



INFORMATION REGARDING ENVIRONMENTAL AUDIT REPORTS

August 2007

VICTORIA'S AUDIT SYSTEM

An environmental audit system has operated in Victoria since 1989. The *Environment Protection Act 1970* (the Act) provides for the appointment by the Environment Protection Authority (EPA Victoria) of environmental auditors and the conduct of independent, high quality and rigorous environmental audits.

An environmental audit is an assessment of the condition of the environment, or the nature and extent of harm (or risk of harm) posed by an industrial process or activity, waste, substance or noise. Environmental audit reports are prepared by EPA-appointed environmental auditors who are highly qualified and skilled individuals.

Under the Act, the function of an environmental auditor is to conduct environmental audits and prepare environmental audit reports. Where an environmental audit is conducted to determine the condition of a site or its suitability for certain uses, an environmental auditor may issue either a certificate or statement of environmental audit.

A certificate indicates that the auditor is of the opinion that the site is suitable for any beneficial use defined in the Act, whilst a statement indicates that there is some restriction on the use of the site.

Any individual or organisation may engage appointed environmental auditors, who generally operate within the environmental consulting sector, to undertake environmental audits. The EPA administers the environmental audit system and ensures its ongoing integrity by assessing auditor applications and ensuring audits are independent and conducted with regard to guidelines issued by EPA.

AUDIT FILES STRUCTURE

Environmental audit reports are stored digitally by EPA in three parts: the audit report (part A), report appendices (part B) and, where applicable, the certificate or statement of environmental audit and an executive summary (part C). A report may be in colour and black-and-white formats. Generally, only black-and-white documents are text searchable.

Report executive summaries, findings and recommendations should be read and relied upon only in the context of the document as a whole, including any appendices and, where applicable, any certificate or statement of environmental audit.

AUDIT REPORT CURRENCY

Audit reports are based on the conditions encountered and information reviewed at the time of preparation and do not represent any changes that may have occurred since the date of completion. As it is not possible for an audit to present all data that could be of interest to all readers, consideration should be made to any appendices or referenced documentation for further information.

When information regarding the condition of a site changes from that at the time an audit report is issued, or where an administrative or computation error is identified, environmental audit reports, certificates and statements may be withdrawn or amended by an environmental auditor. Users are advised to check [EPA's website](http://www.epa.vic.gov.au) to ensure the currency of the audit document.

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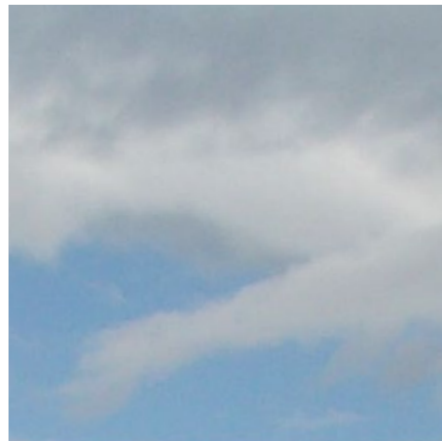
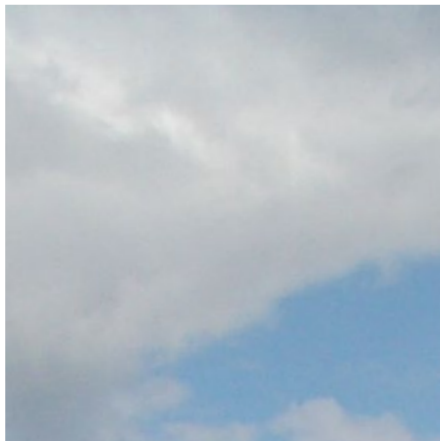
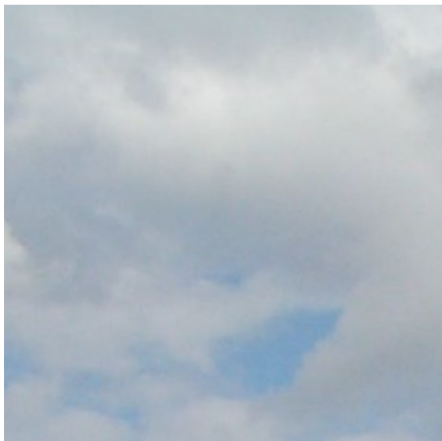
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Web: www.epa.vic.gov.au/envaudit

