch of samples to the laboratory, an esky was dropped. As a result, a number of soil jars were broken and a number of jar lids were also broken. Further discussion is presented in the QA/QC Data Validation Reports in Appendix I.

6.4 Laboratory Analysis

Primary laboratory analysis was undertaken by Australian Laboratory Services (ALS), a NATA registered laboratory. ALS subcontracted asbestos identification to ASET, who is NATA registered for asbestos identification. Inter-laboratory duplicate samples were analysed by Amdel, a NATA registered laboratory.

The soil samples were dispatched on 10 and 16 July 2004. The groundwater samples were dispatched on 23 July 2004. The samples were dispatched under chain of custody conditions.

A total of nineteen primary soil samples were selected for laboratory analysis, while other samples were held in the laboratory for further analysis, if required. The soil samples were selected for analysis based on a combination of sample location, field observations (ie material type, odours, etc) and PID results. In addition, the three primary groundwater samples were analysed.

The analytical suite was selected based on the potential chemicals of concern identified during the site history. The soil and groundwater analysis schedules are summarised in Tables 3 and 4.

TABLE 3: ANALYSIS SCHEDULE FOR SOIL SAMPLES

Sample ID / Depth	Geological Origin of the Material	Laboratory Analysis Undertaken	Remarks / AECs
BH1 / 0-0.3	Clay Fill	Metal,TPH,BTEX,PAH,OCP,PCB,Asbestos	Vicinity of diesel tank, waste collection bay and suspected fill area.
BH1 / 0.5-0.95	Clay Fill	Metal,TPH,BTEX,PAH (lid broken)	
BH1 / 1.3-1.75	Clay Fill	Hold	
BH1 / 2.8-3.02	Weathered Shale	Hold	
BH2 / 0-0.3	Clay Fill	Jar Broken (Re-sampled at BH2A)	General site coverage.
BH2A / 0-0.2	Clay Fill	Metal,TPH,BTEX,PAH,Asbestos,TCLP	
BH2 / 0.5-0.7	Sand Fill	Jar Broken	
BH2 / 0.7-0.95	Residual Clay	Hold	
BH3 / 0-0.3	Sand Fill	Metal,TPH,BTEX,PAH,Asbestos	General site coverage.
BH3 / 0.5-0.95	Clay Fill	Metal,TPH,BTEX,PAH (DUP2 analysed)	
BH3 / 1.3-1.75	Residual Clay	Hold	
BH4 / 0.1-0.3	Sand Fill	Metal,TPH,BTEX,PAH,Asbestos	General site coverage.
BH4 / 0.5-0.95	Residual Clay	Hold (lid broken)	
BH4 / 1.3-1.75	Residual Clay	Hold	
BH5 / 0-0.3	Silt Topsoil	Metal,TPH,BTEX,PAH,Asbestos	General site coverage.
BH5 / 0.5-0.95	Residual Clay	Hold (lid broken)	
BH5 / 1.1-1.55	Residual Clay	Hold	
BH6 / 0.1-0.3	Clay Fill	Metal,TPH,BTEX,PAH,Asbestos	General site coverage.
BH6 / 0.5-0.95	Residual Clay	Hold	
BH7 / 0.1-0.3	Sand Fill	Metal,TPH,BTEX,PAH,OCP,PCB,Asbestos	Adjacent to diesel tank and generator.
BH7 / 0.5-0.95	Residual Clay	Metal,TPH,BTEX,PAH	
BH8 / 0.1-0.3	Silt Fill	Metal,TPH,BTEX,PAH,OCP,PCB,Asbestos	General site coverage.
BH8 / 0.4-0.85	Residual Clay	Metal,TPH,BTEX,PAH	
BH9 / 0.2-0.5	Gravel Fill	Metal,TPH,BTEX,PAH,OCP,PCB,Asbestos	Adjacent to boiler house, near previous incinerator, coal and ash bunkers.
BH9 / 0.6-1.05	Residual Clay	Metal,TPH,BTEX,PAH	
BH9 / 1.3-1.75	Residual Clay	Hold	
BH10 / 0.1-0.4	Clay Topsoil	Metal,TPH,BTEX,PAH,Asbestos,TCLP	General site coverage.
BH10 / 0.5-0.75	Residual Clay	Metal,TPH,BTEX,PAH	
BH11 / 0.15-0.3	Sand Fill	Metal,TPH,BTEX,PAH,Asbestos	General site coverage.
BH11 / 1.3-1.75	Residual Clay	Hold	
BH12 / 0-0.3	Sand Fill	Metal,TPH,BTEX,PAH,OCP,PCB,Asbestos, TCLP	Vicinity of known fill area.
BH12 / 0.7-1.15	Sand Fill	Metal,TPH,BTEX,PAH,TCLP	
BH12 / 1.4-1.85	Residual Clay	Hold	

TABLE 3: ANALYSIS SCHEDULE FOR SOIL SAMPLES (CONTINUED)

Sample ID / Depth	Geological Origin of the Material	Laboratory Analysis Undertaken	Remarks / AECs
DUP1 / 0-0.3	Duplicate of BH3	Metal,TPH,BTEX,PAH	Quality control samples.
DUP2 / 0.5-0.95	Duplicate of BH3	(Lid broken) Renamed as BH3 / 0.5-0.95 as the original BH3 / 0.5-0.95 jar was broken	
DUP3 / 0.5-0.95	Duplicate of BH4	Hold	
DUP4 / 0.1-0.3	Duplicate of BH7	Jar Broken	
DUP5 / 0.5-0.95	Duplicate of BH7	Hold	
DUP6 / 0.1-0.3	Duplicate of BH8	Metal,TPH,BTEX,PAH,OCP,PCB	
DUP7 / 0.1-0.4	Duplicate of BH10	Hold	
DUP8 / 0.15-0.3	Duplicate of BH11	Hold	
TS070604	Trip Spike	BTEX	
TB070604	Trip Blank	BTEX	
WB080604	Wash Blank	Metal,TPH,BTEX,PAH,OCP,PCB	
TS150604	Trip Spike	Hold	
TB150604	Trip Blank	Hold	

Metal – Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc
PAH – Polycyclic Aromatic Hydrocarbons
TPH – Total Petroleum Hydrocarbons
BTEX – Benzene, Toluene, Ethyl-benzene, Xylenes
OCP – Organo-chlorine Pesticides
PCB – Poly-chlorinated Biphenyls
TCLP –Arsenic, Cadmium, Chromium, Lead, Mercury, Nickel and PAH based on Toxicity Characteristic Leaching Procedure

TABLE 4: ANALYSIS SCHEDULE FOR GROUNDWATER SAMPLES

Sample ID	Sample Description	Laboratory Analysis Undertaken	Remarks / AECs
BH4	Cloudy, brown	Metal,TPH,BTEX,PAH,Cl^-,SO_4^{2-},pH	Near mid- to up-gradient boundary.
BH5	Translucent/colourless	Metal,TPH,BTEX,PAH,Cl^-,SO_4^{2-},pH	Near up-gradient boundary.
BH9	Cloudy brown	Metal,TPH,BTEX,PAH,Cl^-,SO_4^{2-},pH	Near down-gradient boundary, vicinity of boiler house and potential contaminated areas.
DUP-GW1	Duplicate of BH5	Metal,TPH,BTEX,PAH	Quality control samples.
TS220604	Trip Spike	BTEX	
TB220604	Trip Blank	BTEX	

Metal – Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc
PAH – Polycyclic Aromatic Hydrocarbons
TPH – Total Petroleum Hydrocarbons
BTEX – Benzene, Toluene, Ethyl-benzene, Xylenes
Cl^- – Chloride
SO_4^{2-} – Sulfate

7. RESULTS & SITE CHARACTERISATION

7.1 Subsurface Conditions

With the exception of BH5 and BH10 where natural soil was encountered at the surface, fill material was generally encountered in most boreholes to depths ranging from about 0.3m to 2m but mainly less than 1m. Fill material can include either imported soil or reworked site soils. Fill material was observed to mainly consist of clayey soil but included a mixture of sand, clay, silt and gravel in some locations. Coal fragments were encountered at BH1 and some ash was encountered at BH12. Significant amount of anthropogenic material was not observed in the fill material. Asbestos containing materials such as fibro cement sheeting were not observed in the boreholes. Odours indicative of hydrocarbon contamination were not encountered.

Based on the results of the fieldwork, the site geology is consistent with the regional geology indicated by the Sydney 1:100,000 Geological Sheet. Across the investigation area there are relatively shallow and variable thicknesses of topsoil and fill, overlying residual soil, overlying bedrock. The bedrock comprises shales and sandstone of variable strength and weathering characteristics.

At the more elevated, northwest end of the investigation area, Ashfield Shale was encountered to the termination depth of the boreholes. As the site grade falls to the east and south, the boreholes located in these areas encountered Ashfield Shale overlying laminite and sandstone inferred to be Mittagong Formation / Hawkesbury Sandstone. At the most southern and eastern boreholes (BH3 and BH9), the shale was not present and sandstone belonging to either the Mittagong Formation or Hawkesbury Sandstone was cored. It should be noted that the boundaries between the various units can be gradational and the Mittagong Formation and Hawkesbury Sandstone can be difficult to differentiate.

Details of the subsurface conditions are presented in the Coffey's geotechnical report and the inferred geological models are summarised in Table 5. It should be noted that the depths and thicknesses of various units presented is based on information at the borehole locations and variations outside of the ranges of depth and thickness could occur between borehole locations.

