ENVIRON

Site Audit Report

Remediation Action Plan

Lee 4, Honeysuckle Drive, Newcastle

for

Honeysuckle Development Corporation

December 2007

Ref: AS120642A

Audit GN75

ENVIRON

21 December 2007 Our Ref: AS120642A

Honeysuckle Development Corporation
PO Box 813
Newcastle NSW 2300

Dear Jacob

Re: Site Audit Report – Remedial Action Plan, Lee 4, Honeysuckle Drive, Newcastle

I have pleasure in submitting the Site Audit Report for the subject site. The Site Audit Statement, produced in accordance with the NSW Contaminated Land Management Act 1997 follows this letter. The Audit was commissioned by Honeysuckle Development Corporation to assess the suitability of a plan of remediation.

This Site Audit Report is not currently required by regulation or legislation and therefore is a non-statutory audit.

Thank you for giving me the opportunity to conduct this Audit. Please call me on 9954 8100 if you have any questions.

Yours faithfully,
ENVIRON Australia Pty Ltd

Graeme Nyland
EPA Accredited Site Auditor 9808

NSW Site Auditor Scheme
SITE AUDIT STATEMENT

Department of Environment and Conservation (NSW)

A site audit statement summarises the findings of a site audit. For full details of the site auditor's findings, evaluations and conclusions, refer to the associated site audit report.

This form was approved under the* Contaminated Land Management Act 1997 *on 21 February 2005. For more information about completing this form, go to Part IV.

PART I: Site audit identification

Site audit statement no. GN 75

This site audit is a ~~**statutory audit**~~**/non-statutory audit*** within the meaning of the *Contaminated Land Management Act 1997*.

Site auditor details (as accredited under the *Contaminated Land Management Act 1997*)

Name:	Graeme Nyland	Company:	ENVIRON Australia Pty Ltd
Address:	Level 3, 100 Miller St (PO Box 560)		
	North Sydney NSW	Postcode:	2060
Phone:	02 9954 8100	Fax:	02 9954 8150

Site details

Address: 'Lee 4' Honeysuckle Drive, Newcastle, NSW

Postcode: 2293

Property description *(attach a list if several properties are included in the site audit)*

Part Lot 230 DP 1094812 (Previously Part Lot 1111 DP 1027135, see Attachment at end of Part 1 of this Statement)

Local Government Area: Newcastle City Council

Area of site (e.g. hectares): 0.7644 ha

Current zoning: 3(c) City Centre Zone

To the best of my knowledge, the site ~~**is**~~**/is not*** the subject of a declaration, order, agreement or notice under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*.

Declaration/Order/Agreement/Notice* no(s): N/A

**** Strike out as appropriate***

Site audit commissioned by

Name: Peter Bowles Company: Honeysuckle Development Corporation (HDC)

Address: PO Box 819, Newcastle NSW

Postcode: 2300

Phone: 02 4904 2750 Fax: 02 4904 2751

Name and phone number of contact person (if different from above)

Jacob Whiting

Purpose of site audit

☐ ~~A. To determine land use suitability *(please specify intended use[s])*~~

……...

OR

☐ ~~B(i) To determine the nature and extent of contamination, and/or~~

☑ B(ii) To determine the appropriateness of an ~~**investigation/**~~**remedial action/**~~**management**~~ **plan***, and/or

☐ ~~B(iii) To determine if the land can be made suitable for a particular use or uses by implementation of a specified remedial action plan/management plan* (please specify intended use[s])~~

……..

Information sources for site audit

Consultancy(ies) which conducted the site investigation(s) and/or remediation

- PPK Environment and Infrastructure (PPK) Pty Ltd.
- Parsons Brinkerhoff Australia Pty Ltd (PB) (formerly PPK)
- JBS Environmental Pty Ltd (JBS).

Title(s) of report(s) reviewed:

- Draft ‘Sampling and Analysis Plan Honeysuckle Development’ dated January 2002 by PPK.
- ‘Sampling and Analysis Plan Honeysuckle Development’ dated March 2002 by PPK.
- Draft ‘Environmental Site Assessment, Lee 4, (Part Lot 1111 DP 1027135) Honeysuckle, NSW’ dated June 2002 by PPK.
- ‘Environmental Site Assessment, Lee 4, (Part Lot 1111 DP 1027135) Honeysuckle, NSW’ dated November 2002 by PB.

**** Strike out as appropriate***

- ‘Sampling, Analysis and Quality Plan. Honeysuckle Development Corporation. Lee 4. Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle, NSW’ dated February 2007 by JBS.
- ‘Supplementary Contamination Assessment. Honeysuckle Development Corporation. Cottage Creek Remediation. Lee 4, Honeysuckle Drive, Newcastle NSW’ dated May 2007 by JBS.
- ‘Remedial Action Plan. Honeysuckle Development Corporation. Lee 4 Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle NSW’ dated June 2007 by JBS.
- ‘Remedial Action Plan. Honeysuckle Development Corporation. Lee 4 Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle NSW’ dated June 2007 by JBS.
- ‘Supplementary Contamination Assessment. Honeysuckle Development Corporation. Cottage Creek Remediation. Lee 4, Honeysuckle Drive, Newcastle NSW’ dated October 2007 by JBS.
- ‘Remedial Action Plan. Honeysuckle Development Corporation. Lee 4 Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle NSW’ dated October 2007 by JBS.

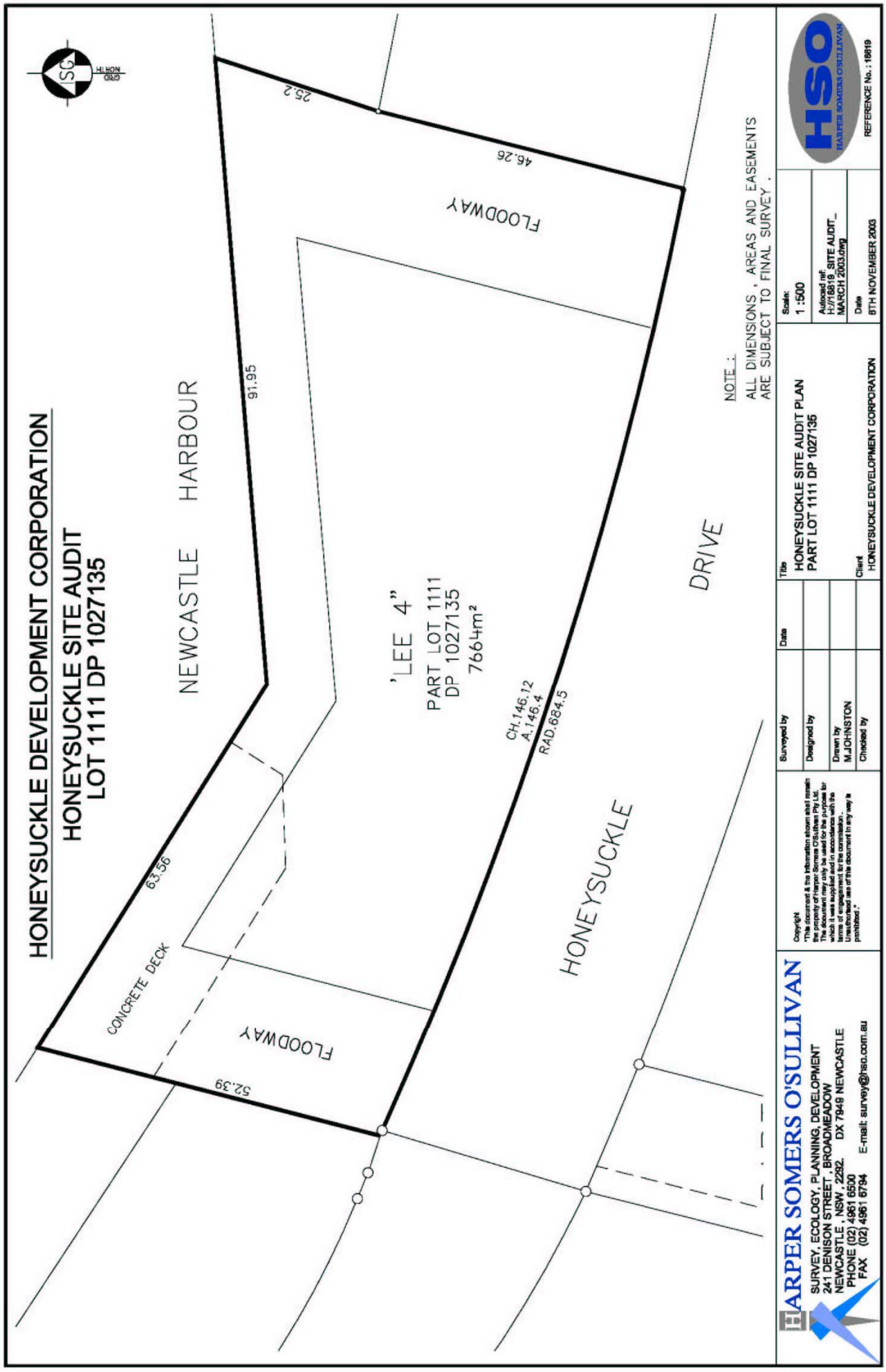
Other information reviewed (including previous site audit reports and statements relating to the site)

N/A

Site audit report

Title: Site Audit Report – Remediation Action Plan, Lee 4, Honeysuckle Drive, Newcastle

Report no. GN 75 (Environ Ref: AS120642A) Date: December 2007


HONEYSUCKLE DEVELOPMENT CORPORATION
HONEYSUCKLE SITE AUDIT
LOT 1111 DP 1027135
NEWCASTLE HARBOUR
'LEE 4"
PART LOT 1111
DP 1027135
766Hm²
FLOODWAY
FLOODWAY
CONCRETE DECK
HONEYSUCKLE DRIVE
91.95
25.2
46.26
63.56
52.39
CH.146.12
A.146.4
RAD.684.5
NOTE :
ALL DIMENSIONS , AREAS AND EASEMENTS
ARE SUBJECT TO FINAL SURVEY .
HARPER SOMERS O'SULLIVAN
SURVEY, ECOLOGY, PLANNING, DEVELOPMENT
241 DENISON STREET , BROADMEADOW
NEWCASTLE , NSW , 2292. DX 7949 NEWCASTLE
PHONE (02) 4961 6500
FAX (02) 4961 6794 E-mail: survey@hso.com.au
Copyright
Surveyed by
Designed by
Drawn by
M.JOHNSTON
Checked by
Date
Title
HONEYSUCKLE SITE AUDIT PLAN
PART LOT 1111 DP 1027135
Client
HONEYSUCKLE DEVELOPMENT CORPORATION
Scale:
1 :500
Autocad ref:
H:/18819_SITE AUDIT_
MARCH 2003.dwg
Date
8TH NOVEMBER 2003
HSO
HARPER SOMERS O'SULLIVAN
REFERENCE No. : 18819

PART II: Auditor's findings

Please complete either Section A or Section B, **not** both. *(Strike out the irrelevant section.)*

Use Section A where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land use(s).

Use Section B where the audit is to determine the nature and extent of contamination and/or the appropriateness of an investigation or remedial action or management plan and/or whether the site can be made suitable for a specified land use or uses subject to the successful implementation of a remedial action or management plan.