Email: environmental.audit@epa.vic.gov.au



Department of Treasury and Finance

Environmental Audit Report Stages 2 and 2A

1136-1138 Nepean Highway Highett 3190 Victoria
(CARMS #37308-2)

December 2011



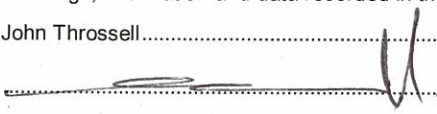
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Revision	Details	Date	Amended By
A	Original	15 December 2011	

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Author: John Throssell.....

Signed:  15/12/2011

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ENVIRONMENT PROTECTION ACT 1970

STATEMENT OF ENVIRONMENTAL AUDIT

I, John Throssell of Parsons Brinckerhoff, a person appointed by the Environmental Protection Authority ('the Authority') under the *Environmental Protection Act 1970* ('the Act') as an environmental auditor for the purpose of the Act, having

1. been requested by the **Department of Treasury and Finance** to issue a certificate of environmental audit in relation to the site located at **1136 - 1138 Nepean Highway Highett Stage 2** ("the site"), owned/occupied by the Department of Treasury and Finance (see **Figure 1** attached to this Statement).
2. had regard to, among other things,
 - i) guidelines issued by the Authority for the purposes of Part IXD of the Act,
 - ii) the beneficial uses that may be made of the site, and
 - iii) relevant State environment protection policies/ industrial waste management policies, namely
 - SEPP Prevention and Management of Contamination of Land
 - SEPP Groundwaters of Victoria
 - SEPP Waters of Victoria
 - Environmental Protection (Industrial Waste Resource) Regulations

in making a total assessment of the nature and extent of any harm or detriment caused to, or the risk of any possible harm or detriment which may be caused to, any beneficial use made of the site by any industrial processes or activity, waste or substance (including any chemical substance), and

3. completed an environmental audit report in accordance with Section 53X of the Act, a copy of which has been sent to the Authority and the relevant planning and responsible authority.

HEREBY STATE that I am of the opinion that

The site is suitable for the beneficial uses associated with:

- Sensitive use (medium to high density)
- Commercial
- Industrial
- Open space

subject to the following conditions attached thereto:

- a) Groundwater at the site is polluted. Groundwater must not be used for any beneficial use without prior testing and review of results by an environmental auditor (appointed under part IXD of the *Environmental Protection Act 1970*) to confirm its suitability for that use. It may be extracted for the purpose of environmental monitoring or remediation.

- b) Prior to 31 January 2012, the Groundwater Quality Management Plan (GQMP) formulated for the site and accepted by the environmental auditor must be implemented and maintained by the Department of Treasury and Finance and future owners of the site. The GQMP provides details on the groundwater monitoring program including, the monitoring wells to be sampled, laboratory analysis program, methodology, monitoring frequency, program duration, review procedure, reporting requirements and, roles and responsibilities.
- c) The GQMP forms part of this Statement of Environmental Audit and must be provided to all future owners/occupiers of the site.
- d) The GQMP must remain in force until such time as an environmental auditor (appointed under part IXD of the Environmental Protection Act 1970) confirms in writing that the monitoring and management requirements are no longer required, and this confirmation is advised in writing to the EPA and the planning authority. The GQMP has identified a Section 53V audit as the appropriate mechanism for cessation of the groundwater management and monitoring requirements.
- e) Prior to 29 February 2012, an Environmental Management Plan (EMP) must be developed for the site by a suitably qualified professional and accepted by an environmental auditor appointed under Part IXD of the *Environment Protection Act 1970*, and this acceptance advised in writing to EPA and the planning authority.
- f) Prior to 15 March 2012, the Department of Treasury and Finance and future owners of the site must implement and maintain the EMP required by condition (e) of this Statement.
- g) The site must be covered with a physical barrier, such as "fill" (consistent with IWRF 621) to a minimum depth of 1m, unless beneath building slabs, roads, or other concrete structures and must be specified in the EMP. The site in its current condition meets this requirement.
- h) Any landscaped area or garden beds must have at least 1m thickness of soil below the finished surface, which is demonstrated to be suitable for the site and consistent with IWRF 621 as "fill" and must be specified in the EMP.
- i) Access to residual soil impacts in shallow soil (<1mBGL) that could not be remediated due to proximity with the site boundary (as indicated in **Figure 2** attached to this Statement) should be minimised with the placement of either permanent paving, buildings or a barrier of at least 1m of clean fill. Where works require the excavation of soil along the northern, southeastern or southern boundaries, relevant workers should be made aware of the presence of contaminated soil in this area and appropriate protective measures taken during any excavation and maintenance works. Any soil/fill excavated from these areas is to be characterised and disposed to a licensed landfill as appropriate. The management of these soils shall be managed in accordance with the EMP to avoid exposure and/or transport of impact material.
- j) All physical barriers (as required in condition (g) of this Statement), if subsequently damaged or removed during development or occupation of the site, must be reinstated as soon as possible and to the same condition or better as they were prior to disturbance.