TABLE 5: INFERRED PRELIMINARY GEOLOGICAL MODEL

Unit	General Description	Typical Depth to Unit Base (m)	Typical Thickness of Unit (m)
Topsoil and Fill	Silty Clay and Clayey Silt, some Gravely Clay, some ash at BH12	0.3 to 2	0.3 to 2
Residual Soil	Silty Clay: medium and high plasticity, very stiff and hard	1.1 to 3.55	0.6 to 3.3
Ashfield Shale	Shale with Sandstone Laminations and Shale (not encountered in BH3 and BH9)	7.36 to >20	4.76 to >16.2
Mittagong Formation/ Hawkesbury Sandstone	Interbedded Sandstone, Laminite and Shale, less laminated and predominantly Sandstone with increasing depth	Drilled to the termination depth of BH1, BH3, BH4, BH8, BH9, BH11	-

7.2 Groundwater

Groundwater was generally not encountered in the augered sections of the boreholes (soil and extremely weathered rock). Potable water was used as a drilling fluid in the cored sections of the boreholes, hence groundwater could not be monitored during the drilling. In the groundwater monitoring wells that were installed in BH4, BH5 and BH9, the groundwater levels were monitored during the investigations. The monitoring results are presented in Table 6.

TABLE 6: GROUNDWATER LEVELS MEASURED IN GROUNDWATER MONITORING WELLS

Well ID	Measurement Date	Water Level in m AHD	Depth Below Ground Surface (m)
BH4	10/6/04	80.31	5.00
	17/6/04	80.93	4.39
	22/6/04	80.71	4.60
BH5	10/6/04	87.52	8.45
	17/6/04	87.32	8.65
	22/6/04	87.39	8.58
BH9	15/6/04	72.81	6.62
	17/6/04	72.75	6.68
	22/6/04	72.73	6.70

Drilling fluids may influence the earlier groundwater readings and the last reading is likely to be the more representative of a standing groundwater level at the borehole locations. Groundwater levels in Sydney are often associated with infiltration through fissured soils into the fractured rock mass and may vary seasonally. Perched groundwater is often encountered at the soil bedrock interface and within joints and bedding partings within the bedrock.

Insufficient data was available to assess the groundwater flow direction at the investigation area. It appears that shallow groundwater at the investigation area generally flows towards the east to southeast.

Field pH, temperature, conductivity, and redox potential were measured. The field measurements are summarised presented in Appendix F.

It should be noted that groundwater monitoring wells were generally screened below the groundwater table for geotechnical investigation purposes. As a result, the presence of free phase hydrocarbon product could not be assessed in the wells. Odours indicative of hydrocarbon contamination were not observed in the wells or in the boreholes into which the wells were installed suggesting the presence of free phase hydrocarbon contamination is unlikely.

7.3 Photo-ionisation Detector (PID) Results

A total of 36 soil samples were subjected to PID headspace screening. The highest PID reading was 16ppm suggesting that volatile ionisable contaminants were unlikely to be present in the soil samples tested at significant concentrations.

The PID results are presented in Appendix G.

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7.4 Laboratory Results

Soil sample analytical results are summarised in Laboratory Results Summary Table L1. Groundwater analytical results are summarised in Laboratory Results Summary Table L2. TCLP results for waste classification are summarised in Laboratory Results Summary Table L3. The laboratory analytical reports are presented in Appendix H.

7.5 Quality Assurance / Quality Control (QA/QC) Results And Data Usability

A data validation report has been prepared for QA/QC purposes and is presented in Appendix I. The conclusions of the data usability assessment are presented in Table 7. Copies of the Chain of Custody documentation are included in Appendix H.

TABLE 7: SUMMARY OF DATA USABILITY ASSESSMENT

Batch No.	Sampling Date	Sample Handling	Precision & Accuracy	Field QA/QC	Lab QA/QC	Data Usability
ALS ES48084 ALS ES48186 ALS ES48409 Amdel 4E1118	3-15 June 04	Partially Satisfactory	Satisfactory	Satisfactory	Satisfactory	Useable with Qualification [1, 2]
ALS ES48360	22 June 04	Partially Satisfactory	Satisfactory	Partially Satisfactory	Partially Satisfactory	Useable with Qualification [3, 4]

1. *Volatiles results for sample BH1 / 0.5-0.95 should be considered approximate only as the jar lid was broken and volatiles could have been lost.*
2. *Leachanility (TCLP) results should be considered approximate only as duplicate samples were not tested.*
3. *Laboratory pH results should be considered approximate only as the holding time was exceeded. However, both the field and laboratory measures were comparable.*
4. *QA/QC samples were not undertaken for chloride and sulfate as these were not used as part of the environmental assessment. The results should be considered approximate only. This data has been used for the geotechnical investigation.*

7.6 Comparison of Sampling Results with Investigation Levels

7.6.1 Soil

Comparison of the laboratory results to the soil investigation levels discussed in Section 5 is summarised as follows:

- Arsenic was detected in three surface samples at BH2A, BH10 and BH12 at concentrations exceeding the provisional phytotoxicity based investigation level (EIL) of 20mg/kg but at concentrations below the human health based soil investigation level (HIL) for commercial/industrial land use.
- Nickel was detected in one surface sample at BH11 at 63mg/kg, marginally exceeding the EIL of 60mg/kg but at a concentration below the HIL for commercial/industrial land use.
- Concentrations of other heavy metals analysed were below the respective HILs and EILs and mainly at concentrations consistent with background concentrations.

- TPH C10-C36 was detected in three samples but at concentrations well below the SIL.
- TPH C6-C9 and BTEX were not detected in the samples analysed, with the exception of toluene detected in one sample at BH7 (0.1m to 0.3m) at a concentration of 0.3mg/kg, well below the SIL of 1.4mg/kg.
- Benzo(a)pyrene was detected in one sample at BH12 (0.7m to 1.15m) at a concentration of 5.6mg/kg marginally exceeding the HIL for commercial/industrial land use of 5mg/kg. Total PAHs and benzo(a)pyrene was detected in a further three samples but at concentrations below the respective HILs.
- The organochlorine pesticide (OCP) compounds DDT and DDD were detected in one of the five samples analysed but at concentrations well below the respective HILs. Other OCP compounds were not detected in the samples analysed;.
- Total polychlorinated biphenyls (PCBs) were detected at a concentration of 0.2mg/kg in one of the five samples analysed but at concentration well below the HIL of 50mg/kg.
- Asbestos was not detected in the twelve surface soil samples analysed.

7.6.2 Groundwater

Comparisons of the groundwater laboratory results to groundwater investigation levels (GILs) discussed in Section 5 are summarised as follows:

- Arsenic was detected in BH4 and BH5 at 12μg/L and 3μg/L respectively, exceeding the ANZECC (2000) lower reliability trigger level for protection of 95% of marine water species for arsenic (III) of 2.3μg/L.
- Copper was detected in BH4 at 4μg/L, exceeding the ANZECC (2000) trigger level for protection of 95% of marine water species of 1.3μg/L.
- Nickel was detected in BH9 at 48μg/L, exceeding the ANZECC (2000) trigger level for protection of 99% of marine water species of 7μg/L. Nickel was also detected in the other two samples at concentrations marginally exceeding 7μg/L.
- Zinc was detected in all three samples at concentrations (81μg/L to 126μg/L) exceeding the ANZECC (2000) trigger level for protection of 95% of marine water species of 15μg/L.
- Other heavy metals (cadmium, chromium, lead and mercury) were either non-detect or detected at concentrations below their respective ANZECC (2000) trigger levels in the three samples analysed.
- TPH and BTEX were not detected in the three samples analysed.
- PAH compounds were not detected in the three samples analysed, although the laboratory's levels of reporting for some of the PAH compounds exceeded the trigger values.

8. DISCUSSION

As requested by RNSH in the Brief, the following sections provide an outline, discussion and/or recommendations on:

- Subsurface and groundwater conditions;
- A preliminary assessment of the likely suitability of the investigation area for the proposed development;
- A preliminary assessment of the likely waste classification of site soils;
- The contamination status in the groundwater (if groundwater is encountered), based on a preliminary assessment;
- Requirements for further investigations to render the investigation area suitable for the proposed development;
- An initial assessment of remediation measures which may be required during construction phase; and
- Waste management issues with respect to excavations, based on a preliminary assessment.

8.1 Subsurface and Groundwater Conditions

The interpreted subsurface and groundwater conditions at the site are presented in Sections 7.1 and 7.2.

8.2 Preliminary Assessment of the Suitability for the Proposed Development

Based on the site history review and a limited site walkover, a number of potential areas of environmental concern (AECs) have been identified at the investigation area which were listed in Table 1.

The significance of the potential AECs was further assessed based on limited field and laboratory investigations as discussed in the following sub-sections.

8.2.1 Fill Material and Deposition of Ash

With the exception of BH5 and BH10 (where natural soil was encountered at the surface), fill material was generally encountered in most boreholes to depths ranging from about 0.3m to 2m mainly less than 1m. Fill material can include imported soils as well as reworked site soils. Fill material was observed to mainly consist of clayey soil but included a mixture of sand, clay, silt and gravel in some locations. Coal fragments were encountered at BH1 and some ash was encountered at BH12. Significant amount of anthropogenic material was not observed in the fill material. Asbestos containing materials such as fibro cement sheeting were not observed in the boreholes. Odours indicative of hydrocarbon contamination were not encountered.