Section A

- ❑ **I certify that, in my opinion, the site is SUITABLE for the following use(s)** *(tick all appropriate uses and strike out those not applicable)*:
  - ❑ Residential, including substantial vegetable garden and poultry
  - ❑ Residential, including substantial vegetable garden, excluding poultry
  - ❑ Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry
  - ❑ Day care centre, preschool, primary school
  - ❑ Residential with minimal opportunity for soil access, including units
  - ❑ Secondary school
  - ❑ Park, recreational open space, playing field
  - ❑ Commercial/industrial
  - ❑ Other *(please specify)* ……

  subject to compliance with the following environmental management plan *(insert title, date and author of plan)* **in light of contamination remaining on the site:**

  ……

  ……

  ……

OR

- ❑ **I certify that, in my opinion, the site is NOT SUITABLE for any use due to the risk of harm from contamination.**

Overall comments

……

……

……

……

Section B

Purpose of the plan[1] which is the subject of the audit is to document procedures that will be undertaken to make the site suitable for the proposed mixed residential/commercial use while ensuring the protection of human health and the surrounding environment.

I certify that, in my opinion:

☑ **the nature and extent of the contamination HAS/~~HAS NOT~~* been appropriately determined**

AND/~~OR~~

☑ **the ~~investigation~~/remedial action plan/~~management plan*~~ IS/~~IS NOT*~~ appropriate for the purpose stated above**

AND/~~OR~~

☑ **the site CAN BE MADE SUITABLE for the following uses** *(tick all appropriate uses and strike out those not applicable)*:

- ☐ ~~Residential, including substantial vegetable garden and poultry~~
- ☐ ~~Residential, including substantial vegetable garden, excluding poultry~~
- ☐ ~~Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry~~
- ☐ ~~Day care centre, preschool, primary school~~
- ☑ Residential with minimal opportunity for soil access, including units
- ☐ ~~Secondary school~~
- ☐ ~~Park, recreational open space, playing field~~
- ☑ Commercial/industrial
- ☐ ~~Other *(please specify)* ……~~

if the site is remediated/~~managed*~~ in accordance with the following remedial action plan/~~management plan~~* *(insert title, date and author of plan)*

'Remedial Action Plan. Honeysuckle Development Corporation. Lee 4 Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle NSW' dated October 2007 by JBS.

subject to compliance with the following condition(s):

A Site Audit Statement certifying suitability should be prepared at the successful completion of remediation.

[1] For simplicity, this statement uses the term 'plan' to refer to both plans and reports.

**** Strike out as appropriate***

Overall comments

Fill materials impacted by PAHs, petroleum hydrocarbons and manganese are located over the surface of the entire site. The RAP proposes the excavation and off-site disposal of the upper 0.5 m (and deeper where required) of the site and subsequent validation by suitably qualified personnel that are familiar with the materials on-site.

There is a risk that deeper pockets of impacts may remain undetected. The remedial and construction works should ensure that the materials are visually validated. Soil removal methods could push impacted materials deeper and the method for removal should ensure that the underlying materials are not cross contaminated.

PART III: Auditor's declaration

I am accredited as a site auditor by the NSW Environment Protection Authority under the *Contaminated Land Management Act 1997* (Accreditation No. 9808).

I certify that:

- I have completed the site audit free of any conflicts of interest as defined in the *Contaminated Land Management Act 1997,* and
- with due regard to relevant laws and guidelines, I have examined and am familiar with the reports and information referred to in Part I of this site audit, and
- on the basis of inquiries I have made of those individuals immediately responsible for making those reports and obtaining the information referred to in this statement, those reports and that information are, to the best of my knowledge, true, accurate and complete, and
- this statement is, to the best of my knowledge, true, accurate and complete.

I am aware that there are penalties under the *Contaminated Land Management Act 1997* for wilfully making false or misleading statements.

Signed ……ORIGINAL SIGNED BY G.NYLAND……. Date …21 DECEMBER 2007….

PART IV: Explanatory notes

To be complete, a site audit statement form must be issued with all four parts.

How to complete this form

Part I identifies the auditor, the site, the purpose of the audit and the information used by the auditor in making the site audit findings.

Part II contains the auditor's opinion of the suitability of the site for specified uses or of the appropriateness of an investigation, or remedial action or management plan which may enable a particular use. It sets out succinct and definitive information to assist decision-making about the use(s) of the site or a plan or proposal to manage or remediate the site.

The auditor is to complete either Section A or Section B of Part II, **not** both.

In **Section A** the auditor may conclude that the land is *suitable* for a specified use(s) OR *not suitable* for any beneficial use due to the risk of harm from contamination.

By certifying that the site is *suitable*, an auditor declares that, at the time of completion of the site audit, no further remediation or investigation of the site was needed to render the site fit for the specified use(s). Any **condition** imposed should be limited to implementation of an environmental management plan to help ensure the site remains safe for the specified use(s). The plan should be legally enforceable: for example a requirement of a notice under the *Contaminated Land Management Act 1997* (CLM Act) or a development consent condition issued by a planning authority. There should also be appropriate public notification of the plan, e.g. on a certificate issued under s.149 of the *Environmental Planning and Assessment Act 1979*.

Auditors may also include **comments** which are key observations in light of the audit which are not directly related to the suitability of the site for the use(s). These observations may cover aspects relating to the broader environmental context to aid decision-making in relation to the site.

In **Section B** the auditor draws conclusions on the nature and extent of contamination, and/or suitability of plans relating to the investigation, remediation or management of the land, and/or whether land can be made suitable for a particular land use or uses upon implementation of a remedial action or management plan.

By certifying that a site *can be made suitable* for a use or uses if remediated or managed in accordance with a specified plan, the auditor declares that, at the time the audit was completed, there was sufficient information satisfying guidelines made or approved under the CLM Act to determine that implementation of the plan was feasible and would enable the specified use(s) of the site in the future.

For a site that *can be made suitable*, any **conditions** specified by the auditor in Section B should be limited to minor modifications or additions to the specified plan. However, if the auditor considers that further audits of the site (e.g. to validate remediation) are required, the auditor must note this as a condition in the site audit statement.

Auditors may also include **comments** which are observations in light of the audit which provide a more complete understanding of the environmental context to aid decision-making in relation to the site.

In **Part III** the auditor certifies his/her standing as an accredited auditor under the CLM Act and makes other relevant declarations.

Where to send completed forms

In addition to furnishing a copy of the audit statement to the person(s) who commissioned the site audit, statutory site audit statements must be sent to:

Department of Environment and Conservation (NSW)
Contaminated Sites Section
PO Box A290, SYDNEY SOUTH NSW 1232
Fax: (02) 9995 5930

AND

the **local council** for the land which is the subject of the audit.

Table of Contents

List of Tables and Figures

List of Appendices

List of Abbreviations

AHD	Australian Height Datum
ALS	Australian Laboratory Services
ASET	Australian Safer Environment and Technology Pty Ltd. (Laboratory)
ANZECC	Australian and New Zealand Environment and Conservation Council
BaP	Benzo(a)pyrene
BGL	below ground level
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes (Monocyclic aromatic Hydrocarbons)
CN	Cyanide (total or free)
CT	Certificate of Title
DP	Deposited Plan
DQO	Data Quality Objectives
EPA	Environment Protection Authority (NSW)
ESA	Environmental Site Assessment report
ha	Hectare
HDC	Honeysuckle Development Corporation
km	Kilometres
LOR	Limit of Reporting
m	Metres
MAH	Monocyclic Aromatic Hydrocarbons
Mercury	Inorganic mercury unless noted otherwise
Metals	As: Arsenic, Cd: Cadmium, Cr: Chromium, Cu: Copper, Fe: Iron, Ni: Nickel, Pb: Lead, Zn: Zinc, Hg: Mercury, Se: Selenium
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
m BGL	Metres below ground level
mg/L	Micrograms per Litre
NATA	National Association of Testing Authorities
NC	Not Calculated
ND	Not Detected
ng/L	Nanograms per Litre
NEHF	National Environmental Health Forum
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
n	Number of Samples
OCPs	Organochlorine Pesticides
OH&S	Occupational Health & Safety
OPPs	Organophosphorus Pesticides
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PID	Photoionisation Detector
PQL	Practical Quantitation Limit
pH	a measure of acidity, hydrogen ion activity
QA/QC	Quality Assurance/Quality Control
RPD	Relative Percent Difference
SILs	Soil Investigation Levels
SVOCs	Semi Volatile Organic Compounds
SPLP	Synthetic Precipitation Leaching Procedure
TCLP	Toxic Characteristic Leaching Potential
TPHs	Total Petroleum Hydrocarbons
UCL	Upper Confidence Limit
VENM	virgin excavated natural material
VOCs	Volatile Organic Compounds
-	On tables is "not calculated", "no criteria" or " not applicable"

1. INTRODUCTION

A site contamination audit has been conducted for Honeysuckle Development Corporation relating to Part Lot 230 DP 1094812 located on Honeysuckle Drive, Newcastle, NSW (Attachment 1, Appendix A).

The Audit was conducted to provide an independent review of the suitability and appropriateness of a plan of remediation i.e. an audit for the purpose stated in Section 47 (1) (b) (iv) of the *NSW Contaminated Land Management Act 1997* (the CLM Act).

Details of the audit are:

Requested by:	Peter Bowles on behalf of Honeysuckle Development Corporation (HDC)
Request/Commencement Date:	8 February 2002
Auditor:	Graeme Nyland
Accreditation No.:	9808

The scope of the audit included:

- Review of the following reports:
  - Draft 'Sampling and Analysis Plan Honeysuckle Development' dated January 2002 by PPK Environment and Infrastructure (PPK) Pty Ltd.
  - 'Sampling and Analysis Plan Honeysuckle Development' dated March 2002 by PPK.
  - Draft 'Environmental Site Assessment, Lee 4, (Part Lot 1111 DP 1027135) Honeysuckle, NSW' dated June 2002 by PPK.
  - 'Environmental Site Assessment, Lee 4, (Part Lot 1111 DP 1027135) Honeysuckle, NSW' dated November 2002 by Parsons Brinkerhoff Australia Pty Ltd (PB).
  - 'Sampling, Analysis and Quality Plan. Honeysuckle Development Corporation. Lee 4. Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle, NSW' dated February 2007 by JBS Environmental Pty Ltd (JBS).
  - 'Supplementary Contamination Assessment. Honeysuckle Development Corporation. Cottage Creek Remediation. Lee 4, Honeysuckle Drive, Newcastle NSW' dated May 2007 by JBS.
  - 'Remedial Action Plan. Honeysuckle Development Corporation. Lee 4 Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle NSW' dated June 2007 by JBS.
  - 'Supplementary Contamination Assessment. Honeysuckle Development Corporation. Cottage Creek Remediation. Lee 4, Honeysuckle Drive, Newcastle NSW' dated October 2007 by JBS.

- ‘Remedial Action Plan. Honeysuckle Development Corporation. Lee 4 Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle NSW’ dated October 2007 by JBS (the RAP).

- A site visit on 27 March 2007 and earlier site inspections.

- Discussions with HDC and with JBS who undertook the investigation in 2007 and prepared the RAP.

2. SITE DETAILS

2.1. Location

The site details are as follows:

Street address:	'Lee 4' Honeysuckle Drive, Newcastle, NSW 2293.
Identifier:	Part Lot 230 DP 1094812 (Previously Part Lot 1111 DP 1027135) (Attachment 2, Appendix A).
Local Government:	Newcastle City Council
Owner:	Honeysuckle Development Corporation (HDC)
Site Area:	7664 m^2

The boundaries of the site are defined by Honeysuckle Drive and Newcastle Harbour. The site is located within the larger Honeysuckle Development Area (HDA). The boundaries with Lee 5 and Park Residential are not marked in the field however follow the view scapes to the south, through the existing HDC development.

2.2. Zoning

The current zoning of the site is 3(c) City Centre Zone.