The condition of the site is detrimental or potentially detrimental to any (one or more) beneficial uses of the site. Accordingly, I have not issued a Certificate of Environmental Audit for the site in its current condition, the reasons for which are presented in the environmental audit report. The terms and conditions that need to be complied with before a Certificate of Environmental Audit may be issued are as set out as follows:

- Remediation of residual groundwater impacts associated with the site to the extent that relevant beneficial uses of groundwater are restored.

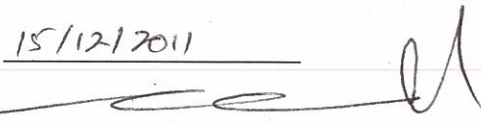
- Removal of all residual soil impacts below the site.

Other related information

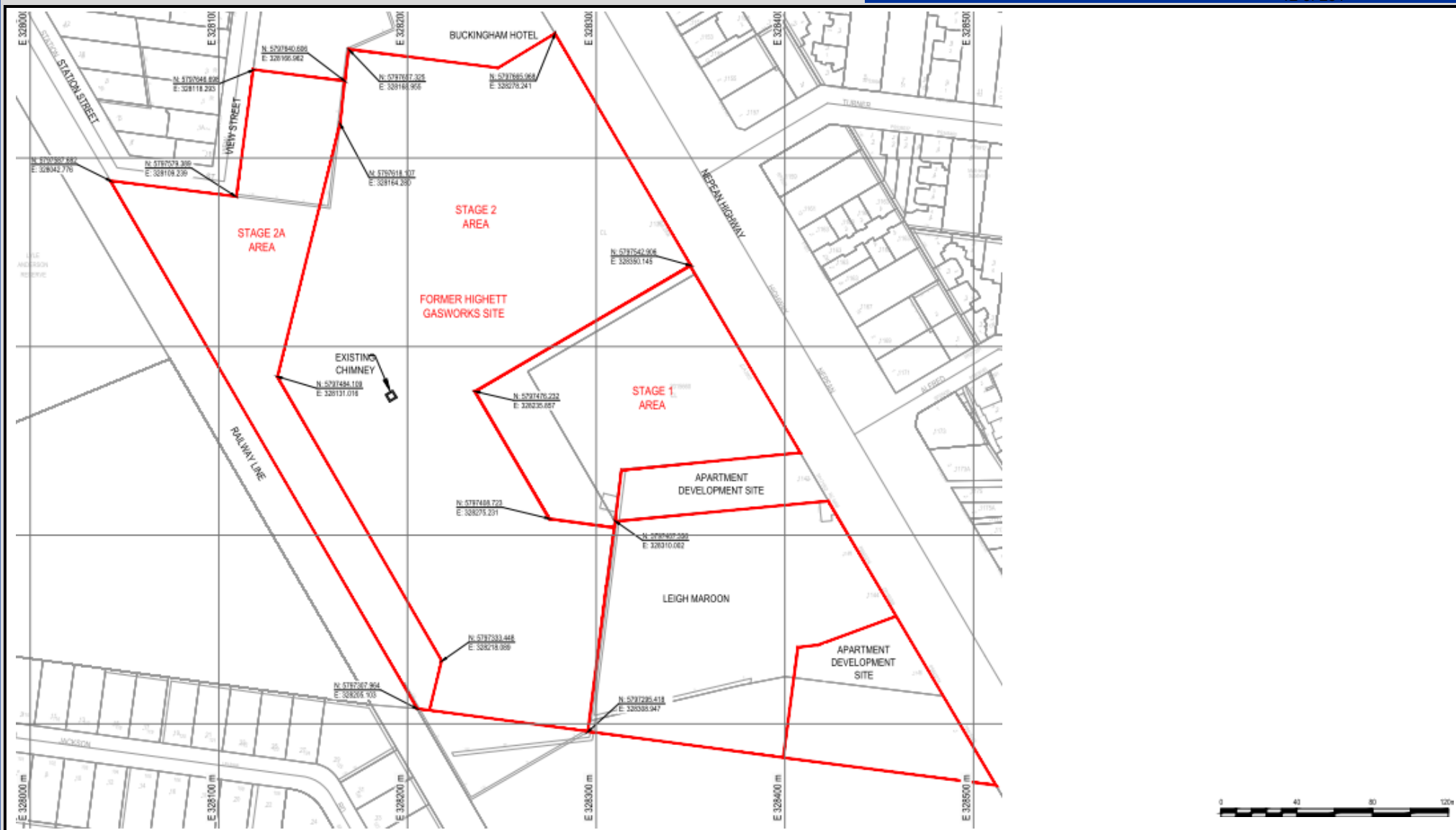
- The site (1136-1138 Nepean Highway Highett Stage 2) is defined by the coordinates presented in the attached survey plan (**Figure 1** attached to this Statement).
- A separate Statement of Environmental Audit has been issued for the adjoining Stage 2A area.
- The Authority has determined that groundwater has been cleaned up to the extent practicable and the site is a groundwater quality restricted use zone (GQRUZ) as illustrated in **Figure 3** attached to this Statement.
- Groundwater below the site is polluted and is not suitable for any beneficial use and should only be extracted for the purpose of environmental monitoring or remediation purposes.
- In accordance with clause 19(3) of the SEPP (Groundwaters of Victoria), the Authority may require periodic reassessment of the practicability of groundwater clean up.
- Soil and groundwater beneath the site may impact on future building footings and other subsurface structures due to its elevated sulphate content and reduced pH.
- Scattered pieces of coke, coal, black stained soil, have been reported at some locations on the site. This material has been removed as far as practicable but minor occurrences may remain within the soil and be uncovered during excavation works.
- Any material excavated from the site and disposed off site must be classified and managed in accordance with relevant statutory regulations and EPA guidelines.
- Any fill or soil imported to the site must be chemically tested soil or fill that classifies as "fill material" in accordance with relevant EPA guidelines.
- In accordance with section 53Z of the Environment Protection Act 1970 the owner/occupier of the site must provide a copy of this Statement to any person who becomes or proposes to become an occupier of the site.
- Not all land uses for which the land is considered suitable by this audit may be allowed under the existing zoning of the Kingston Council Planning Scheme.

This Statement forms part of environmental audit report *Parsons Brinckerhoff, 1136-1138 Nepean Highway Highett 3190 Victoria, (CARMS 37308-2) 2125064A-RPT001-A, 15 December 2011*. Further details regarding the condition of the site may be found in the environmental audit report.