A total of thirteen soil samples collected from fill were selected for laboratory analysis. Chemicals of concern analysed were either non-detect or detected below the respective HILs and EILs with the following exceptions:

- Heavy metals (arsenic and/or nickel) were detected in three of the samples analysed at concentrations exceeding the EILs based on the provisional phytotoxicity guidelines but below the commercial/industrial HILs.
- Benzo(a)pyrene (a PAH compound) was detected in one sample (BH12) at a concentration of 5.6mg/kg marginally exceeding the HIL of 5mg/kg. It is considered that the benzo(a)pyrene exceedance at BH12 was likely associated with ash. BH12 was located in the vicinity of Westbourne Street which was identified in the site history review to have been an area where ash from the boiler was deposited and ash was observed in the borehole at this location.

At a preliminary screening level based on only twelve boreholes over an approximately 8ha investigation area, the limited available results suggest that there is a low likelihood of widespread fill being present containing contamination exceeding the human health based criteria for commercial and industrial sites.

However localised contamination has been detected within the fill material including PAHs which were detected in fill at one location (at BH12) exceeding the HILs for commercial/industrial sites and heavy metals which were detected at three locations exceeding the provisional phytotoxicity based EILs.

It is noted that only very limited sampling and analysis of fill material has been undertaken at this stage. More detailed investigation would be required to assess the extent of fill and whether further contamination to that already detected could be present in the fill material across the investigation area.

Fill which is assessed to contain contaminants exceeding the HILs would require remediation or management for the investigation area to be considered suitable for hospital use.

Fill which is assessed to contain contaminants exceeding the EILs may impact plant growth in the existing and proposed gardens and landscaped areas. Remediation or management of fill containing contamination exceeding the EILs would be required in future gardens and landscaped areas.

8.2.2 Underground and Aboveground Diesel Tanks and Generators

One underground diesel tank and a generator are present to the south of Building 22. It is understood that the tanks have a capacity of about 5000L. One aboveground diesel tank of 1000L and a generator are present to the west of Building 9. In addition, one underground diesel tank (understood to be 3000L) was previously located at the south-western corner of Building 22, but was removed about 25 years ago. Although unlikely, additional underground storage tanks could be present given the long history of site use. It is possible that they may have leaked causing contamination of soil around the tanks.

Limited sampling and analysis was undertaken targeting the tanks and generators. Borehole BH1 was drilled to the south the existing underground diesel tank and the aboveground generator, located near Building 22. Borehole BH7 was drilled adjacent to the 1000L aboveground diesel tank and the generator to the west of Building 9. Evidence of diesel contamination, such as oil staining and hydrocarbon odours, was not observed in the boreholes and significant PID headspace results were not detected in the soil samples collected from these boreholes.

Two soil samples from each of these two boreholes were selected for laboratory analysis. Chemicals of concern analysed were detected below the respective HILs and EILs. TPH, BTEX and PAH (chemicals often associated with diesel) were generally non-detect with the following exceptions:

- PAH compounds were detected in the surface fill sample (0m to 0.3m) in BH1 at relatively low concentrations below the HILs. It is considered that the presence of low level PAH was likely associated with the presence of fill, rather than the diesel tank.
- TPH C10-C36 was detected in the surface fill sample (0.1m to 0.3m) in BH7 at a concentration of 410mg/kg below the SIL. It is considered likely that that this TPH was the result of minor leakages and/or spillages from the tank (although no evidence of oil staining was observed). PCBs and toluene were also detected at low concentrations in this sample suggesting that the oil could have contained low levels of PCBs and toluene.

At a preliminary screening level based on our limited investigation, the above results and the observed subsurface conditions (relatively low permeability clays and shale) suggest that there is a low likelihood of widespread contamination, which may pose a significant constraint to the proposed development, being present as a result of spillages and leakages of the diesel tanks.

However, it is important to note that it is common for fuel storage tanks to leak and impact surrounding soil. Furthermore, given the age and history of the investigation area, it is possible that additional underground storage tanks could be present.

It is recommended that more detailed investigations be undertaken in the vicinity of the aboveground and underground diesel tanks to further assess if contamination is present. Where appropriate, it is recommended that the tanks and associated pipework be removed and contaminated soil (if any) be remediated. It is considered that costs for removal of the tanks and remediation of associated hydrocarbon contaminated soil would be unlikely to present a significant constraint to the proposed development.

8.2.3 Boiler and Incinerator

A boiler has been present before 1957 nearing the vicinity of Building 21. The boiler was originally coal fire powered. A coal bunker, an ash bunker and an incinerator had been present around the boiler house. In addition, asbestos materials were present in the old boiler house and the area surrounding the old boiler house was unpaved. It is understood that significant amount of surface soil around the boiler house had been excavated and disposed of offsite during the boiler house extension.

Borehole BH9 was drilled within the former footprint of the old boiler house immediately to the south of Building 21. The location of BH9 was positioned adjacent to the former incinerator and the former ash bunker. Evidence of ash or asbestos contamination was not observed in the borehole.

Two soil samples from borehole BH9 were selected for laboratory analysis. Chemicals of concern analysed were either non-detect, or detected well below the respective HILs and EILs.

A groundwater monitoring well was also installed at BH9. One groundwater sample was collected from this well for laboratory analysis. Significant groundwater contamination was not identified in the sample (refer to Section 8.6 for further discussion).

At a preliminary screening level based on only one borehole at the boiler house area, the results suggest that widespread contamination, which may pose a significant constraint to the proposed development, is unlikely to be present in the vicinity of Building 21, as a result of the present and former boiler related activities.

However, there may be relatively localised contamination that could potentially require remediation. Given the scope of the investigation was limited, it is considered that the areas around Building 21 were not adequately covered by the investigation.

It is recommended that more detailed testing should be undertaken in the vicinity of the boiler house to provide a better coverage of the area and to further assess the extent (if any) of remediation required. While considered unlikely to be present at significant concentrations, the additional sampling program should consider the potential for dioxins to be present as a result of the incineration activities.

8.2.4 Lead Paint, Asbestos and Galvanised Iron Building Materials

Asbestos, lead based paint and galvanised iron had been widely used in buildings and are still present in buildings across the investigation area. Given the age of the site, localised contamination of surface soils around buildings/sheds/pipes may have occurred as a result of: peeling/leaching of lead based paint; leaching of zinc from galvanised iron sheds/buildings/roofs; weathering of asbestos from fibro buildings, roofs, insulation, service pipes etc. Demolition of buildings containing the above materials may also result in contamination of the near surface soil although the site history review did not reveal evidence of significant past building demolitions across the investigation area.

Asbestos containing materials were not observed in the limited boreholes while asbestos was not detected in the twelve soil samples analysed. Lead and zinc concentrations in the samples analysed were below both the HILs and EILs

At a preliminary screening level, this suggests that there is a low likelihood of widespread lead, zinc and asbestos contamination at the investigation area.

However, it is noted that investigations to date have been limited and have not specifically targeted areas around current and former buildings. Further sampling and analysis would be required to assess the extent of contamination, if present, associated with this issue.

It is further recommended that buildings be demolished using appropriate environmental control measures to reduce the likelihood of further contamination of soils associated with this issue.

8.2.5 Engineering Workshop and Waste Collection Bay

Building 22 contains an engineering/maintenance workshop and a waste collection bay on concrete. A small quantity of various chemicals including lubricants was stored in containers at the engineering/maintenance workshop. The waste collection bay located at the south-western corner contains various types of general waste including chemical containers, car batteries and rusted metals. Evidence of staining on the concrete and in the vicinity of the bay was present.

Boreholes BH1 and BH11 were drilled in the vicinity of Building 22. Oil staining and/or hydrocarbon odours were not observed in these boreholes. Significant PID headspace results were not detected in the soil samples collected from these boreholes. Three soil samples from BH1 and BH11 were selected for laboratory analysis. Chemicals of concern analysed were either non-detect or detected below the respective HILs and EILs with the exception of nickel which was detected in the surface soil sample collected from BH11 at a concentration marginally exceeding the EIL. The nickel contamination was discussed in Section 8.2.1.

At a preliminary screening level based on our limited investigation, the results suggest that widespread soil contamination, which may pose a significant constraint to the proposed development, is unlikely to be present in the vicinity of Building 22. However, given the previous uses of the area at and around Building 22, and that the investigations in the area were very limited, it is considered that further investigations are required to further assess whether contamination requiring remediation is present in this area.

8.2.6 The Remainder of the Investigation Area

Due to the age of the site, the possibility of other potentially contaminating activities having occurred on the site cannot be ruled out.

The twelve boreholes drilled to target selected areas of environmental concern (discussed above) and to provide a reasonable coverage of the remainder of the site. A total of nineteen soil samples (including those described above) were selected for laboratory analysis. With the exception of the exceedances already discussed in the previous sections, chemicals of concern analysed in the other samples were either non-detect or detected below the respective HILs and EILs.

At a preliminary screening level, the results suggest that widespread soil contamination, which may pose a significant constraint to the proposed development, is unlikely to be present in the investigation area.

It is considered that investigations undertake to assess other potential contamination issues on the site as discussed in the previous sub-sections would also allow an assessment of other potentially contaminating activities to be made.