2.3. Adjacent Uses

The site is located within an area of mixed residential and commercial land uses. The current landuses located adjacent to Lee 4 are:

- Throsby Basin, a tidal channel is located along the northern boundary of the site
- Vacant land to the west (Lee 5)
- Honeysuckle Drive to the south and office buildings further to the south
- Vacant land to the east (Park Residential).

2.4. Site Condition

The site is currently bare and is being used for landfarming of material sourced from other areas across the HDC.

Lee 4 extends approximately 155 metres along Newcastle Harbour and is bounded by Honeysuckle Drive to the south. Former remnants of a wharf, predominantly pylons, are located over the north of the Site. The majority of the surface consists of weeds and sparse patches of grass, with the former Wharf Road bitumen surface located over the south. A former tramway line traverses east-west across the site. A light tower is located towards the centre of the Site. A concrete lined and covered floodway is located at the western end of the Site.

The site is relatively flat; however surface water from the Site is likely to flow towards the harbour. Some surface water from across the HDA may also flow south due to the local topography towards a stormwater system that also discharges into the harbour.

2.5. Proposed Development

It is understood that the site is to be developed at some stage for mixed residential and commercial / industrial land uses. For the purposes of this audit, the 'residential with minimal access to soil' land use scenario will be assumed.

3. SITE HISTORY

The majority of land within the HDA was reclaimed from Newcastle Harbour and the mouth of Cottage Creek during the development of the timber cargo wharves from 1908. A retaining wall was constructed along the harbour edge and dredged sands were used to fill the site. HDA has previously been used by various government authorities for rail and port related activities. The site history for Lee 4 includes the use as a wharf, storage facility and Wharf Road until 1990s, after which the road was realigned further south of the site.

In the Auditor's opinion the site history is limited. However, the high density of sampling, analyses and the proposed remediation works have compensated for the data gaps in the site history.

4. CONTAMINANTS OF CONCERN

PPK identified a number of broad activities and the likely potential contaminants of concern. Following a review of the results obtained by PPK, JBS identified a number of areas requiring further information as shown in Table 4.1.

Table 4.1 – Contaminants of Potential Concern

Area	Activity (PPK)	Potential Contaminants (PPK)	Activity (JBS)	Potential Contaminants (JBS)
Across the site	Filling	Petroleum hydrocarbons, PAHs, heavy metals	Shallow fill material	PAHs, manganese, OCPs, OPPs and PCBs
Across the site	Railway facilities	Petroleum hydrocarbons, PAHs, heavy metals, asbestos, PCBs	Old rail alignments	Petroleum hydrocarbons, PAHs, metals and asbestos
Across the site	Shipping dockyard facilities (eg storage sheds	Petroleum hydrocarbons, PAHs, heavy metals, Phenols, asbestos	Not discussed (based on locations of elevated concentrations detected by PPK)	Petroleum hydrocarbons, PAHs and heavy metals

In addition to those contaminants of concern outlined in Table 4.1, PPK (2002) identified:

- OCPs, OPPs and PCBs as contaminants of concern for the fill materials. These contaminants were included in the analytical suite by PPK. Following a review of results obtained for the HDA the Auditor considers that these compounds are no longer contaminants of concern for this site.

- Phenols were also identified as contaminants of concern by PPK in the draft report. Final reports for other sites within the HDC did not include phenol as a contaminant of concern. The Auditor considers this to be appropriate.

In the Auditor's opinion the contaminants of concern listed above are adequately reflected in the analytical suite used by PPK and JBS. The individual substances included in each analytical suite are listed in Appendix D.

5. STRATIGRAPHY AND HYDROGEOLOGY

Following a review of the reports provided a summary of the site stratigraphy and hydrogeology was compiled as follows.

5.1. Stratigraphy

The majority of land within the HDA has been reclaimed from Newcastle Harbour and Cottage Creek using fill materials. The depth of these materials varies across the HDA, increasing towards the harbour. Previous and current investigations indicate that the fill materials used across the HDA contain substances that are associated with the following:

- past rail activities i.e. railway sleepers, rail spikes
- energy production i.e. coal ash, chitter, coal tar and slag
- construction activities i.e. pipes, wood, building rubble.

The stratigraphy at Lee 4 as determined from borehole logs from JBS and PPK is summarised as Table 5.1.

Table 5.1 – Stratigraphy

Typical Depth (m)	Stratigraphy	JBS Classification
0 – 0.1	Asphalt sometimes with overlying silty sand	
0 – 1 m	Fill: Gravelly sand, fine basalt gravels, slag and concrete. The materials that contain 'slag' extended to approximately 0.5 m in the eastern corner, to 1m over the majority of the site and up to 3 m in the western corner (below the standing water level at 2 m). Only a limited number of sample descriptions provided by PPK refer specifically to slag gravels. JBS note that the slag referred to by PPK at depth > 0.5m was actually black shell grit rather than the slag encountered by JBS at shallower depths. The Auditor notes however that samples collected from these materials also reported slightly elevated concentrations of manganese, although much reduced compared to those reported at 0.1 m. The Auditor notes that delineation between materials containing slag and those containing grit will need to be robust and supported by validation sampling and documented visual observations. Within these fill materials the upper layer (0.5 m) was described by PPK and JBS as being dark brown/black.	Samples were classed as 'Slag/Basalt' fill generally < 0.5 m depth (and at depths of up to 1 m in isolated areas due to reworking) and as dredged material > 0.5 m depth.
1 – 3	Fill: Grey or yellow sand with gravels. Increased clay, organic matter and wood fragments. These materials are located below the standing groundwater level at 2m.	Dredged Material
3 - 4	Fill: Grey sand with increased shell fragments	Dredged Material

4 - 5	Alluvial sand or clayey sand brown with organic material, wood fragments and dark clay with coal seams.	Natural

Bedrock was not encountered during the investigation which extended to a maximum depth of 5 m.

5.2. Hydrogeology

Nine bores are registered within a 1km radius up or cross-gradient to the site at depths ranging between 4.9 and 10.1 metres below ground level. These bores are used for domestic, recreational and industrial uses. The Auditor notes that numerous other monitoring wells were previously located across the Honeysuckle Development area during previous investigations.

Groundwater was encountered at approximately 2 m depth below ground surface, which is consistent with the levels encountered across the Honeysuckle Development Area. While groundwater was generally encountered below the depth of filling at Lee 4, this was not the case over the centre and western section of the site. This filling mainly consists of dredged sands.

Groundwater contours generated for the Honeysuckle Development area indicate that groundwater generally flows in a north to north-west direction towards Newcastle Harbour. Given the close proximity of the Harbour to HDA it is likely that a tidal influence exists. Local groundwater contours extrapolated for Lee 4 also indicate that groundwater from this Site flows to Newcastle Harbour.

6. EVALUATION OF QUALITY ASSURANCE AND QUALITY CONTROL

The Auditor has assessed the overall quality of the data obtained by PPK and JBS by review of the information presented in the referenced reports, supplemented by field observations. The Auditor's assessment follows in Tables 6.1 and 6.2.

Table 6.1 – QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Works Undertaken	Auditor Comments
Sampling Pattern, Locations, Density and Depth	**Soil**: Grid sampling undertaken by PPK met the minimum recommended by EPA (1995) 'Sampling Design Guidelines' however not all samples were submitted for the full suite of analysis. Additional sampling was undertaken by JBS to target previously elevated results obtained by PPK, referred to by JBS as hotspots. The Auditor notes that there is no evidence, through sampling or the site history, that these elevated concentrations do not occur randomly over the entire site. Given that the remedial works outlined in the RAP are based on the assumption that the results are representative of similar materials across the site, the Auditor considers that the density is suitable to develop a remedial strategy. **Groundwater**: Four wells were previously installed along the southern (up-gradient) boundary. Two had been installed by PPK and were sampled in April 2002. Only one could be relocated by JBS and was sampled by JBS in 2007. An additional two wells were installed by JBS at the northern (down-gradient) boundary which were gauged in March and April 2007 and sampled in April 2007. In addition, approximately 20 wells comprise a groundwater well network across the Honeysuckle Development Area that the Auditor has considered.	The Auditor will consider the results for TPH in consideration of the limited coverage over the western half of the site, the limited number of PAH analysis between 0.1 and 0.5m and that of the slag material at depths greater than 0.5m. The Auditor considers that the various other potential sources of impacts were targeted by an adequate density of sampling. The density of groundwater wells on-site is considered appropriate to characterise the contaminant status.

Sampling and Analysis Plan and Sampling Methodology	Works Undertaken	Auditor Comments
Well construction	**PPK**: 'RCA indicate that 'Old MW01' was installed previously. There is no borehole log and it is not noted on the PPK site plans. The total depth of the well is 4.4 m as indicated during JBS gauging of the wells. Wells (MW02 and MW13) are screened from 1 m to 4 m. The wells are screened above the standing water levels (2 m). Casing was 0.4mm machine slotted and 50 mm in width. The wells were installed with a hollow stem auger. The wells have a bentonite seal and 2 mm sand filter pack. The wells were developed with a bailer followed by repeated purging. Wells were rested for 3 days. **JBS:** Wells are screened from 1 m to 4 m through sandy fill (one was screened through sand containing slag – this well also reported the most elevated concentrations of manganese). The wells are screened above the standing water levels (1.8 to 2.1 m). The wells were developed with a stainless steel bailer followed by repeated purging. Wells were not tested for 3 days following development. From the construction log it appears that a filter pack was placed to 0.5 m above the screened interval. The wells were installed with 'solids and hollows'.	Adequate for groundwater conditions at the site.
Sample Collection Method	**Soils** **PPK**: Excavations were completed with either a backhoe or a hollow stem auger. Samples were collected with either an SPT or directly from the auger. Surface samples from boreholes were collected from the base of the auger.	**Soil:** Collection using augers is not ideal, especially in fill, as it is difficult to accurately observe the profile. The potential loss of volatiles is not of particular concern as heavier fractions of TPH, PAHs and manganese are the main contaminants of concern. The Auditor considers that sufficient sampling has been undertaken to allow

Sampling and Analysis Plan and Sampling Methodology	Works Undertaken	Auditor Comments
	JBS: Collected using solid and hollow flight augers, and push tubes where possible. Samples were collected directly from the auger. **Groundwater**: **PPK**: New disposable bailers were used for each well across the Honeysuckle Development Area. **JBS**: A peristaltic pump was used to collect the samples.	preparation of a remedial plan. **Groundwater**: Sample collection is considered to be adequate.
Decontamination Procedures	**PPK:** All sampling equipment was cleaned in Decon 90 and rinsed with distilled water between sampling locations. The auger was high pressure cleaned between locations. **JBS:** Not discussed.	Decontamination procedures implemented by JBS were not discussed so the risk of cross-contamination cannot be assessed.
Sample handling and containers	All samples were placed into prepared and preserved sampling bottles provided by the laboratory and chilled during storage and subsequent transport to the labs. PPK and JBS do not state whether samples were filtered for metals.	Given the sandy soils, turbidity is unlikely to be high and the risk of over or under estimation due to filtering or not is predicted to be low. All other sampling handling is considered to be adequate.
Chain of Custody	Completed chain of custody forms were provided in the reports. Chain of custody forms indicate that samples were generally delivered 5 days after collection to EnviroLab. Inter-laboratory samples were sent to SGS. Inter-laboratory chain of custody forms were provided.	Trip blanks and trip spikes were included within these sample batches, the results of which will confirm sample handling practices.
Detailed description of field screening protocols including calibration	Field parameters were measured prior to groundwater sampling.	Adequate to determine whether groundwater samples are representative.
Sampling Logs	Soil logs are provided within the report, indicating sample depth, lithology and well construction. There is some discrepancy with PPK logs however this is discussed by JBS and an attempt to classify soils as ‘slag/basalt’ or ‘dredged materials’	These were considered to be adequately detailed.