DATED 15/12/2011

Signed: 

ENVIRONMENTAL AUDITOR



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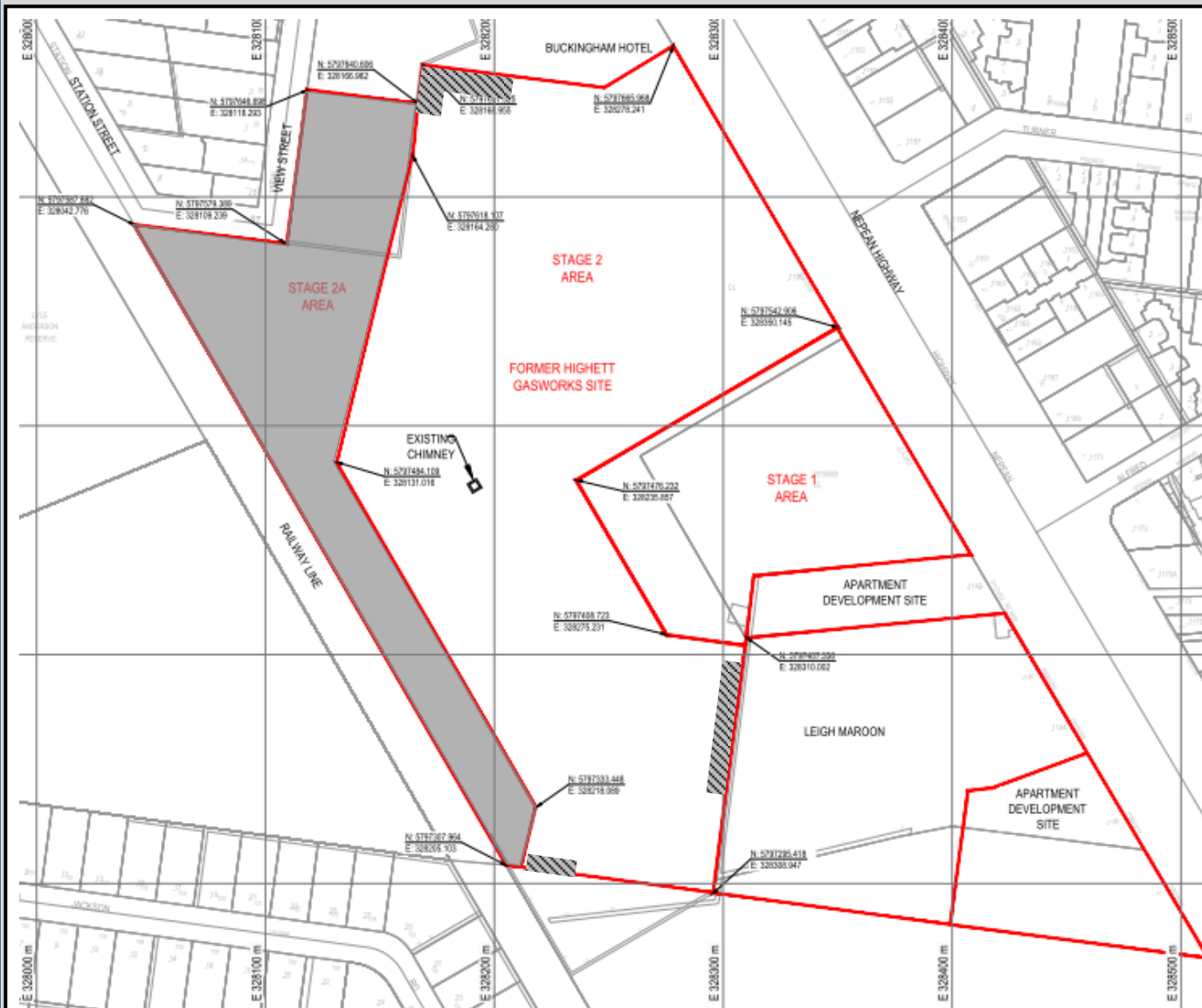
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Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016

Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

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LEGEND

- Beneficial uses of land precluded
- Residual soil impacts at site boundaries requiring management