8.2.7 Overall Site Suitability for Redevelopment as a Hospital

Overall, based on the limited available data and the discussion presented above, it is considered that widespread soil contamination is unlikely to be present at the investigation area that would pose a major constraint to development of the investigation area as a hospital.

However, PAHs were detected within fill material at one location exceeding the HIL for commercial/industrial landuse while heavy metals were detected at three locations in fill material exceeding the phytotoxicity based EILs. Given the limited nature of the investigations undertaken to date, it is considered that further investigations would be required to assess if additional contamination was present.

It is considered likely, based on the site history, the limited sampling and analysis undertaken to date and our experience on similar sites, that the investigation area would be capable of being remediated for hospital (ie commercial/industrial) use.

The extent of remediation required would need to be assessed based on additional investigations as discussed in Section 8.5.

8.3 Waste Classification

8.3.1 Waste Classification Procedure

Soil required to be disposed of offsite will need to be classified in accordance with the NSW EPA (1999) Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes prior to offsite disposal. Non-virgin excavated material and material that has been excavated from a contaminated area must be classified using the procedures in Technical Appendix 1 of the guidelines.

An excavated material is given a waste classification by comparing analytical results from the material to threshold criteria provided in the guidelines. The guidelines provide threshold concentrations for three different waste categories, namely inert waste; solid waste; and industrial waste. The wastes which fail to meet the criteria for industrial waste classify as hazardous waste. The guidelines provide threshold values for total concentrations and leachable concentrations based on the toxicity characteristics leaching procedure (TCLP) for a list of about 50 contaminants and groups of contaminants. For a waste to be classified under a given category, both total and leachable (TCLP) concentrations of the waste should meet the respective threshold concentrations. The waste may be classified solely based on total concentrations (ie without undertaking leachability testing), but the applicable threshold concentrations are significantly lower (ie stringent criteria) compared to when leachability testing is undertaken.

8.3.2 Preliminary Waste Classification of Site Soils

Four selected soil samples from the nineteen samples analysed were subjected for leachability of heavy metals and PAH based on TCLP. A summary of the total and TCLP analytical results compared to the waste classification criteria are presented in Table L3.

With the exception of benzo(a)pyrene from BH12 (0.7m to 1.15m) exceeding the inert waste threshold value:

- The concentrations of chemicals tested for are below the respective inert waste threshold values (CT1 or SCC1) listed in Table A3 or A4 of the NSW EPA Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes (1999); and
- The leachable concentrations (based on TCLP) of all chemicals tested for are below the respective inert waste threshold values (TCLP1) listed in Table A4 of the NSW EPA (1999) guidelines.

A preliminary assessment of the results suggests the following classifications:

- The majority of fill material is likely to classify as either inert or solid waste. Although considered relatively unlikely, there could potentially also be pockets of industrial or hazardous waste.
- The majority of underlying residual soil and bedrock is likely to classify as virgin excavated natural material (VENM). However there may be some localised areas where the underlying soil/bedrock has been impacted by contaminants (eg around the underground diesel tank) and may classify differently.

It is important to note that the waste classification assessment presented above is preliminary only based on limited sampling and analysis. The waste classification of soils will need to be confirmed by additional sampling and analysis.

8.4 Groundwater Contamination

Three groundwater monitoring wells were installed across the site during the field investigation:

- BH4 – South to southwest part of the investigation area (mid- to up-gradient);
- BH5 – North-western corner of the investigation area (up-gradient);
- BH9 – Eastern boundary of the investigation area (down-gradient).

Groundwater level monitoring data is presented in Section 7.2. Groundwater was encountered approximately 4m to 9m below the ground surface within the bedrock. Insufficient data was available to assess the groundwater flow direction at the investigation area. However, it appears that shallow groundwater at the investigation area generally flows towards the east to southeast. Industrial areas are located to the north of the investigation area. However, given the topography and the expected groundwater flow direction, it is considered that groundwater from the industrial areas is unlikely to migrate onto the site.

Groundwater samples were collected from the monitoring wells for laboratory analysis. Chemicals of concern analysed were either non-detect (TPH, BTEX and PAH) or detected well below the respective aquatic ecosystem based GILs (some heavy metals), with the exceptions of arsenic, copper, nickel and zinc.

Given that the heavy metal concentrations were generally comparable or higher in the upgradient samples to the downgradient samples, that concentrations of metal detected in soil were low to moderate and that the groundwater is located within the bedrock, it is considered that the metal exceedances are unlikely to be associated with the hospital activities at the site and are more likely to represent regional groundwater quality.

While, PAH compounds were not detected above the laboratory detection limit in the groundwater samples analysed, the detection limit for some PAH compounds was higher than the GILs. Future groundwater testing should include ultra-trace PAH analysis.

It should be noted that the wells were generally screened below the groundwater table for geotechnical investigation purposes. As a result, the presence of hydrocarbon free-products (ie light non aqueous phase liquids, LNAPLs), were not able to be assessed during the monitoring. However, given the above laboratory results and other olfactory evidence (no hydrocarbon odours and no observable staining), it is considered unlikely that hydrocarbon free-products would be present in the wells.

Given the above discussed results, the relatively low permeability subsurface and the relatively deep groundwater table, it is considered that widespread groundwater contamination attributable to site activities is unlikely to be present at the investigation area.

In addition, groundwater disposal options would need to be assessed if basement dewatering were to be required.

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8.5 Further Investigations

It is considered that additional investigations are required to assess the suitability of the investigation area with respect to contamination for the proposed hospital development, as well as to assess the waste classification of soils for offsite disposal.

The additional investigations should be aimed at assessing:

- The extent and contamination status of fill material across the investigation area;
- The extent of hydrocarbon contamination (if any) in the vicinity of the identified aboveground and underground diesel tanks;
- The extent of contamination in the vicinity of Building 21 (the boiler and incinerator area) including the potential for dioxins to be present as a result of the incineration activities;
- The extent of asbestos, lead and zinc contamination in near surface soil around current and former buildings/sheds/pipes;
- The extent of contamination associated with engineering/maintenance activities including the waste collection bay in the vicinity of Building 22;
- The waste classification of soils required to be disposed of offsite either to facilitate the development (eg construction of basements) or for site remediation; and
- The contamination status of groundwater in the investigation area.

It is important to note that the extent of additional investigations required will depend to a large extent on the details of the proposed development and the preferred remedial strategy. For example, in areas where basement excavations are proposed, any contaminated soil would likely be removed during the basement excavations and therefore in these area the investigation would only need to focus on the waste classification of soils for offsite disposal. Another example is in future unpaved areas, detailed sampling for heavy metals is likely to be required whereas in future paved areas, heavy metals are unlikely to be a significant issue.

A preliminary recommendation on scope for additional investigations is presented in Table 8. Further delineation of contamination beyond the recommended investigations may be required if further contamination is identified during the additional investigations. Further check sampling may also be required beneath building footprints following demolition of site buildings.

TABLE 8: PRELIMINARY RECOMMENDATION ON ADDITIONAL INVESTIGATIONS

AEC	Approximate Area for Further Investigation	Number of Additional Sampling Locations	Depth of Investigation Below Ground	Chemicals of Concern
1. Fill material – entire site, particularly area to the north of Building 5, area to the south and southeast of Building 22, areas underneath buildings, vicinity of Westborune Street but also on approx grid across site	~8ha	30 Note that the EPA Sampling Design Guidelines require around 80 locations for a site of 8ha. Additional sampling may need to be undertaken at a later stage to bring the sampling density to comply with the Sampling Design Guidelines.	To below the base of fill (typically 0.5m to 2m).	Analysis should mainly focus on PAH and metals which were detected at elevated concentrations in this assessment. Selected samples should also be analysed for TPH, BTEX, OCP, PCB and asbestos.
2. Existing and previous underground and aboveground diesel tanks – area to the south and southeast of Building 22, area to the west of Building 9	~200m^2 and ~100m^2 respectively	7	Locations targeting the underground tank should be extended to at least 4m. Locations targeting the aboveground tank can be shallower.	TPH, BTEX, PAH, Metals.
3. Boiler and incinerator – vicinity of Building 21	~1500m^2	5	Generally near surface sampling as top down contamination.	Metals, TPH, PAH. Selected samples also for dioxin.
4. Asbestos, lead and zinc in near surface soil – around existing and previous buildings/sheds/pipes	~1ha (say)	30 around selected buildings.	Generally near surface sampling as top down contamination.	Asbestos, lead, zinc.
5. Engineering/maintenance workshop and waste collection bay – vicinity of Building 22	~2000m^2	6	Generally near surface sampling as top down contamination Selected deeper samples	Metals, TPH, BTEX, PAH, Phenol, VOC, SVOC
6. Waste classification – basement excavation	~1.2ha	Likely to be covered by above sampling locations.	As per above samples.	Additional TCLP analysis.
7. Groundwater – entire site	~8ha	Re-sampling of existing wells.	Shallow groundwater.	Ultra trace PAH.

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8.6 Remediation Options

8.6.1 Remediation Option Overview

There are a range of remediation technologies that are available for remediation of contaminated sites. Some of these technologies are proven while others have not yet been successfully implemented, particularly in Australia and/or there is limited local expertise for implementation.

Based on the available information and our experience, the following remediation methods could potentially be applicable to this site:

- Excavation and landfilling;
- Cap and contain;
- Bioremediation/landfarming (for hydrocarbon contamination); and
- Other treatment/stabilisation technologies.