Sampling and Analysis Plan and Sampling Methodology	Works Undertaken	Auditor Comments
	was made in the results tables provided by JBS.	

Table 6.2 – QA/QC – Field and Lab Quality Assurance and Quality Control

Field and Lab QA/QC		Auditor Comments
Field quality control samples	**PPK and JBS**: Field quality control samples including soil inter and intra laboratory duplicates for soil (JBS: not for OCPs, OPPs and PCBs) and groundwater were undertaken. Trip blanks and trip spikes were submitted for analysis. Rinsate blanks were undertaken by JBS.	Duplicate frequency is considered to be adequate.
Field quality control results	**JBS:** RPDs for intra and inter-laboratory duplicates were reported at up to 166%, mainly for manganese and PAHs. JBS indicate that this is likely due to the heterogeneity of the fill and that the results 'do not significantly affect the outcomes of this investigation'. **PPK** QA/QC undertaken by PPK was undertaken for the Honeysuckle Development Area as a whole (as approximately 12 sites were investigated concurrently). RPDs for soil inter-laboratory field duplicates were reported above 30% for PAHs (2/25 duplicate pairs), and metals (19/45) (mainly manganese). RPDs for soil intra-laboratory field duplicates were reported above 30% for metals (4/14 pairs). Some metals were detected in 7 of the 11 trip blanks (mainly zinc, however also copper and mercury). All other results were within the appropriate control limits.	The Auditor agrees that the fill is likely to be heterogenous given the borehole log descriptions. Given the number of samples and the consistency of the magnitudes reported, the precision is considered adequate for the purposes of the proposed RAP.

Field and Lab QA/QC		**Auditor Comments**
NATA registered laboratory and NATA endorsed methods	Laboratories used by JBS included: EnviroLab and SGS (secondary). Laboratories used by PPK included ALS and AMDEL (secondary). All laboratory certificates were NATA stamped.	NATA stamped certificates are considered adequate.
Analytical methods	Method summaries are provided in the laboratory reports. JBS undertook leachate tests including a Synthetic Precipitation Leaching Procedure (SPLP) to simulate rainfall using distilled fresh water and Toxic Characteristic Leaching Potential (TCLP). No further details were provided.	Adequate to provide accuracy and precision. The leachate tests provide an indication of relative leachability of materials under different conditions and magnitudes of contamination.
Holding times	Review of the COCs and laboratory certificates indicate that the holding times had been met except for OCPs, OPPs and PCBs that were held 28 days after sample collection. JBS considers these analytes to be stable and persistent.	The Auditor considers that OCPs, OPPs and PCBs are unlikely to be contaminants of concern. The results have only been included for completeness.
Practical Quantitation Limits (PQLs)	Not all PQLs for the groundwater assessment were sufficiently low, with the PQL for copper of 5 µg/L exceeding the trigger value of 1.3 µg/L (only in one sample due to ion interference attributed to saline water).	Given that the PQL for copper was only greater than the trigger value in one sample the discrepancy does not affect characterisation of groundwater at the site.
Laboratory quality control samples	Laboratory quality control samples including laboratory control spikes, matrix spikes, surrogate spikes, blanks, internal standards and laboratory duplicates were undertaken by the laboratory.	These were undertaken at appropriate frequencies.
Laboratory quality control results	**JBS:** Low recoveries of surrogates for PAHs were reported in two samples. Spike and surrogate recoveries for TPH and PAHs were not available for a number of batches due to significant background levels of analyte in the samples. All other results were within control limits.	Given the number of samples and the consistency of the magnitudes reported, the accuracy and precision is considered adequate for the purposes of the proposed RAP.
Data Quality Objectives and Data Evaluation	**PPK**: Predetermined data quality objectives (DQOs) were not established however PPK concluded	The Auditor considers that the DQOs for laboratory and field analysis have been met.

Field and Lab QA/QC		Auditor Comments
(completeness, comparability, representativeness, precision, accuracy)	in the review of the QA/QC that the analytical results provided are reliable and representative. **JBS**: Predetermined data quality objectives (DQOs) were provided for data collection and laboratory analysis including a plan to achieve these. Limited discussion regarding actions required if data do not meet the expected objectives was provided. The results are discussed with regard to the five category areas.	

In considering the data as a whole the Auditor concludes that:

- Data are likely to be representative of the groundwater and fill types within which they were collected.
- Adequate data was collected to characterise the two main fill types such that a RAP can be prepared i.e. data is complete for the purposes of the RAP.
- JBS have attempted to standardise soil sample descriptions provided by PPK and JBS that were not directly comparable. Groundwater results were obtained by PPK three years prior to sampling undertaken by JBS, indicating that the results may not be indicative of current conditions. There is a high degree of confidence that analytical data for soil is comparable for each sampling event.
- The laboratories provided sufficient information to conclude that data are of sufficient precision.
- Data are likely to be accurate for the contaminants of concern. Holding times were not met for OCPs, OPPs and PCBs which are not considered by the Auditor to be contaminants of concern.

7. ENVIRONMENTAL QUALITY CRITERIA

The Auditor has assessed the soil data provided by PPK and JBS in reference to Soil Investigation Levels for Urban Redevelopment Sites in NSW (SIL Column 2 – 'residential with minimal access to soil' and SIL Column 5 – 'provisional phytotoxicity-based investigation levels') in DEC (2006) *Guidelines for the NSW Site Auditor Scheme*.

EPA (1994) *Guidelines for Assessing Service Station Sites* have also been referred to for assessing TPH and BTEX results.

The Auditor has assessed the groundwater data in reference to ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* for marine waters. Trigger values (TVs) provided are concentrations that, if exceeded, indicate a potential environmental problem and 'trigger' further investigation.

The current NSW EPA position is that there should be no free phase product in groundwater, and that the aromatic components of dissolved-phase TPH in groundwater should be assessed using the ANZECC (2000) TVs where available. These guidelines include criteria for some BTEX compounds and for some polycyclic aromatic hydrocarbons.

There are no national or DEC endorsed guidelines for asbestos in soil relating to human health. DEC (2006) state that Auditors must exercise their professional judgement when assessing whether a site is suitable for a specific use. The EPA has stated that the position of the Health Department is that there should be no asbestos in surface soil.

The RAP indicates that validation results would be assessed in reference to

- National Environment Protection (Assessment of Site Contamination) Measures, National Environment Protection Council, 1999 (NEPC 1999) 'residential with minimal opportunities for soil access' for soils underlying buildings, paved area and filled areas of the site.

- EPA (1994) Guidelines for Assessing Service Station Sites for assessing TPH and BTEX results.

The RAP notes that 'in consideration to the design and density of the surrounding recent development, consideration has not been given to the provisional phytotoxicity based criteria, since any landscaped portions would be minor and involve topsoil in constructed garden areas'. The Auditor notes that this is appropriate for soils to be retained underneath buildings or slabs.

8. EVALUATION OF SOIL ANALYTICAL RESULTS

Investigations were undertaken by PPK in 2002 (Attachment 3, Appendix A) and JBS in 2007 (Attachment 4, Appendix A) with samples analysed for a variety of contaminants including petroleum hydrocarbons, PAHs, asbestos, heavy metals, OCPs and PCBs.

The sampling targeted fill material, old rail alignments and historical activities. JBS have discussed the soils as fill containing slag and basalt (characterised by elevated concentrations of PAHS, petroleum hydrocarbons and manganese) and dredged sands. The results for these are discussed in Section 8.1, 8.2 and 8.3. The remaining results for other metals and organics for all materials are discussed in Section 8.4.

8.1. Fill (slag/basalt) – Petroleum Hydrocarbons, PAHs and Manganese

Fill consisting of a gravelly clayey sand including slag is described by JBS as 'slag/basalt' fill. JBS indicate that these materials generally only extend to 0.5 m depth with sections of deeper fill due to reworking in the central part of the site.

The results for the upper 0.5 m of material are summarised in Table 8.1. The JBS RAP indicates that these materials would be removed during remedial works as outlined in Section 10.

Table 8.1 – Evaluation of Soil Analytical Results – Fill (Slag/Basalt) < 0.5 m Slag - Summary Table (mg/kg).

Analyte	n	Detections	Maximum	n > EPA (1994)	> SIL Column 2 (DEC 2006)	> SIL Column 5 (DEC 2006)
BTEX	13	0	-	0	na	na
TPH (C_6-C_9)	14	1	159	**1**	na	na
TPH (C_{10}-C_{36})	14	12	20185	**7**	na	na
Total PAHs	21	21	7377	na	**12**	na
Benzo(a)Pyrene	21	21	351	na	**13**	na
Manganese	19	19	23000	na	**11**	**15**

n *number of samples*
na *not applicable*
- *not detected above the PQLs*

The results demonstrate that these fill materials are impacted by particularly elevated concentrations of manganese, PAHs and petroleum hydrocarbons. A review of the borehole logs and the results indicates that manganese, PAHs and TPH (where tested) are well correlated. The elevated concentrations were mostly reported in samples collected at less than 0.1 m that were dark brown/black. It is not clear whether this is significant as most samples less than 0.5m were collected at less than 0.1 m.

Samples collected by JBS tended to target previously elevated results obtained by PPK referred to by JBS as hotspots. The Auditor notes that there is no evidence that these elevated

concentrations do not extend randomly over the entire site. JBS also discussed TPH hotspots due to historical spills of diesel or oil at the site. The Auditor notes that the site history does not indicate that there was fuel usage or that diesel spills were recorded. The Auditor notes that given the site history and the lack of samples between these 'hotspots' that there is no evidence that these impacts do not extend over the entire site.

Not included in Table 8.1, four samples were collected from 'slag/basalt' material at a depth greater than 0.5 m to a maximum depth of 1.5 m (above the water table). Manganese was reported at 6830 mg/kg marginally above the SIL 2 of 6000 mg/kg in one sample with the three other sample results reported in excess of the provisional phytotoxicity-based SIL 5. PAHs were elevated in one sample at 1012 mg/kg with the other two samples analysed reporting PAHs at less than 32 mg/kg. These materials were not submitted for TPH analysis.

8.2. Remaining Fill (dredged sand) – Petroleum Hydrocarbons, PAHs and Manganese

The remaining fill encountered at depths greater than 0.5 m consist mainly of yellow to grey sands with gravels. PPK noted that some of these materials included fine gravels of slag. Following intrusive works JBS consider that the materials are in fact a black shell grit. All results obtained from these materials are shown in Table 8.2. The JBS RAP indicates that the dredged materials would be retained on-site following the remedial works. Approximately 2 m of the dredged materials are located below the standing water levels.

Table 8.2 – Evaluation of Soil Analytical Results – Remaining Fill (Dredged Material) - Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	> SIL Column 2 (DEC 2006)	> SIL Column 5 (DEC 2006)
BTEX	10	0	-	0	na	na
TPH (C_6-C_9)	10	0	-	0	na	na
TPH (C_{10}-C_{36})	10	0	-	0	na	na
Total PAHs	18	17	82	na	**1**	na
Benzo(a)Pyrene	18	17	3.6	na	0	na
Manganese	32	32	1380	na	0	**4**

n *number of samples*
na *not applicable*
- *not detected above the PQLs*

Total PAHs were reported at 82 mg/kg marginally above the criteria of 80 mg/kg in one sample collected from dredged sands immediately below the interface with the fill layer. All other PAH results were less than 52 mg/kg.

Manganese was reported at more elevated concentrations in fill containing the grit than the grey to yellow sands. The maximum concentration of manganese was 1380 mg/kg with four results greater than the phytotoxicity criteria of 500 mg/kg. The natural underlying clay also reported a slightly elevated concentration of manganese at 350 mg/kg.