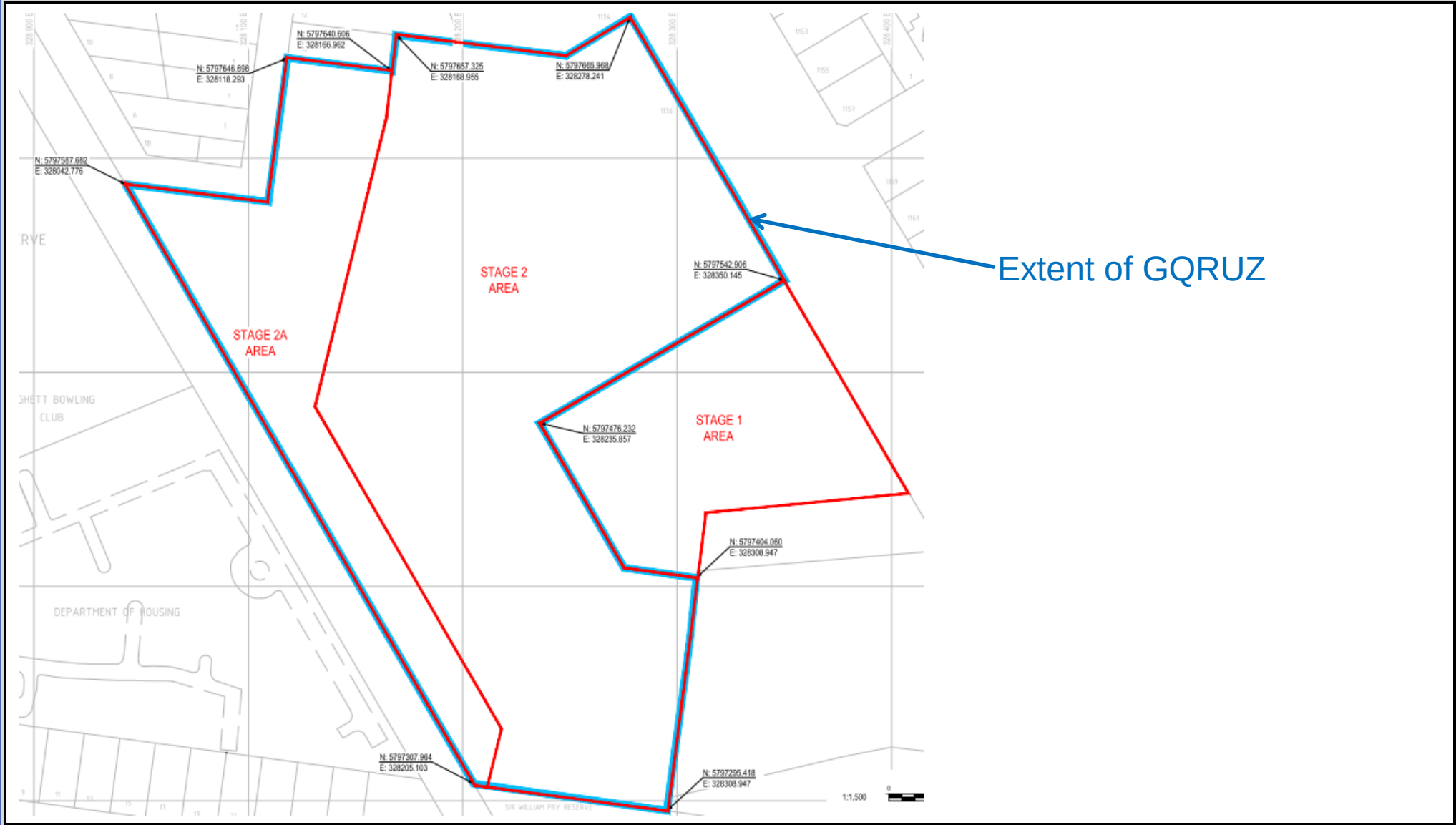
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PB PARSONS BRINCKERHOFF
125+
ABN 84 797 323 433
Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

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Extent of GQRUZ



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Email: melbourne@pb.com.au

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ENVIRONMENT PROTECTION ACT 1970

STATEMENT OF ENVIRONMENTAL AUDIT

I, John Throssell of Parsons Brinckerhoff, a person appointed by the Environmental Protection Authority ('the Authority') under the *Environmental Protection Act 1970* ('the Act') as an environmental auditor for the purpose of the Act, having