Excavation and landfilling entails excavating the contaminated soil and disposing the soil at an off-site licensed landfill. The advantage of this option is that the contaminated fill material would be removed from site and therefore, restrictions on site use, notifications on the land title due to the presence of such material and ongoing maintenance costs can be avoided. Another advantage is the relatively short time of implementation. A disadvantage is that landfill disposal for a large volume of soil is expensive. In addition, landfill disposal is viewed by the NSW EPA as one of the least preferable method of managing contaminated soil. Also some of the soil is likely to classify as hazardous waste and would require pre-treatment prior to disposal.

Cap and contain entails providing a barrier (a cap) preventing or reducing the contact between site users and the contaminated soil. If constructed of a low permeability material, the cap also acts as a low permeability barrier, which reduces infiltration through the contaminated zone and abates the erosion and runoff of contaminated soil. The cap could be constructed of compacted clay, asphalt, geomembrane and clay composite or concrete and should contain a warning layer between the cap and the contaminated soil. A site Environmental Management Plan would be needed to ensure the integrity of the cap is maintained and that any work penetrating the cap is undertaken in accordance with adequate health and safety measures and environmental controls. It is important to note that selection of capping as the remediation strategy may result in a Section 149(2) notice being imposed on the property to indicate that contaminated soil has been left on the site. The main advantage of capping is the relatively low initial capital cost. The contamination remaining on-site and thus carrying the associated liabilities is a major disadvantage. In addition, the need for periodic, on-going monitoring and risk of the cap failing and requiring repair work are other disadvantages.

Landfarming entails natural bio-degradation of the hydrocarbon contamination. The degradation rate can be enhanced by the periodic turning of the soil with appropriate plant and/or machinery to aerate soils and to enhance the natural attenuation. Degradation may also be enhanced through the addition of nutrients (fertiliser/manure), commercially available surfactants such as (Biosolve), microbes, by optimising soil moisture conditions and improved air circulation to the landfarm by the installation of agricultural pipe. Landfarming typically becomes more cost effective than offsite disposal for volumes of hydrocarbons greater than around 300m^3 of soil.

For treatment and stabilisation of contamination, there are a number of other potential technologies available for a range of chemicals including heavy metals and petroleum hydrocarbons. However, unless the volume of the contamination is large and the level of the contamination is high, most of these technologies are likely to be considerably more expensive than the other alternatives discussed above.

8.6.2 Initial Assessment of Remediation Measures

Given that the proposed development will likely involve excavations of a basement(s) and therefore soil will in any case need to be excavated and disposed offsite, it is considered that excavation and disposal to landfill would likely be the main remediation strategy for the site.

Capping could also be considered where basements were not proposed providing NSH were willing to accept the resulting conditions on the site (eg notice on 149 certificate, EMP etc), particularly if large volumes of contaminated soil were identified or contamination were to be identified in inaccessible areas.

If large volumes of petroleum hydrocarbon contaminated soil are identified (eg around the underground tanks) landfarming or bioremediation may be adopted to lower the level of the contamination in the soil for reuse or offsite disposal.

Soil containing contamination exceeding the EILs but not the HILs only needs to be remediated or managed in proposed landscaped areas. Where such soil is found to be present in proposed landscaped areas, an alternative option may be to strip the impacted material and replace it in an area where no landscaping is proposed (eg underneath proposed roads or buildings).

It is important that the above assessment is preliminary only. The remediation options should be reconsidered once the extent of contamination has been assessed and the development layout is known.

8.7 Waste Management Issues Associated with Contamination

During demolition and construction, a number of wastes will be generated and will require management. Preliminary recommendations on waste management measures for the expected major waste categories are outlined below:

- Soils classifying as solid waste – Soils classifying as solid waste should be disposed of to an appropriately licensed landfill.
- Soils classifying as inert waste – Soil classifying as inert waste can either be disposed of to a landfill licensed to accept inert waste or also could potentially be reused on sites that receive no more than 20,000 tonnes of inert waste and only if the disposal of the waste is ancillary to the land being used for a purpose other than as a landfill site (eg the construction of buildings or roads or other similar types of infrastructure development). If a material is to be reused, the contamination levels must also meet the criteria on the proposed reuse site.
- Soil classifying as virgin excavated natural material (VENM) – VENM can be reused onsite or offsite.
- Soil classifying as asbestos waste – Asbestos waste should be disposed of to a licensed asbestos waste landfill. The asbestos handling should be undertaken by a licensed contractor in accordance with WorkCover requirements.

- Soil classifying as industrial waste (if any) – Soils classifying as industrial waste should be disposed of to an appropriately licensed landfill or could potentially be pre-treated to a lessor waste classification (eg to solid waste).
- Soil classifying as hazardous waste (if any) – There are currently no landfills in NSW licensed to accept hazardous waste. Hazardous waste (if encountered) would need to be pre-treated prior to offsite disposal to a licensed landfill.

A preliminary assessment of the waste classification of soils on the site was presented in Section 8.3.2. At this stage, the majority of fill material is considered likely to classify as either inert or solid waste while the majority of underlying residual soil and bedrock is likely to classify as VENM, with the possible exception of some localised areas where the underlying soil/bedrock may have been impacted by contaminants (eg around the underground diesel tank) and may classify differently. At this stage, no industrial or hazardous waste has been identified.

Groundwater disposal options would need to be assessed if basement dewatering were to be required.

9. CONCLUSIONS

Overall, based on the limited available data and the discussion presented above, it is considered that widespread soil contamination is unlikely to be present at the investigation area that would pose a major constraint to development as a hospital.

However, PAHs were detected within fill material at one location exceeding the HIL for commercial/industrial landuse while heavy metals were detected at three locations in fill material exceeding the phytotoxicity based EILs. Given the limited nature of the investigations undertaken to date, it is considered that further investigations would be required to assess if additional contamination was present and the extent of contamination.

It is considered likely, based on the site history, the limited sampling and analysis undertaken to date and our experience on similar sites, that the investigation area would be capable of being remediated for hospital (ie commercial/industrial) use. The extent of remediation required would need to be assessed based on additional investigations.

It is recommended that additional investigations be undertaken to further assess the suitability of the investigation area with respect to contamination for the proposed hospital development, as well as to assess the extent of remediation required and the waste classification of soils for offsite disposal. As discussed in Section 8.5, the additional investigations should be aimed at assessing:

- The extent and contamination status of fill material across the investigation area;
- The extent of hydrocarbon contamination (if any) in the vicinity of the identified aboveground and underground diesel tanks;
- The extent of contamination in the vicinity of Building 21 (the boiler and incinerator area) including the potential for dioxins to be present as a result of the incineration activities;
- The extent of asbestos, lead and zinc contamination in near surface soil around current and former buildings/sheds/pipes;

- The extent of contamination associated with engineering/maintenance activities including the waste collection bay in the vicinity of Building 22;
- The waste classification of soils required to be disposed of offsite either to facilitate the development (eg construction of basements) or for site remediation; and
- The contamination status of groundwater in the investigation area.

The extent of additional investigations required will depend to a large extent on the details of the proposed development and the preferred remedial strategy. A preliminary recommendation on scope for additional investigations has been presented in Table 8. It is recommended that investigation requirements be reassessed as more information regarding the proposed development layout becomes available.

10. LIMITATIONS

The findings contained within this report are the result of discrete/specific sampling methodologies used in accordance with normal practices and standard. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

It is important that the investigations reported herein, were only intended to support the master planning process. Given the size and the various potentially contaminating activities undertaken at the site historically, the limited field and laboratory investigations undertaken at the site are considered as preliminary in magnitude. Only very limited sampling and analysis was undertaken. For this reason, areas of contamination not identified in this investigation could be present at the site. More detailed investigations should be undertaken prior to redevelopment to assess the extent of remediation required to make each area suitable, with respect to contamination, for the proposed land use.

Geotechnical issues and issues associated with hazardous building materials are discussed in separate reports.

11. REFERENCES

ANZECC/ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australian and New Zealand, Canberra, ACT.

NOHSC (1988) Code of Practice for the Safe Removal of Asbestos, NOHSC:2002, National Occupational Health and Safety Commission, Canberra, ACT.

NEPC (1999) National Environmental Protection (Assessment of Site Contamination) Measure, NEPC, Canberra, ACT.

NSW EPA (1994) Contaminated Sites: Guidelines for Assessing Service Station Sites, NSW EPA, Chatswood, NSW.

NSW EPA (1995) Contaminated Sites: Sampling Design Guidelines for Contaminated Sites, NSW EPA, Chatswood, NSW.

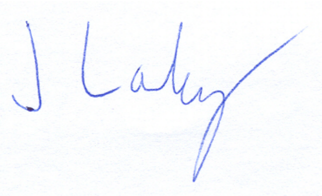
NSW EPA (1997) Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites, NSW EPA, Chatswood, NSW.

NSW EPA (1998) Contaminated Sites: Guidelines for the NSW Site Auditor Scheme, NSW EPA, Chatswood, NSW.

NSW EPA (1999) Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes, NSW EPA, Chatswood, NSW.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD



JOSHUA LASKY

Senior Environmental Engineer

EDWARD WU

Environmental Engineer

Information

Important information about your **Coffey** Environmental Site Assessment

Coffey

Uncertainties as to what lies below the ground on potentially contaminated sites can lead to remediation costs blow outs, reduction in the value of land and to delays in the redevelopment of land. These uncertainties are an inherent part of dealing with land contamination. The following notes have been prepared by Coffey to help you interpret and understand the limitations of your environmental site assessment report.