8.3. Leachability of Manganese

JBS undertook leachate tests including a Synthetic Precipitation Leaching Procedure (SPLP) to simulate rainfall using distilled fresh water and Toxic Characteristic Leaching Potential (TCLP) to indicate results under aggressive conditions using acetic acid. The results as shown in Table 8.3 clearly demonstrate that the 'slag/basalt' material has the potential to leach manganese. JBS also note that these materials are 'most likely to be acting as source material for groundwater impact'. These materials are being targeted for remediation as discussed in Section 10. The impact to groundwater is discussed in Section 9.

JBS conclude that manganese is slightly mobile.

JBS note that a definitive assessment of the leachability of the dredged material can not be made given the low total concentrations in the samples selected. The Auditor notes that the samples are not representative of the maximums reported (1380 mg/kg) with the maximum of 32 mg/kg chosen for leachate analysis.

The source pf manganese in the underlying alluvial clay is not clear and may have leached from the overlying materials. Manganese has been shown to be more leachable under acidic conditions than neutral. Remediation works proposed will remove the most leachable materials.

Table 8.3 – Evaluation of Soil Leachate Analytical Results (TCLP and SPLP)

Material Type	Total Manganese (mg/kg)	TCLP (mg/L)	SPLP (mg/L)
'slag/basalt'	16000	**68**	**0.23**
Alluvial clayey sand	350	**4.7**	< 0.01
Dredged Material (yellow to grey sand with no slag noted)	32	**0.1**	**0.13**
Dredged Material (yellow sand with no slag noted)	10	**0.14**	< 0.01
Dredged Material (yellow sand with no slag noted)	7.5	0.08	< 0.01

Bold – Exceeds the ANZECC (2000) marine trigger value of 0.08 mg/L

8.4. Other Results

All material types were also submitted for asbestos, PCB, OCP, OPP and metals analysis. The results are summarised in Table 8.4.

Table 8.4 – Evaluation of Soil Analytical Results – All Other Results - Summary Table (mg/kg).

Analyte	n	Detections	Maximum	> SIL Column 2 (DEC 2006)	> SIL Column 5 (DEC 2006)
Asbestos	4	0	-	na	na
Arsenic	54	42	16	0	0
Cadmium	54	7	13	0	**4**
Total Chromium	54	42	256	0	0
Copper	54	37	230	0	**1**
Nickel	54	38	31	0	0
Lead	54	42	450	0	0
Zinc	54	54	1500	0	**8**
Mercury (inorganic)	54	6	0.2	0	0
PCBs	4	0	-	0	na
OPP	4	0	-	0	na
OCP	4	0	-	0	na

n *number of samples*
na *not applicable*
- *not detected above the PQLs*

Zinc and to a lesser extent, cadmium (4) and copper (1) were reported above the provisional phytotoxicity based SILs. The maximum concentrations of zinc were reported in the upper 0.5 m of fill that is being targeted for remediation due to elevated manganese, PAHs and TPHs. All zinc results in the underlying dredged sand were reported at less than 368 mg/kg.

Leachate (TCLP and SPLP) tests were undertaken with JBS concluding that zinc is slightly mobile. The maximum leachable concentration reported was 1.1 mg/L (TCLP) for which the SPLP results was only 0.22 mg/L only marginally above the ANZECC (2000) trigger value. The maximum total concentration submitted for analysis was 65 mg/kg compared to the maximum of 368 mg/kg detected in the dredged materials. The Auditor notes that only four samples collected from these materials reported zinc at greater than 65 mg/kg.

8.5. Conclusions

In the Auditor's opinion, the analytical results are consistent with the site history and field observations. The Auditor is satisfied that contaminant impacts are associated with the slag/basalt material encountered mostly in the upper 0.5 m of the fill with some areas of deeper impact noted. The Auditor is satisfied that sufficient soil investigations have been conducted to allow a plan of remediation to be prepared.

The Auditor considers that the remainder of the fill (dredged sand) and the site in general has been adequately characterised and that no further investigations are required other than validation of the remedial works.

9. EVALUATION OF GROUNDWATER ANALYTICAL RESULTS

Groundwater samples were collected in April 2007 from wells placed within the centre of the site (MW07/1), one on the up-gradient boundary (MW1) and two in close proximity to each other (MW07/2 and MWA) in the eastern half of the site at the northern boundary. The results for the 4 wells are summarised in Table 9.1.

Two other wells were also sampled in April 2004 by PPK the results of which were consistent with those obtained by JBS. The results are discussed below. These results were not included in Table 9.1 given the three years between sample events.

Table 9.1 – Evaluation of Groundwater Analytical Results – Summary Table (μg/L)

Analyte	N	Detections	Maximum	n >ANZECC Marine (2000)
TPH (C_6-C_9)	4	0	-	na
TPH (C_{10}-C_{36})	4	1	370	na
BTEX	4	0	-	0
Benzo(a)Pyrene	6	1	0.2	**1**
Naphthalene	6	1	0.1	0
Anthracene	6	2	0.4	**1**
Fluoranthene	6	3	2.6	**3**
Phenanthrene	6	2	1.1	**1**
Arsenic	4	3	4	0
Cadmium	4	1	0.4	0
Total Chromium	4	0	-	0
Copper	4	0	< 5	0
Lead	4	1	1.8	0
Manganese	4	4	900	**2**
Nickel	4	3	1.6	0
Zinc	4	4	13	0
Mercury (inorganic)	4	0	-	0

n *number of samples*
- *No criteria available/used*

The most elevated concentration of manganese in groundwater of 900 μg/L was reported in the well placed towards the northern boundary. This well reported the most elevated EC at 10870 μS/cm consistent with being located 5 m from the Throsby Basin. Particularly elevated concentrations of manganese in soil were reported at 0.1 m in slag/basalt fill in the vicinity. The detection of elevated manganese in groundwater at this location is consistent with the potential of the slag/basalt materials to leach.

Manganese was reported by JBS at the up-gradient boundary (110 μg/L) and previously by PPK (99 and 113 μg/L) in two wells that have since been destroyed. These results are consistent with groundwater results obtained over the Honeysuckle Development Area.

Slightly elevated concentrations of PAHs were reported in groundwater at the site however these are less than concentrations reported over the Honeysuckle Development Area.

The Auditor is satisfied that sufficient groundwater investigations have been conducted to allow a plan of remediation to be prepared to address potential sources of impacts i.e. impacted fill material (mostly at depths of < 0.5 m). No other risks have been identified and the Auditor concludes that no further delineation investigations are required.

10. EVALUATION OF REMEDIATION

10.1. Remediation Strategy and Methodology

Based on the investigations previously completed, JBS identify that 'slag/basalt' fill material requires remediation due to elevated concentrations of manganese and PAHs. The underlying 'dredged material' would be retained. JBS consider separation of the layers to be feasible.

10.2. Evaluation of Remedial Action Plan

The Auditor has assessed the RAP by comparison with the checklist included in EPA (1997) "Guidelines for Consultants Reporting on Contaminated Sites". The RAP was found to address the required information for most items, as detailed in Table 10.1, below. The Auditor notes that the contractors should be suitably qualified to undertake the works. An appropriately licensed landfill should be selected and the material tracked from the Site to the landfill.

Table 10.1 – Evaluation of Remedial Action Plan

Remedial Action Pan	Key Features	Auditor Comments
Remedial Goal	Reduce the exposure to human health and the environment from fill to an acceptable level and ensure the site is suitable for the proposed use.	Acceptable
Discussion of the extent of remediation required.	'Control of the slag/basalt fill'. The proposed extent is 0.5 m to 1.5 m depth (L4BH10 and SB6) over the entire site. The horizontal extent is the lateral site boundaries. JBS acknowledge that deeper pockets of the slag/basalt fill may be present which will be chased out. Removal of stockpile material at the south-eastern and western potions of the site.	Field staff employed to separate the fill would need to be familiar with the various fill types to ensure consistency with earlier field investigations. As impacts were occasionally encountered at depth, visual and analytical validation works will need to be undertaken to confirm the extent.
Remedial Options	Excavation and either - on-site treatment - Immobilisation - Off-site disposal - consolidation and isolation with an engineered barrier containment	The assessment of the remedial options is considered adequate.
Selected Preferred Option and Rationale	Excavation and off-site disposal	The Auditor is satisfied that the option selected is reasonable to achieve site suitability for development.

Remedial Action Pan	Key Features	Auditor Comments
Proposed Validation Testing of Excavations	The minimum density as specified by EPA (1995) is proposed as 18 samples. In deeper locations, validation will include 1 per 5 m of the excavation wall and 1 per 25 m^2 of the base. JBS indicate that features such as seepage, discolouration, staining, odours and other indications of contamination would be considered. If excavations are large the minimum densities outlined in EPA (1995) would be referred to. The validation samples would be submitted for metals (including manganese) and PAHs. Imported Fill: 1 per 100 m^3 for non-homogeneous. 1 per 500 m^3 with documentation provided. JBS indicated that all imported fill material should be accompanied by relevant documentation. Only VENM would be imported to site. Imported fill would be submitted for metals, TPH, BTEX, PAHs, OCPs, PCBs and pH.	As the minimum has been chosen the consultant should ensure that the results are consistent and that adequate visual validation was undertaken. The density of testing of imported material will depend on the amount and type of material and the documentation/ previous sampling undertaken. The Auditor agrees that visual inspections are essential. Sample descriptions of the validation samples should be provided. If any potentially contaminated materials are retained on-site the extent and location will need to be discussed.
QA/QC	JBS provided soil sampling methodology, laboratory and field analysis and QA/QC DQOs.	The Auditor considers that the works proposed are appropriate.
Interim Site Management Plan (before remediation)	JBS consider that interim management is not required.	Agree
Reporting	JBS outlines what will be included in validation reporting.	The Auditor agrees that clear reporting of the remedial and validation works is essential. This includes descriptions of the remedial works undertaken i.e. order of works, observations, sample locations with sample descriptions, descriptions of any residual impacts, etc.

Remedial Action Pan	Key Features	Auditor Comments
Site Management Plan (operation phase) including stormwater, soil, noise, dust, odour and OH&S. Contingency Plans to Respond to site Incidents.	JBS provide a framework for a Site Management Plan. JBS indicated that a Construction Management Plan (CMP) must be prepared and outline the key information to be included.	The Auditor notes that the CMP should ensure that any pockets of impact are dealt with appropriately.
Contingency Plan if Selected Remedial Strategy Fails	Continued controlled validation until the results are achieved or consider on-site or off-site treatment.	This indicates that all residual material would be chased out until validated which is considered adequate.
Remediation Schedule and Hours of Operation	Monday to Friday 7 am to 5 pm and Saturdays 8 am to 1 pm.	
Licence and Approvals	The works are Category 2 i.e. does not require council consent. Given the land in located within 40 m of a natural water body, approval from Department of Natural Resources under the Rivers and Foreshores Improvement Act (1948). JBS note that the site is located within an area of mine subsidence for which approval for works will be obtained from the Mine Subsidence Board. JBS anticipate the use of immobilisation approval under the Protection of the Environment Operations (Waste) Regulations 2005. The works are consistent with Councils policies in the Development Control Plan and the Regional Environmental Plan.	The contractors should be suitably qualified and licensed to undertake the works. An appropriately licensed landfill should be selected and the material tracked from the Site to the landfill.
Contacts/ Community Relations/	Not discussed.	
Staged Progress Reporting	Not discussed	Not applicable
Notification	Not discussed	Not applicable if RAP successfully implemented.