1. been requested by the Department of Treasury and Finance to issue a certificate of environmental audit in relation to the site located at **1136 - 1138 Nepean Highway Highett Stage 2A**, owned/occupied by the Department of Treasury and Finance (see **Figure 1** attached to this Statement).
2. had regard to, among other things,
 - i) guidelines issued by the Authority for the purposes of Part IXD of the Act,
 - ii) the beneficial uses that may be made of the site, and
 - iii) relevant State environment protection policies/ industrial waste management policies, namely
 - SEPP Prevention and Management of Contamination of Land
 - SEPP Groundwaters of Victoria
 - SEPP Waters of Victoria
 - Environmental Protection (Industrial Waste Resource) Regulations

in making a total assessment of the nature and extent of any harm or detriment caused to, or the risk of any possible harm or detriment which may be caused to, any beneficial use made of the site by any industrial processes or activity, waste or substance (including any chemical substance), and

3. completed an environmental audit report in accordance with Section 53X of the Act, a copy of which has been sent to the Authority and the relevant planning and responsible authority.

HEREBY STATE that I am of the opinion that

The site is suitable for the beneficial uses associated with:

- none (as indicated in **Figure 2** attached to this Statement).

subject to the following conditions attached thereto:

- a) Groundwater at the site is polluted. Groundwater must not be used for any beneficial use without prior testing and review of results by an environmental auditor (appointed under part IXD of the Environmental Protection Act 1970) to confirm its suitability for that use. It may be extracted for the purpose of environmental monitoring or remediation.
- b) Prior to 31 January 2012, the Groundwater Quality Management Plan (GQMP) formulated for the site and accepted by the environmental auditor must be implemented and maintained by the Department of Treasury and Finance and future owners of the site. The GQMP provides details on the groundwater monitoring program including, the monitoring wells to be sampled, laboratory analysis program, methodology, monitoring frequency, program duration, review procedure, reporting requirements and, roles and responsibilities.

- c) The GQMP forms part of this Statement of Environmental Audit and must be provided to all future owners/occupiers of the site.
- d) The GQMP must remain in force until such time as an environmental auditor (appointed under part IXD of the Environmental Protection Act 1970) confirms in writing that the monitoring and management requirements are no longer required, and this confirmation is advised in writing to the EPA and the planning authority. The GQMP has identified a Section 53V audit as the appropriate mechanism for cessation of the groundwater management and monitoring requirements.
- e) Prior to 29 February 2012, an Environmental Management Plan (EMP) must be developed for the site by a suitably qualified professional and accepted by an environmental auditor appointed under Part IXD of the *Environment Protection Act 1970*, and this acceptance advised in writing to EPA and the planning authority.
- f) Prior to 15 March 2012, the Department of Treasury and Finance and future owners of the site must implement and maintain the EMP required by condition (e) of this Statement.
- g) No disturbance of soil shall be undertaken prior to the implementation of the EMP.

The condition of the site is detrimental or potentially detrimental to all beneficial uses of land. Accordingly, I have not issued a Certificate of Environmental Audit for the site in its current condition, the reasons for which are presented in the environmental audit report. The terms and conditions that need to be complied with before a Certificate of Environmental Audit may be issued are as set out as follows:

- Remediation of residual groundwater impacts associated with the site to the extent that relevant beneficial uses of groundwater are restored.
- Removal of all residual soil impacts below the site.