Your report has been written for a specific purpose

Your report has been developed on the basis of a specific purpose as understood by Coffey and applies only to the site or area investigated. For example, the purpose of your report may be:

- To assess the environmental effects of an on-going operation.
- To provide due diligence on behalf of a property vendor.
- To provide due diligence on behalf of a property purchaser.
- To provide information related to redevelopment of the site due to a proposed change in use, for example, industrial use to a residential use.
- To assess the existing baseline environmental, and sometimes geological and hydrological conditions or constraints of a site prior to an activity which may alter the sites environmental, geological or hydrological condition.

For each purpose, a specific approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible, quantify risks that both recognised and unrecognised contamination pose to the proposed activity. Such risks may be both financial (for example, clean up costs or limitations to the site use) and physical (for example, potential health risks to users of the site or the general public).

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man and may change with time. For example, groundwater levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project and/or on the property.

Interpretation of factual data

Environmental site assessments identify actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from indirect field measurements and sometimes other reports on the site are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of Coffey through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered with redevelopment or on-going use of the site. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. In particular, a due diligence report for a property vendor may not be suitable for satisfying the needs of a purchaser. Your report should not be applied for any purpose other than that originally specified at the time the report was issued.

Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other professionals who are affected by the report. Have Coffey explain the report implications to professionals affected by them and then review plans and specifications produced to see how they have incorporated the report findings.

Coffey

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, laboratory data, drawings etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), field testing and laboratory evaluation of field samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Contact Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to land development and land use. It is common that not all approaches will be necessarily dealt with in your environmental site assessment report due to concepts proposed at that time. As a project progresses through planning and design toward construction and/or maintenance, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

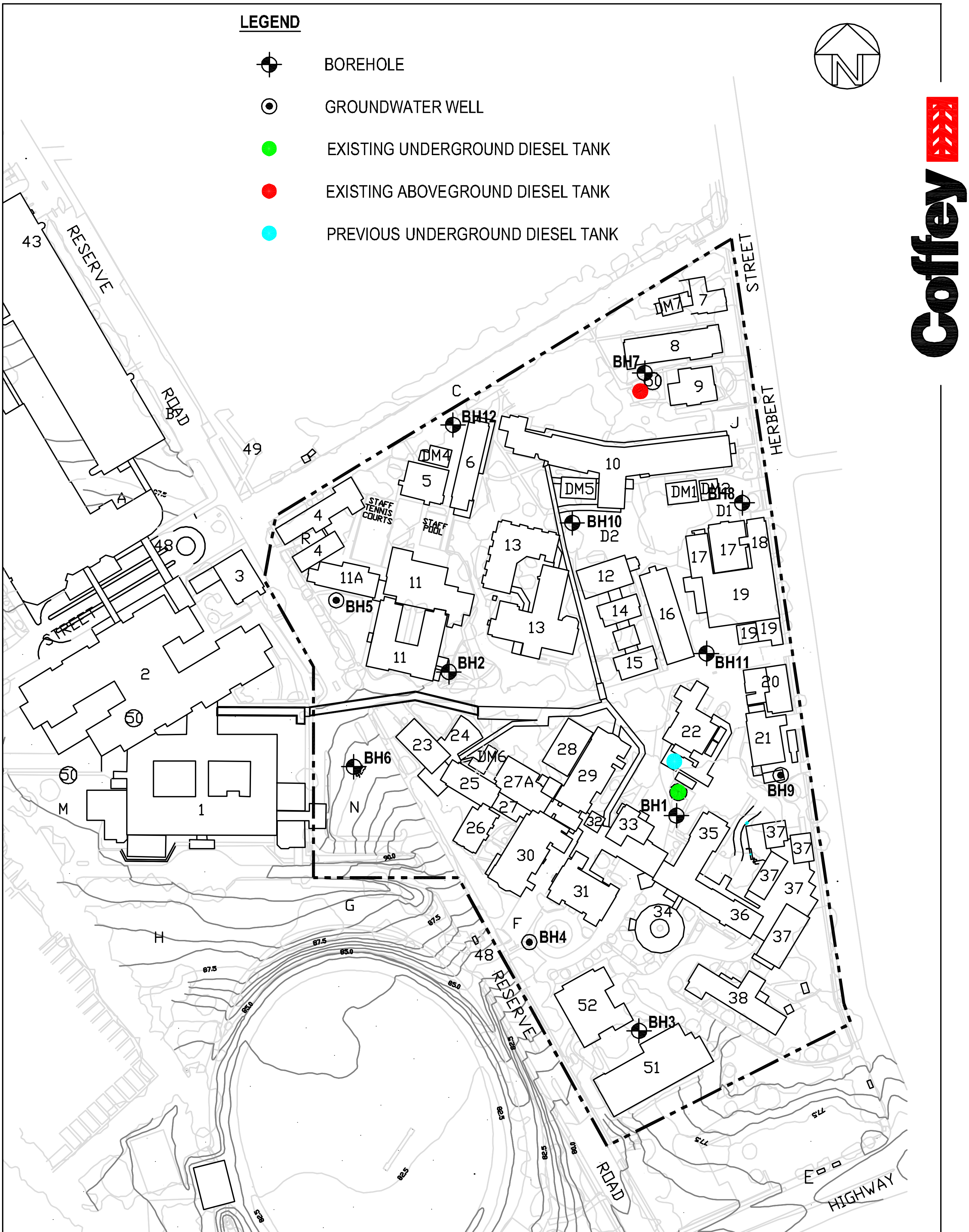
Environmental reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

FIGURES

Coffey Geosciences Pty Ltd ACN 056 335 516

Geotechnical | **Resources** | Environmental | **Technical** | Project Management

Drawn	EW/SW	NORTHERN SYDNEY HEALTH REDEVELOPMENT OF ROYAL NORTH SHORE HOSPITAL ST LEONARDS PRELIMINARY CONTAMINATION ASSESSMENT SITE LOCATION PLAN	FIGURE 1
Approved	JML		
Date	13/9/04		
Scale	1:10,000		Job no: S21855/4-AM



Coffey Geosciences Pty Ltd ACN 056 335 516

Geotechnical | **Resources** | Environmental | **Technical** | Project Management

Drawn	EW/SW	
Approved	JML	
Date	13/9/04	
Scale	1:2500	

NORTHERN SYDNEY HEALTH
REDEVELOPMENT OF ROYAL NORTH SHORE HOSPITAL
ST LEONARDS
PRELIMINARY CONTAMINATION ASSESSMENT
SITE PLAN SHOWING BOREHOLE LOCATIONS

FIGURE 2

Job no: S21855/4-AM

LABORATORY RESULTS SUMMARY TABLES

S21855/4-AM
13 September 2004

SUMMARY OF LABORATORY RESULTS FOR SOIL

(Results in mg/kg unless specified)

Sample ID			BH1	BH1	BH2A	BH3	BH3	BH4	BH5	BH6	BH7	BH7
Geological Origin	THRESHOLD		Fill	Fill	Fill	Fill	Fill	Fill	Topsoil	Fill	Fill	Residual
Date of Sampling	CONCENTRATION		3-Jun-04	3-Jun-04	11-Jun-04	4-Jun-04	4-Jun-04	4-Jun-04	7-Jun-04	8-Jun-04	8-Jun-04	8-Jun-04
Depth (m)	Human Health	Phytotoxicity	0-0.3	0.5-0.95	0-0.2	0-0.3	0.5-0.95	0.1-0.3	0-0.3	0.1-0.3	0.1-0.3	0.5-0.95
HEAVY METALS												
Arsenic	500 [1]	20 [2]	7	9	**40**	5	6	7	11	3	5	11
Cadmium	100 [1]	3 [2]	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	600000 [1]	400 [2]	11	13	10	14	28	37	27	11	25	17
Copper	5000 [1]	100 [2]	27	8	36	22	26	13	26	30	16	3
Nickel	3000 [1]	60 [2]	4	<1	4	24	37	19	6	36	12	<1
Lead	1500 [1]	600 [2]	48	79	116	21	34	8	91	6	49	18
Zinc	35000 [1]	200 [2]	65	78	106	36	37	15	62	18	15	2
Mercury	75 [1]	1 [2]	0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TOTAL PETROLEUM HYDROCARBONS												
C6 - C9 Fraction	65 [3]		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
C10 - C14 Fraction			<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction			<100	<100	<100	<100	<100	<100	<100	<100	107	<100
C29 - C36 Fraction			<100	<100	<100	<100	<100	<100	<100	<100	403	<100
Total C10-C36	1000 [3]		ND	ND	ND	ND	ND	ND	ND	ND	510	ND
BTEX												
Benzene	1 [3]		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	1.4 [3]		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2
Ethylbenzene	3.1 [3]		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Xylene	14 [3]		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
POLYCYCLIC AROMATIC HYDROCARBONS												
Naphthalene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene			0.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Anthracene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene			1.3	<0.5	0.6	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pyrene			1.3	<0.5	0.6	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benz(a)anthracene			0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chrysene			0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(bk)fluoranthene			0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene	5 [1]		0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3-cd)pyrene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz(a.h)anthracene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(g.h.i)perylene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total PAHs	100 [1]		6.5	ND	1.2	1.4	ND	ND	ND	ND	ND	ND
ORGANOCHLORINE PESTICIDES												
DDD			<0.05	-	-	-	-	-	-	-	<0.05	-
DDT	1000 [1]		<0.2	-	-	-	-	-	-	-	<0.2	-
Other OCP Analytes			ND	-	-	-	-	-	-	-	ND	-
POLYCHLORINATED BIPHENYLS												
Total PCBs	50 [1]		<0.05	-	-	-	-	-	-	-	0.2	-
ASBESTOS	ND [4]		ND	-	ND	ND	-	ND	ND	ND	ND	-