Remedial Action Pan	Key Features	Auditor Comments
Long term site management plan	Not required. Abstraction of groundwater underlying the area will be prohibited.	Appropriate if RAP successfully implemented.
Data Quality Objectives (DQOs)	DQOs outlined	Adequate

The Auditor considers that there has been adequate consideration of remedial options and agrees that the remediation approach proposed should ensure protection of the environment and human health in a mixed residential and commercial/industrial land use.

Potential risks associated with the remedial works include:

- Deeper pockets of impacts may remain undetected given that all locations cannot be sampled and that an evenly distributed grid was not implemented.
- Given the risk of pockets of impacts, excavation works should ensure that the materials are visually validated.
- Inappropriate soil removal methods could push contaminated materials deeper and the method for removal should ensure that the underlying material does not become cross contaminated and thereby fail validation.

11. CONTAMINATION MIGRATION POTENTIAL

JBS concluded that following removal of the 'slag/basalt fill' that the 'levels of groundwater impact will rapidly improve' such that direct remediation of groundwater is not required. The Auditor considers that removal of the substantially impacted fill material will reduce the risk of migration of contamination to groundwater and off-site, and minimise the potential for contaminant concentrations in groundwater to increase.

12. ASSESSMENT OF RISK

Based on assessment of results against relevant guidelines and consideration of the overall investigation and proposed remediation, it is the Auditor's opinion that:

- The remedial approach to remove impacted fill by separation is a feasible option for the protection of occupiers of the site and the environment.
- There is a risk of cross contamination by pushing impacted materials deeper during removal. The RAP indicates that this risk will be addressed by implementing remedial methods that ensure that the underlying materials do not fail validation.
- There is a risk that deeper pockets of impacts may remain undetected given that all locations cannot be sampled and that an evenly distributed grid was not implemented. This risk will be managed by the RAP requiring control of excavation depths by a suitably qualified person during remediation activities.
- Groundwater at the site is impacted by PAHs and manganese. JBS noted that 'abstraction of groundwater underlying the area of the site will be prohibited, apart from monitoring purposes'. The risk to site users is considered to be low as future abstraction is unlikely (saline) and would require investigation of the groundwater resources and approval from the NSW Department of Natural Resources.

13. COMPLIANCE WITH REGULATORY GUIDELINES AND DIRECTIONS

Guidelines currently approved by the EPA under section 105 of the NSW Contaminated Land Management Act 1997 are listed in Appendix C. The Auditor has used these guidelines.

The investigation was generally conducted in accordance with SEPP 55 Planning Guidelines and reported in accordance with the EPA (1997) Guidelines for Consultants Reporting on Contaminated Sites. The checklist included in that document has been completed and is kept on file. The EPA's Checklist for Site Auditors using the EPA Guidelines for the NSW Site Auditor Scheme 1998 (December 1999) has also been completed and is kept on file.

Well licences were not obtained by PPK or JBS from Department of Natural Resources.

14. CONCLUSIONS AND RECOMMENDATIONS

JBS prepared a Remediation Action Plan the remedial strategy of which is for the excavation of contaminated fill materials, off-site disposal and validation such that the site is suitable for the proposed mixed residential/commercial uses.

Based on the information presented in PPK and JBS reports and observations made on site, and following the Decision Process for Assessing Urban Redevelopment Sites in DEC (2006) Guidelines for the NSW Site Auditor Scheme, the Auditor concludes that the site can be made suitable for the purposes of 'residential with minimal access to soil' if the site is remediated in accordance with the following remedial action plan:

- 'Remedial Action Plan. Honeysuckle Development Corporation. Lee 4 Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle NSW' dated October 2007 by JBS

subject to compliance with the following conditions:

- A Site Audit Statement certifying suitability should be prepared at the successful completion of remediation.

15. OTHER RELEVANT INFORMATION

The Audit was conducted to provide an independent review of the suitability and appropriateness of a plan of remediation i.e. an audit for the purpose stated in Section 47 (1) (b) (iv) of the CLM Act. This summary report may not be suitable for other uses. JBS included limitations in their report. The audit must also be subject to those limitations. The Auditor has prepared this document in good faith, but is unable to provide certification outside of areas over which he had some control or is reasonably able to check.

The Auditor has relied on the documents referenced in Section 1 of the Site Audit Report in preparing his opinion. If the Auditor is unable to rely on any of those documents, the conclusions of the audit could change.

It is not possible in a Site Audit Report to present all data which could be of interest to all readers of this report. Readers are referred to the referenced reports for further data. Users of this document should satisfy themselves concerning its application to, and where necessary seek expert advice in respect to, their situation.

APPENDIX A

Attachments

ATTACHMENT 1: Site Location

ATTACHMENT 2: Survey Plan

ATTACHMENT 3: Site Plan and Sampling Locations (PPK)

ATTACHMENT 4: Sampling Locations (PPK and JBS)

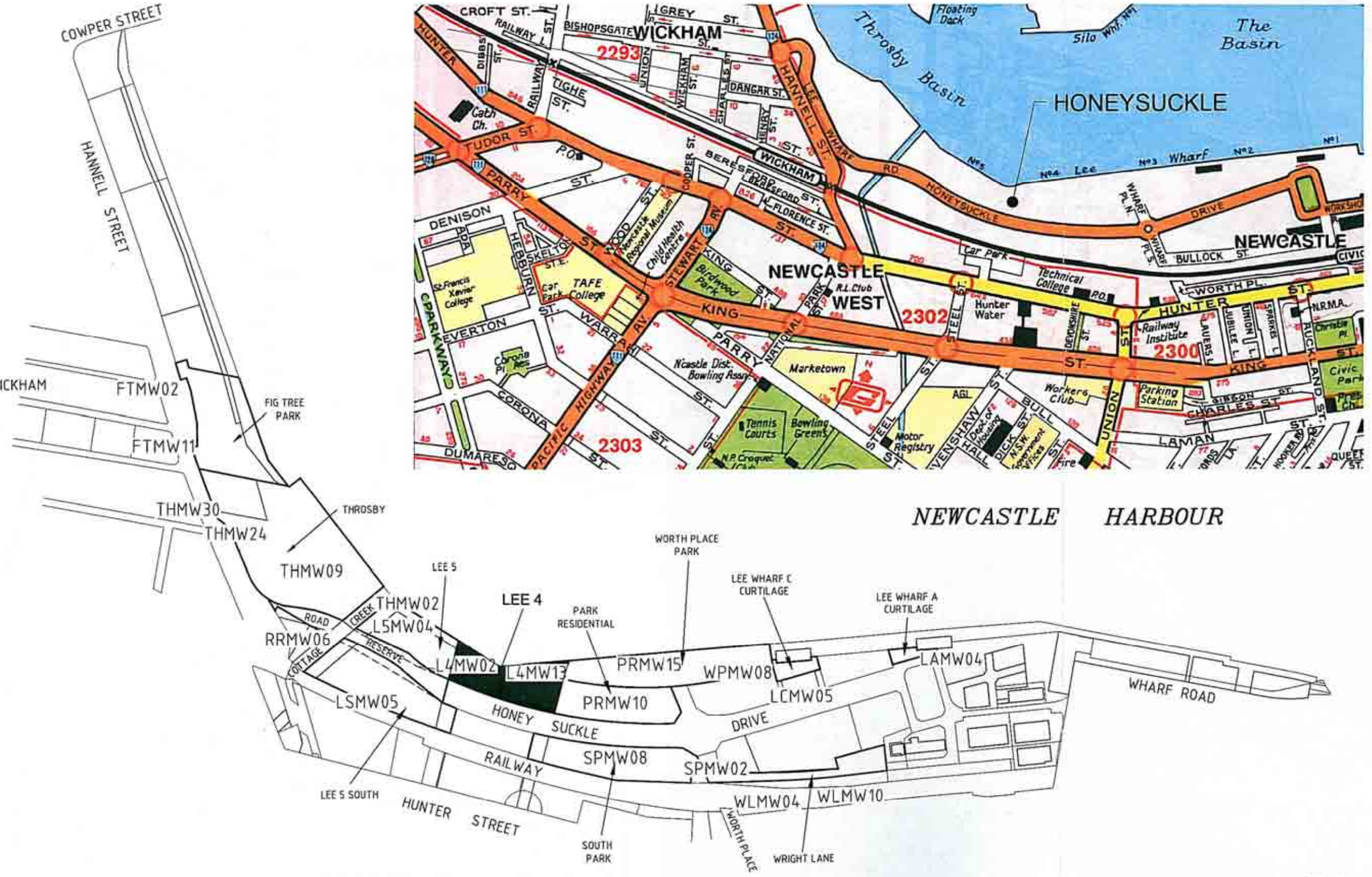
ATTACHMENT 1: Site Location

Client: Honeysuckle Development Corporation
Project: Environmental Site Assessment
Location: Honeysuckle Development

50 0 50 100 150 200 250 m

Scale 1: 5000

PPK Environment&Infrastructure



Site Location
Figure 1

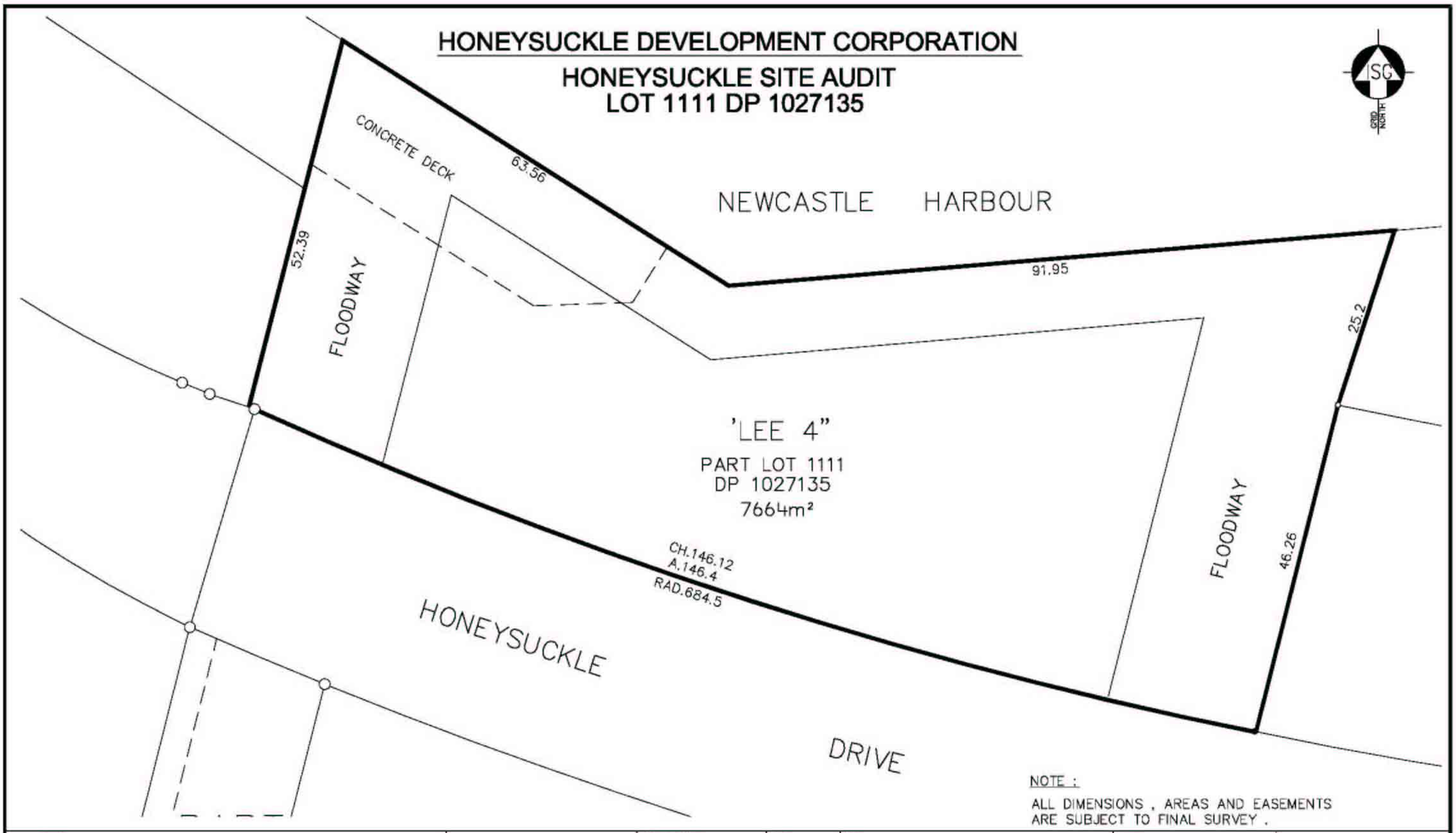
BASE PLAN PROVIDED BY HONEYSUCKLE DEVELOPMENT CORPORATION

REPORT: 2122128A\PR_0603
CAD REFERENCE: E:\2122128A\CAD\Pr_0603\FIGURE01.DWG

ATTACHMENT 2: Survey Plan

HONEYSUCKLE DEVELOPMENT CORPORATION

HONEYSUCKLE SITE AUDIT
LOT 1111 DP 1027135



NOTE :

ALL DIMENSIONS , AREAS AND EASEMENTS ARE SUBJECT TO FINAL SURVEY .

HARPER SOMERS O'SULLIVAN
SURVEY, ECOLOGY, PLANNING, DEVELOPMENT
241 DENISON STREET , BROADMEADOW
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PHONE (02) 4961 6500
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Surveyed by	
Designed by	
Drawn by	M.JOHNSTON
Checked by	
Date	

Title
HONEYSUCKLE SITE AUDIT PLAN
PART LOT 1111 DP 1027135

Client
HONEYSUCKLE DEVELOPMENT CORPORATION

Scale:
1 :500

Autocad ref:
H://16819_SITE AUDIT_ MARCH 2003.dwg

Date
6TH NOVEMBER 2003

HSO
HARPER SOMERS O'SULLIVAN
REFERENCE No. : 16819

ATTACHMENT 3: Site Plan and Sampling Locations

Client: Honeysuckle Development Corporation
Project: Environmental Site Assessment
Location: Honeysuckle Development

5 0 5 10 15 20 25 m

Scale 1: 500

PPK Environment&Infrastructure

NEWCASTLE HARBOUR

LEGEND

- Groundwater Monitoring Well Location
- Borehole Sampling point
- Test Pit Sampling point

CONCRETE DECK
FORESHORE
OLD TRAMWAY LINES
PROMENADE
SHED
SHEDS
LEE 5
FLOODWAY
ROAD SURFACE
FENCE
LIGHT TOWER
LEE 4
OLD TRAMWAY LINE
OLD BITUMEN ROAD SURFACE
OLD MONITORING WELL
GRASS VERGE
PARK RESIDENTIAL
HONEYSUCKLE DRIVE
FLOODWAY

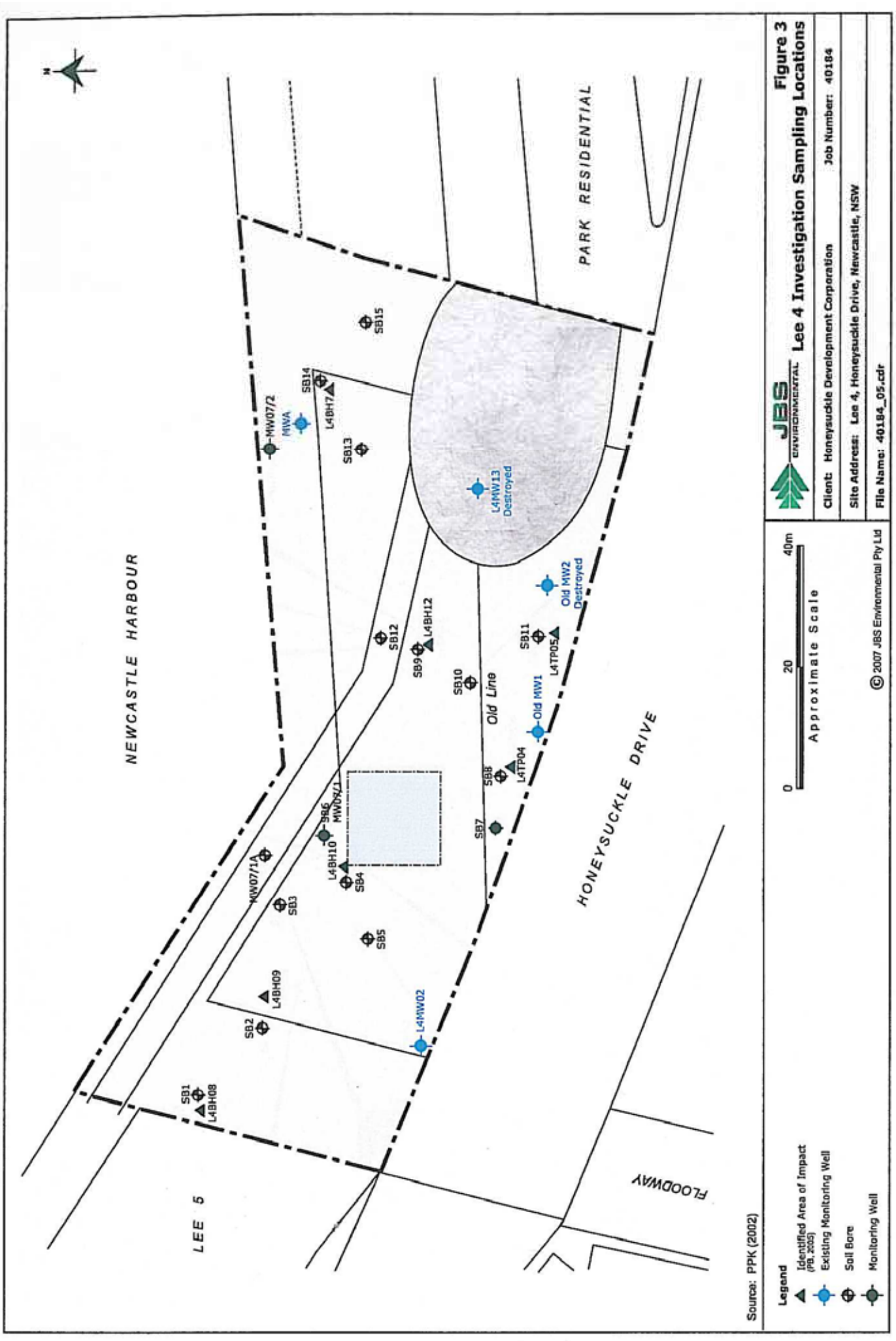
L4BH08
L4BH09
L4BH10
L4BH15
L4BH16
L4BH17
L4BH14
L4BH11
L4BH12
L4BH13
L4MW13
L4TP01
L4BH02
L4MW02
L4TP03
L4TP04
L4TP05
OLD MONITORING WELL
L4TP07
L4TP06

Site Layout & Soil Sampling Locations - Lee 4
Figure 2

BASE PLAN PROVIDED BY HONEYSUCKLE DEVELOPMENT CORPORATION. EXISTING FEATURES SHOWN BY PPK.

REPORT: 2122128A\PR_0603
CAD REFERENCE: E:\2122128A\CAD\Pr 0603\FIGURE02.DWG

ATTACHMENT 4: Sampling Locations (PPK and JBS)



APPENDIX B

Soil and Groundwater Criteria

Soil investigation levels for urban development sites
Department of Environment and Conservation NSW (April 2006)

Substance	Health-based investigation levels[1] (mg/kg)				Provisional phytotoxicity-based investigation levels[2] (mg/kg)
	Residential with gardens and accessible soil (home-grown produce contributing < 10% fruit and vegetable intake; no poultry), including children's day-care centres, preschools, primary schools, townhouses, villas (NEHF A)[3]	Residential with minimal access to soil including high-rise apartments and flats (NEHF D)	Parks, recreational open space, playing fields including secondary schools (NEHF E)	Commercial or industrial (NEHF F)	
	Column 1	**Column 2**	**Column 3**	**Column 4**	**Column 5**
Metals and metaloids					
Arsenic (total)	100	400	200	500	20
Beryllium	20	80	40	100	–
Cadmium	20	80	40	100	3
Chromium (III)[4]	12%	48%	24%	60%	400
Chromium (VI)	100	400	200	500	1
Cobalt	100	400	200	500	–
Copper	1,000	4,000	2,000	5,000	100
Lead	300	1,200	600	1,500	600
Manganese	1,500	6,000	3,000	7,500	500
Methyl mercury	10	40	20	50	–
Mercury (inorganic)	15	60	30	75	1[5]
Nickel	600	2,400	600	3,000	60
Zinc	7,000	28,000	14,000	35,000	200
Organics					
Aldrin + dieldrin	10	40	20	50	–
Chlordane	50	200	100	250	–
DDT + DDD + DDE	200	800	400	1,000	–
Heptachlor	10	40	20	50	–
PAHs (total)	20	80	40	100	–
Benzo(a)pyrene	1	4	2	5	–
Phenol[6]	8,500	34,000	17,000	42,500	–
PCBs (total)	10	40	20	50	–
Petroleum hydrocarbon components[7]					
> C16–C35 (aromatics)	90	360	180	450	–
> C16–C35	5,600	22,400	11,200	28,000	–
> C35 (aliphatics)	56,000	224,000	112,000	280,000	–
Other					
Boron	3,000	12,000	6,000	15,000	–[8]
Cyanides (complex)	500	2,000	1,000	2,500	–
Cyanides (free)	250	1,000	500	1,250	–

1 The limitations of health-based soil investigation levels are discussed in Schedule B(1) Guidelines on the Investigation Levels for Soil and Groundwater and Schedule B(7a) Guidelines on Health-based Investigation Levels, *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 1999)

2 The provisional phytotoxicity-based investigation levels proposed in this document are single number criteria. Their use has significant limitations because phytotoxicity depends on soil and species parameters in ways that are not fully understood. They are intended for use as a screening guide and may be assumed to apply to sandy loam soils or soils of a closely similar texture for pH 6–8.

3 National Environmental Health Forum (NEHF) is now known as enHealth.

4 Soil discolouration may occur at these concentrations.

5 Total mercury

6 Odours may occur at these concentrations.

7 The carbon number is an 'equivalent carbon number' based on a method that standardises according to boiling point. It is a method used by some analytical laboratories to report carbon numbers for chemicals evaluated on a boiling point GC column.

8 Boron is phytotoxic at low concentrations. A provisional phytotoxicity-based investigation level is not yet available.

Notes:

This table is adapted from Table 5-A in Schedule B(1): Guidelines on Investigation Levels for Soil and Groundwater to the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 1999).

Soil investigation levels (SILs) may not be appropriate for the protection of ground water and surface water. They also do not apply to land being, or proposed to be, used for agricultural purposes. (Consult NSW Agriculture and NSW Health for the appropriate criteria for agricultural land.)

SILs do not take into account all environmental concerns (for example, the potential effects on wildlife). Where relevant, these would require further consideration.

Impacts of contaminants on building structures should also be considered.

For assessment of hydrocarbon contamination for residential land use, refer to the *Guidelines for Assessing Service Station Sites* (EPA 1994).