NOTES:

(shaded cell) Concentration exceeds the respective human health and/or phytotoxicity based threshold concentration

1 Based on the Health Based Soil Investigation Level in Column 4 of the NSW EPA (1998) Auditor Guidelines

2 Based on the Phytotoxicity Based Soil Investigation Level in Column 5 of the NSW EPA (1998) Auditor Guidelines

3 Based on NSW EPA (1994) Guidelines for Assessing Service Station Sites

4 Current NSW EPA Policy is that there should be no detectable asbestos in surface soil

ND Not Detected

\- Not Analysed

S21855/4-AM
13 September 2004

SUMMARY OF LABORATORY RESULTS FOR SOIL

(Results in mg/kg unless specified)

Sample ID			BH8	BH8	BH9	BH9	BH10	BH10	BH11	BH12	BH12
Geological Origin	THRESHOLD		Fill	Residual	Fill	Residual	Topsoil	Residual	Fill	Fill	Fill
Date of Sampling	CONCENTRATION		10-Jun-04	10-Jun-04	10-Jun-04	10-Jun-04	11-Jun-04	11-Jun-04	15-Jun-04	15-Jun-04	15-Jun-04
Depth (m)	Human Health	Phytotoxicity	0.1-0.3	0.4-0.85	0.2-0.5	0.6-1.05	0.1-0.4	0.5-0.75	0.15-0.3	0-0.3	0.7-1.15
HEAVY METALS											
Arsenic	500 [1]	20 [2]	6	4	3	2	**30**	9	4	**114**	10
Cadmium	100 [1]	3 [2]	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	600000 [1]	400 [2]	16	5	10	4	31	6	9	12	11
Copper	5000 [1]	100 [2]	27	9	42	2	15	3	72	20	19
Nickel	3000 [1]	60 [2]	36	<1	78	<1	24	<1	**63**	6	1
Lead	1500 [1]	600 [2]	15	7	8	14	89	12	4	42	64
Zinc	35000 [1]	200 [2]	21	2	38	<1	41	1	32	46	71
Mercury	75 [1]	1 [2]	<0.1	<0.1	0.5	<0.1	<0.1	<0.1	<0.1	<0.1	0.8
TOTAL PETROLEUM HYDROCARBONS											
C6 - C9 Fraction	65 [3]		<2	<2	<2	<2	<2	<2	<2	<2	<2
C10 - C14 Fraction			<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction			<100	<100	<100	<100	<100	<100	<100	<100	263
C29 - C36 Fraction			186	<100	<100	<100	<100	<100	<100	<100	177
Total C10-C36	1000 [3]		186	ND	ND	ND	ND	ND	ND	ND	440
BTEX											
Benzene	1 [3]		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	1.4 [3]		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	3.1 [3]		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Xylene	14 [3]		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
POLYCYCLIC AROMATIC HYDROCARBONS											
Naphthalene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.7
Acenaphthene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	6.7
Anthracene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2.5
Fluoranthene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	13.8
Pyrene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	12.7
Benz(a)anthracene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	6
Chrysene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	5.4
Benzo(bk)fluoranthene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	9.3
Benzo(a)pyrene	5 [1]		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**5.6**
Indeno(1.2.3-cd)pyrene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3
Dibenz(a.h)anthracene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Benzo(g.h.i)perylene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3.6
Total PAHs	100 [1]		ND	ND	ND	ND	ND	ND	ND	ND	71
ORGANOCHLORINE PESTICIDES											
DDD			<0.05	-	0.42	-	-	-	-	<0.05	-
DDT	1000 [1]		<0.2	-	1.4	-	-	-	-	<0.2	-
Other OCP Analytes			ND	-	ND	-	-	-	-	ND	-
POLYCHLORINATED BIPHENYLS											
Total PCBs	50 [1]		<0.1	-	<0.5	-	-	-	-	<0.1	-
ASBESTOS	ND [4]		ND	-	ND	-	ND	-	ND	ND	-

NOTES:

(shaded) Concentration exceeds the respective human health and/or phytotoxicity based threshold concentration

1 Based on the Health Based Soil Investigation Level in Column 4 of the NSW EPA (1998) Auditor Guidelines

2 Based on the Phytotoxicity Based Soil Investigation Level in Column 5 of the NSW EPA (1998) Auditor Guidelines

3 Based on NSW EPA (1994) Guidelines for Assessing Service Station Sites

4 Current NSW EPA Policy is that there should be no detectable asbestos in surface soil

ND Not Detected

\- Not Analysed

SUMMARY OF LABORATORY RESULTS FOR GROUNDWATER

(Results in µg/L unless specified)

Sample ID		BH4	BH5	BH9
Location	THRESHOLD	Mid-upgradient	Upgradient	Downgradient
Date of Sampling	CONCENTRATION	22-Jun-04	22-Jun-04	22-Jun-04
FIELD MEASUREMENTS				
pH Value		5.15	5.71	5.75
Electrical Conductivity (µS/cm)		735	1705	1944
Redox Potential (mV)		+142.1	+35.4	+24.8
Temperature (degree C)		23.7	23.4	24.6
PHYSICAL PARAMETERS (LABORATORY)				
pH Value		5.08	5.8	5.5
Sulphate (mg/L)		149	124	1130
Chloride (mg/L)		154	466	122
HEAVY METALS (µg/L)				
Arsenic - Filtered	2.3 [1,3]	**12**	**3**	1
Cadmium - Filtered	0.7 [8]	0.1	0.3	<0.1
Chromium - Filtered	4.4 [3,4]	<1	<1	<1
Copper - Filtered	1.3 [2]	**4**	<1	<1
Nickel - Filtered	7 [8]	**10**	**9**	**48**
Lead - Filtered	4.4 [2]	<1	4	<1
Zinc - Filtered	15 [2]	**105**	**81**	**126**
Mercury - Filtered	0.1 [8]	<0.1	<0.1	<0.1
TOTAL PETROLEUM HYDROCARBONS (µg/L)				
C6 - C9 Fraction		<20	<20	<20
C10 - C14 Fraction		<50	<50	<50
C15 - C28 Fraction		<100	<100	<100
C29 - C36 Fraction		<50	<50	<50
Total C6-C36	325 [3]	ND	ND	ND
BTEX (µg/L)				
Benzene	500 [8]	<1	<1	<1
Toluene	180 [2,6]	<2	<2	<2
Ethylbenzene	5 [2,6]	<2	<2	<2
Total Xylenes	200 [1]	<4	<4	<4
POLYCYCLIC AROMATIC HYDROCARBONS (µg/L)				
Naphthalene	70 [7]	<1	<1	<1
Phenanthrene	0.6 [7]	<1	<1	<1
Anthracene	0.01 [7]	<1	<1	<1
Fluoranthene	1 [7]	<1	<1	<1
Benzo(a)pyrene	0.1 [7]	<0.5	<0.5	<0.5
Other PAH Analytes		<1	<1	<1

NOTES:
(shaded) Concentration exceeds the respective trigger value for protection of aquatic ecosystems
1 Based on the ANZECC (2000) Trigger Values for Fresh Water (95% Protection of Species)
2 Based on the ANZECC (2000) Trigger Values for Marine Water (95% Protection of Species)
3 Criteria for Arsenic III in marine water whereas our results are for total arsenic.
4 Criteria for Chromium VI
5 Dutch (1994) average of the target and intervention values
6 Low reliability trigger values
7 Low reliability trigger values for protection of 99% of species
8 Based on the ANZECC (2000) Trigger Values for Marine Water (99% Protection of Species)
\- Not Analysed
ND Not Detected

Coffey

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SUMMARY OF LABORATORY RESULTS FOR WASTE CLASSIFICAITON

(TCLP results in mg/L unless specified)

Sample ID				BH1	BH1	BH2A	BH3	BH3	BH4	BH5	BH6	BH7	BH7
Geological Origin	THRESHOLD			Fill	Fill	Fill	Fill	Fill	Fill	Topsoil	Fill	Fill	Residual
Date of Sampling	CONCENTRATION			3-Jun-04	3-Jun-04	11-Jun-04	4-Jun-04	4-Jun-04	4-Jun-04	7-Jun-04	8-Jun-04	8-Jun-04	8-Jun-04
Depth (m)	Inert	Solid	Industrial	0-0.3	0.5-0.95	0-0.2	0-0.3	0.5-0.95	0.1-0.3	0-0.3	0.1-0.3	0.1-0.3	0.5-0.95
HEAVY METALS													
Arsenic	500 [1]	500 [2]	2000 [3]	7	9	40	5	6	7	11	3	5	11
Cadmium	100 [1]	100 [2]	400 [3]	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium - total	1900 [1]	1900 [2]	7600 [3]	11	13	10	14	28	37	27	11	25	17
Copper				27	8	36	22	26	13	26	30	16	3
Nickel	1050 [1]	1050 [2]	4200 [3]	4	<1	4	24	37	19	6	36	12	<1
Lead	1500 [1]	1500 [2]	6000 [3]	48	79	116	21	34	8	91	6	49	18
Zinc				65	78	106	36	37	15	62	18	15	2
Mercury	50 [1]	50 [2]	200 [3]	0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TOTAL PETROLEUM HYDROCARBONS													
C6 - C9 Fraction	650 [1]	650 [2]	2600 [3]	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
C10 - C14 Fraction				<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction				<100	<100	<100	<100	<100	<100	<100	<100	107	<100
C29 - C36 Fraction				<100	<100	<100	<100	<100	<100	<100	<100	403	<100
Total C10-C36	5000 [1]	10000 [2]	40000 [3]	ND	ND	ND	ND	ND	ND	ND	ND	510	ND
BTEX													
Benzene	1 [4]	10 [5]	40 [6]	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	28.8 [4]	288 [5]	1152 [6]	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2
Ethylbenzene	60 [4]	600 [5]	2400 [6]	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total Xylene	100 [4]	1000 [5]	4000 [6]	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
POLYCYCLIC AROMATIC HYDROCARBONS													
Benzo(a)pyrene	1 [1]	10 [2]	23 [3]	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total PAHs	200 [1]	200 [2]	800 [3]	6.5	ND	1.2	1.4	ND	ND	ND	ND	ND	ND
OTHERS													
Total OCP	2 [1]	<50 [2]	<50 [3]	ND	-	-	-	-	-	-	-	ND	-
PCBs	2 [1]	<50 [2]	<50 [3]	<0.05	-	-	-	-	-	-	-	0.2	-
Asbestos	See Note 10 below			ND	-	ND	ND	-	ND	ND	ND	ND	-
LEACHABILITY BASED ON TCLP (mg/L)													
Arsenic	0.5 [7]	5 [8]	20 [9]	-	-	<0.1	-	-	-	-	-	-	-
Cadmium	0.1 [7]	1 [8]	4 [9]	-	-	<0.1	-	-	-	-	-	-	-
Chromium - total	0.5 [7]	5 [8]	20 [9]	-	-	<0.1	-	-	-	-	-	-	-
Copper				-	-	-	-	-	-	-	-	-	-
Nickel	0.2 [7]	2 [8]	8 [9]	-	-	<0.1	-	-	-	-	-	-	-
Lead	0.5 [7]	5 [8]	20 [9]	-	-	<0.1	-	-	-	-	-	-	-
Zinc				-	-	-	-	-	-	-	-	-	-
Mercury	0.02 [7]	0.2 [8]	0.8 [9]	-	-	<0.01	-	-	-	-	-	-	-
Benzo(a)pyrene	0.004 [7]	0.04 [8]	0.16 [9]	-	-	<0.0005	-	-	-	-	-	-	-

NOTES:

	Concentration exceeds Inert Waste Criteria
	Concentration exceeds Inert and Solid Waste Criteria
	Concentration exceeds Inert, Solid and Industrial Waste Criteria
	Asbestos Waste
1	Based on the Inert Waste Criteria (SCC1) in Table A4 of NSW EPA (1999)
2	Based on the Solid Waste Criteria (SCC2) in Table A4 of NSW EPA (1999)
3	Based on the Industrial Waste Criteria (SCC3) in Table A4 of NSW EPA (1999)
4	Based on the Inert Waste Criteria (CT1) in Table A3 of NSW EPA (1999)
5	Based on the Solid Waste Criteria (CT2) in Table A3 of NSW EPA (1999)
6	Based on the Industrial Waste Criteria (CT3) in Table A3 of NSW EPA (1999)
7	Based on the Inert Waste Criteria (TCLP1) in Table A4 of NSW EPA (1999)
8	Based on the Solid Waste Criteria (TCLP2) in Table A4 of NSW EPA (1999)
9	Based on the Industrial Waste Criteria (TCLP3) in Table A4 of NSW EPA (1999)
10	Material containing asbestos classifies as asbestos waste
ND	Not Detected
-	Not Analysed

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SUMMARY OF LABORATORY RESULTS FOR WASTE CLASSIFICATION

(TCLP results in mg/L unless specified)

Sample ID				BH8	BH8	BH9	BH9	BH10	BH10	BH11	BH12	BH12
Geological Origin	THRESHOLD			Fill	Residual	Fill	Residual	Topsoil	Residual	Fill	Fill	Fill
Date of Sampling	CONCENTRATION			10-Jun-04	10-Jun-04	10-Jun-04	10-Jun-04	11-Jun-04	11-Jun-04	15-Jun-04	15-Jun-04	15-Jun-04
Depth (m)	Inert	Solid	Industrial	0.1-0.3	0.4-0.85	0.2-0.5	0.6-1.05	0.1-0.4	0.5-0.75	0.15-0.3	0-0.3	0.7-1.15
HEAVY METALS												
Arsenic	500 [1]	500 [2]	2000 [3]	6	4	3	2	30	9	4	114	10
Cadmium	100 [1]	100 [2]	400 [3]	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium - total	1900 [1]	1900 [2]	7600 [3]	16	5	10	4	31	6	9	12	11
Copper				27	9	42	2	15	3	72	20	19
Nickel	1050 [1]	1050 [2]	4200 [3]	36	<1	78	<1	24	<1	63	6	1
Lead	1500 [1]	1500 [2]	6000 [3]	15	7	8	14	89	12	4	42	64
Zinc				21	2	38	<1	41	1	32	46	71
Mercury	50 [1]	50 [2]	200 [3]	<0.1	<0.1	0.5	<0.1	<0.1	<0.1	<0.1	<0.1	0.8
TOTAL PETROLEUM HYDROCARBONS												
C6 - C9 Fraction	650 [1]	650 [2]	2600 [3]	<2	<2	<2	<2	<2	<2	<2	<2	<2
C10 - C14 Fraction				<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction				<100	<100	<100	<100	<100	<100	<100	<100	263
C29 - C36 Fraction				186	<100	<100	<100	<100	<100	<100	<100	177
Total C10-C36	5000 [1]	10000 [2]	40000 [3]	186	ND	ND	ND	ND	ND	ND	ND	440
BTEX												
Benzene	1 [4]	10 [5]	40 [6]	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	28.8 [4]	288 [5]	1152 [6]	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	60 [4]	600 [5]	2400 [6]	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total Xylene	100 [4]	1000 [5]	4000 [6]	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
POLYCYCLIC AROMATIC HYDROCARBONS												
Benzo(a)pyrene	1 [1]	10 [2]	23 [3]	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**5.6**
Total PAHs	200 [1]	200 [2]	800 [3]	ND	ND	ND	ND	ND	ND	ND	ND	71
OTHERS												
Total OCP	2 [1]	<50 [2]	<50 [3]	ND	-	1.82	-	-	-	-	ND	-
PCBs	2 [1]	<50 [2]	<50 [3]	<0.1	-	<0.5	-	-	-	-	<0.1	-
Asbestos	See Note 10 below			ND	-	ND	-	ND	-	ND	ND	-
LEACHABILITY BASED ON TCLP (mg/L)												
Arsenic	0.5 [7]	5 [8]	20 [9]	-	-	-	-	<0.1	-	-	<0.1	<0.1
Cadmium	0.1 [7]	1 [8]	4 [9]	-	-	-	-	<0.1	-	-	<0.1	<0.1
Chromium - total	0.5 [7]	5 [8]	20 [9]	-	-	-	-	<0.1	-	-	<0.1	<0.1
Copper				-	-	-	-	-	-	-	-	-
Nickel	0.2 [7]	2 [8]	8 [9]	-	-	-	-	<0.1	-	-	<0.1	<0.1
Lead	0.5 [7]	5 [8]	20 [9]	-	-	-	-	0.1	-	-	<0.1	<0.1
Zinc				-	-	-	-	-	-	-	-	-
Mercury	0.02 [7]	0.2 [8]	0.8 [9]	-	-	-	-	<0.01	-	-	<0.01	<0.01
Benzo(a)pyrene	0.004 [7]	0.04 [8]	0.16 [9]	-	-	-	-	<0.0005	-	-	<0.0005	<0.0005

NOTES:

- (green) Concentration exceeds Inert Waste Criteria
- (yellow) Concentration exceeds Inert and Solid Waste Criteria
- (pink) Concentration exceeds Inert, Solid and Industrial Waste Criteria
- (hatched) Asbestos Waste

1 Based on the Inert Waste Criteria (SCC1) in Table A4 of NSW EPA (1999)
2 Based on the Solid Waste Criteria (SCC2) in Table A4 of NSW EPA (1999)
3 Based on the Industrial Waste Criteria (SCC3) in Table A4 of NSW EPA (1999)
4 Based on the Inert Waste Criteria (CT1) in Table A3 of NSW EPA (1999)
5 Based on the Solid Waste Criteria (CT2) in Table A3 of NSW EPA (1999)
6 Based on the Industrial Waste Criteria (CT3) in Table A3 of NSW EPA (1999)
7 Based on the Inert Waste Criteria (TCLP1) in Table A4 of NSW EPA (1999)
8 Based on the Solid Waste Criteria (TCLP2) in Table A4 of NSW EPA (1999)
9 Based on the Industrial Waste Criteria (TCLP3) in Table A4 of NSW EPA (1999)
10 Material containing asbestos classifies as asbestos waste
ND Not Detected
\- Not Analysed