Threshold Concentration for Sensitive Land Use – Soils
Guidelines for Assessing Service Station Site (NSW EPA 1994)

Contaminant	Threshold Concentration (mg/kg)
TPH (C_6-C_9)	65
TPH (C_{10}-C_{36})	1,000
Benzene	1
Toluene	1.4
Ethylbenzene	3.1
Xylenes (total)	14

Trigger Values (TV) for Screening Marine Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)

Contaminant	Threshold Concentration (µg/L))	Guideline Source
Metals and Metalloids		
Arsenic – As (III/V)	2.3/4.5	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Cadmium – Cd	0.7	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Nickel – Ni	7	
Mercury – Hg	0.1	
Manganese	80	Low reliability trigger values (derived from the mollusc figure) from Volume 2 of ANZECC (2000)
Chromium – Cr (III/VI)	27.4/4.4	ANZECC (2000) 95% protection levels.
Copper – Cu	1.3	
Cobalt	1	
Lead – Pb	4.4	
Zinc – Zn	15	
Aromatic Hydrocarbons		
Benzene	500	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Toluene	180	
Ethylbenzene	5	
o-xylene	350	
m-xylene	75	
p-xylene	200	
Polycyclic Aromatic Hydrocarbons		
Naphthalene	50	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Anthracene	0.01	Low reliability trigger values from Volume 2 of ANZECC (2000) ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Phenanthrene	0.6	
Fluroanthene	1	
Benzo (a) pyrene	0.1	
Chlorinated Alkanes		
Tetrachloroethene - PCE	70	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
1,1,2 Trichlorothene- TCE	330	
1,1,2 Trichlorothene- 1,1,2-TCE	330	
Vinyl chloride (chloroethene)	100	
1,1,1 Trichloroethane – 1,1,1-TCA (111-TCE)	270	
1,1 Dichloroethene	700	
1,1 Dichloroethane	250	
1,2 Dichloroethane	1900	
1,1,2 - Trichloroethane	1900	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Chloroform	370	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)

Trigger Values (TV) for Screening Marine Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)

Non-Metallic Inorganics		
Ammonia Total – NH_3 (at pH of 8)	910	ANZECC (2000) 95% protection levels.
Cyanide (Free or unionised HCN)	4	

While the low reliability figures should not be used as default guidelines they will be useful for indicating the quality of groundwater migrating off-site.

APPENDIX C

EPA Approved Guidelines

Guidelines made or approved by the EPA under section 105 of the *Contaminated Land Management Act 1997*

(*as of 4 July 2005*)

Guidelines made by the EPA

- *Contaminated Sites: Guidelines for Assessing Service Station Sites*, December 1994
- *Contaminated Sites: Guidelines for the vertical mixing of soil on former broad-acre agricultural land*, January 1995.
- *Contaminated Sites: Sampling Design Guidelines*, September 1995
- *Contaminated Sites: Guidelines for Assessing Banana Plantation Sites*, October 1997
- *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*, November 1997
- *Contaminated Sites: Guidelines for the NSW site auditor scheme,* June 1998
- *Contaminated Sites: Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report*, April 1999.
- *Contaminated Sites: Guidelines for Assessing Former Orchards and Market Gardens,* June 2005

Note: All references in the EPA's contaminated sites guidelines to the *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC, November 1992) are replaced as of 6 September 2001 by references to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ, October 2000), subject to the same terms.

Guidelines approved by the EPA

ANZECC publications

- *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites,* published by Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC), January 1992
- *Australian Water Quality Guidelines for Fresh and Marine Waters,* Australian and New Zealand Environment and Conservation Council (ANZECC), November 1992, which are only approved for the purposes of contaminated site assessment, investigation, remediation and site auditing under the Contaminated Land Management Act (or other relevant legislation) commenced before September 2001
- *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 Australia and New Zealand, Paper No 4, October 2000

EnHealth publications (formerly National Environmental Health Forum monographs)

- *Composite Sampling*, by Lock, W. H., National Environmental Health Forum Monographs, Soil Series No.3, 1996, SA Health Commission, Adelaide
- *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards*, Department of Health and Ageing and EnHealth Council, Commonwealth of Australia, June 2002

National Environment Protection Council publications

- *National Environment Protection (Assessment of Site Contamination) Measure 1999*

The Measure consists of a policy framework for the assessment of site contamination, Schedule A (*Recommended General Process for the Assessment of Site Contamination**)*** and Schedule B (*Guidelines*). Schedule B guidelines include:

B(1) *Guideline on Investigation Levels for Soil and Groundwater*

B(2) *Guideline on Data Collection, Sample Design and Reporting*

B(3) *Guideline on Laboratory Analysis of Potentially Contaminated Soils*

B(4) *Guideline on Health Risk Assessment Methodology*

B(5) *Guideline on Ecological Risk Assessment*

B(6) *Guideline on Risk Based Assessment of Groundwater Contamination*

B(7a) *Guideline on Health-Based Investigation Levels*

B(7b) *Guideline on Exposure Scenarios and Exposure Settings*

B(8) *Guideline on Community Consultation and Risk Communication*

B(9) *Guideline on Protection of Health and the Environment During the Assessment of Site Contamination*

B(10) *Guideline on Competencies & Acceptance of Environmental Auditors and Related Professionals*

Other documents

- *Guidelines for the Assessment and Clean Up of Cattle Tick Dip Sites for Residential Purposes*, NSW Agriculture and CMPS&F Environmental, February 1996
- *Australian Drinking Water Guidelines*, NHMRC & Agriculture and Resource Management Council of Australia and New Zealand, 1996

APPENDIX D

Analytical Lists and Methods

AMDEL ANALYTICAL METHODS

TARGET COMPOUNDS	AMDEL METHOD ID	METHODOLOGY SUMMARY
HEAVY METALS		
Arsenic	E-5910	E-5910 Soil – HNO_3, HCL & H_2O_2 digestion USEPA 200.2 (modification). ICP-AES
Cadmium		
Chromium		
Copper		
Nickel		
Lead		
Zinc		
Mercury	E5950	Soil – Kmn04 digestion USEPA 3051. CV-AAS.

ENVIROLAB ANALYTICAL LISTS AND METHODS

TARGET COMPOUNDS	ENVIROLAB METHOD ID	METHODOLOGY SUMMARY
ASBESTOS		
Asbestos	ASB.1.	Qualitative identification of asbestos type fibres in bulk using Polarised Light Microscopy and Dispersion Staining Techniques
HEAVY METALS		
Arsenic	Metals 20	Determination of various metals by ICP-AES Toxicity Characteristic Leaching Procedure
Cadmium		
Chromium		
Copper		
Nickel		
Lead		
Zinc		
Mercury	Metals 21	Determination of mercury by Cold Vapour AAS
POLYNUCLEAR AROMATICS		
Naphthalene	GC.12	Soil: samples extracted with Dichlormethane and analysed by GC-MS
Fluorene		
Phenanthrene		
Anthracene		
Acenaphthylene		
Acenaphthene		
Fluoranthene		
Pyrene		
Benz(a)anthracene		
Chrysene		
Benzo(b) & (k)fluoranthene		
7.12-Dimethylbenz(a)anthracene		
Benzo(a)pyrene		
Indeno(1.2.3-cd)pyrene		
Dibenzo(a.h)anthracene		
Benzo(g.h.l)perylene		
BTEX COMPOUNDS		
Benzene	GC.14	Soil: samples extracted with methanol Analysed by purge and trap GC-MS
Toluene		
Chlorobenzene		
Ethylbenzene		
Meta- & para-Xylene		
Ortho-Xylene		
TOTAL PETROLEUM HYDROCARBONS		
C6-C9 Fraction	GC.16	Soil: samples extracted with methanol Analysis by purge and trap GC-MS Water: samples analysed directly by Purge and trap GC-MS
C10-C14 Fraction	GC.3	Soil: samples extracted with Dichlormethane and analysed by GC-FID
C15-C28 Fraction		
C29-C36 Fraction		
POLYCHLORINATED BIPHENYLS		
Total Polychlorinated biphenyls		

TARGET COMPOUNDS	ENVIROLAB METHOD ID	METHODOLOGY SUMMARY
	GC-6	Soil: samples extracted with hexane/acetone

ORGANOCHLORINE PESTICIDES		
alpha-BHC	GC.8	Soil samples are extracted with hexane/acetone and water with dichloromethane and analysed by GC with dual ECDs.
HCB		
beta-BHC & gamma-BHC		
delta-BHC		
Heptachlor		
Aldrin		
Heptachlor epoxide		
Endosulfan 1		
Hexachlorobenzene (HCB)		
Trans-Chlordane		
Cis-Chlordane		
Endrin-aldehyde		
Endrine Ketone		
methoxychlor		
4.4'-DDE		
Dieldrin		
Endrin		
Endosulfan 11		
4.4'-DDD		
Endosulfan sulfate		
4.4'-DDT		
ORGANOPHOSPHORUS PESTICIDES		
Methanesulfonate methyl	GC-5	Soil: samples extracted with hexane/acetone
Methanesulfonate ethyl		
Dichlorvos		
Demeton-s-methyl		
Monocrotophos		
cis-Isosafrole		
trans-Isosafrole		
Safrole		
Dimethoate		
Diazinon		
Chlorpyrifos methyl		
Parathion methyl		
Malathion		
Fenthion		
Chlorpyrifos		
Parathion		
Pirimiphos ethyl		
Chlorofenvinphos-E		
Bromophos-ethyl		
Fenamiphos		
Chlorfenvinphos-Z		
Prothiofos		
Ethion		
Carbophenothion		
Methyl azinphos		

SGS ANALYTICAL METHODS FOR SOIL AND WATERS

TARGET COMPOUNDS	SGS METHOD ID	METHODOLOGY SUMMARY
METALS		
Arsenic		**Extraction:** Based on USEPA 200.7 or 3050 for soil and APHA methods for waters **Analysis:** Analysis is performed using Flame or Hydride Generation Atomic Absorption Spectrophotometry or ICP.
Cadmium	SEM-010	
Chromium		
Copper		
Lead		
Nickel		
Zinc		
Mercury	SEM-005	
PETROLEUM HYDROCARBONS & BTEX		
TRH C_6-C_9		**Extraction:** Volatile Aromatic Hydrocarbons (BTEX and TRH C6-C9) based upon USEPA 5030 Purge & Trap Technique and USEPA 8020 Aromatic Volatiles. **Analysis:** Gas Chromatography with FID & PID detectors in series.
Benzene	SEO-017 and SEO-018	
Toluene		
Ethylbenzene		
Xylenes		
TRH C_{10}-C_{14}	SEO-020	**Extraction:** Petroleum Hydrocarbons (C10-C36) based upon the separatory funnel liquid- liquid extraction USEPA method 3510 for waters and USEPA 3550 for solids. **Analysis:** Gas Chromatography with FID detection in accordance with 8015B.
TRH C_{15}-C_{28}		
TRH C_{29}-C_{36}		
POLYAROMATIC HYDROCARBONS		
Naphthalene	SEO-030	**Extraction:** Based upon the separatory funnel liquid-liquid extraction USEPA method 3510 for solids. **Analysis:** Based upon the USEPA method 8270 using GC with MS detector.
Acenaphthylene		
Acenaphthene		
Fluorene		
Phenanthrene		
Anthracene		
Fluoranthene		
Pyrene		
Benz(a)anthracene		
Chrysene		
Benzo(b) & (k)fluoranthene		
Benzo(a)pyrene		
Indeno(1.2.3-cd)pyrene		
Dibenz(a.h)anthracene		
Benzo(g.h.i)perylene		