Other related information

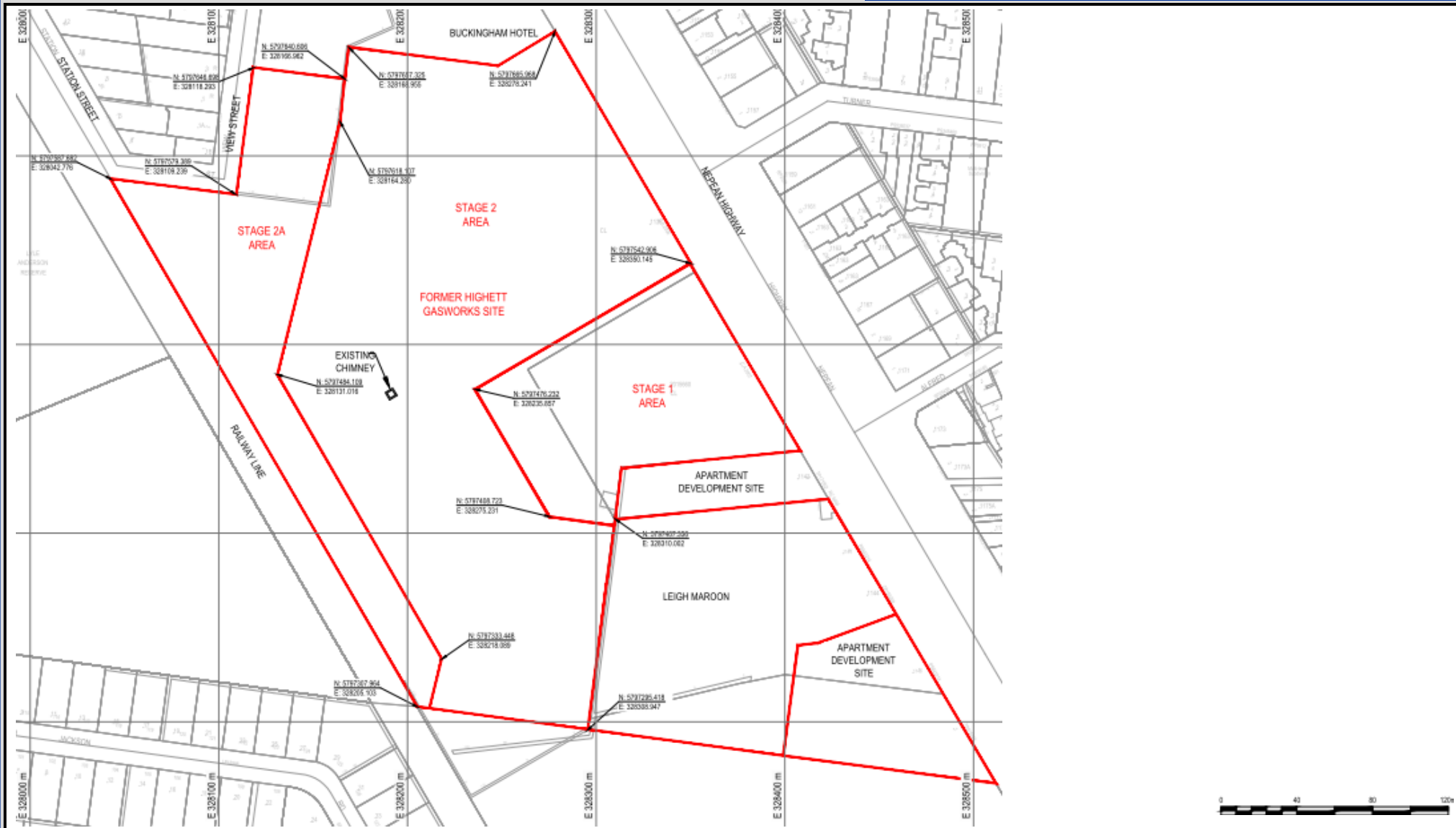
- The site (1136-1138 Nepean Highway Highett Stage 2A) is defined by the coordinates presented in the attached survey plan (**Figure 1** attached to this Statement).
- A separate Statement of Environmental Audit has been issued for the adjoining Stage 2 area.
- The Authority has determined that groundwater has been cleaned up to the extent practicable and the site is a groundwater quality restricted use zone (GQRUZ) (**Figure 3** attached to this Statement).
- Groundwater below the site is polluted and is not suitable for any beneficial use and should only be extracted for the purpose of environmental monitoring or remediation purposes.
- In accordance with clause 19(3) of the SEPP (Groundwaters of Victoria), the Authority may require periodic reassessment of the practicability of groundwater clean up.

This Statement forms part of environmental audit report *Parsons Brinckerhoff, 1136-1138 Nepean Highway Highett 3190 Victoria, (CARMS 37308-2) 2125064A-RPT001-A, 15 December 2011*. Further details regarding the condition of the site may be found in the environmental audit report.

DATED 15/12/2011

Signed: 

ENVIRONMENTAL AUDITOR



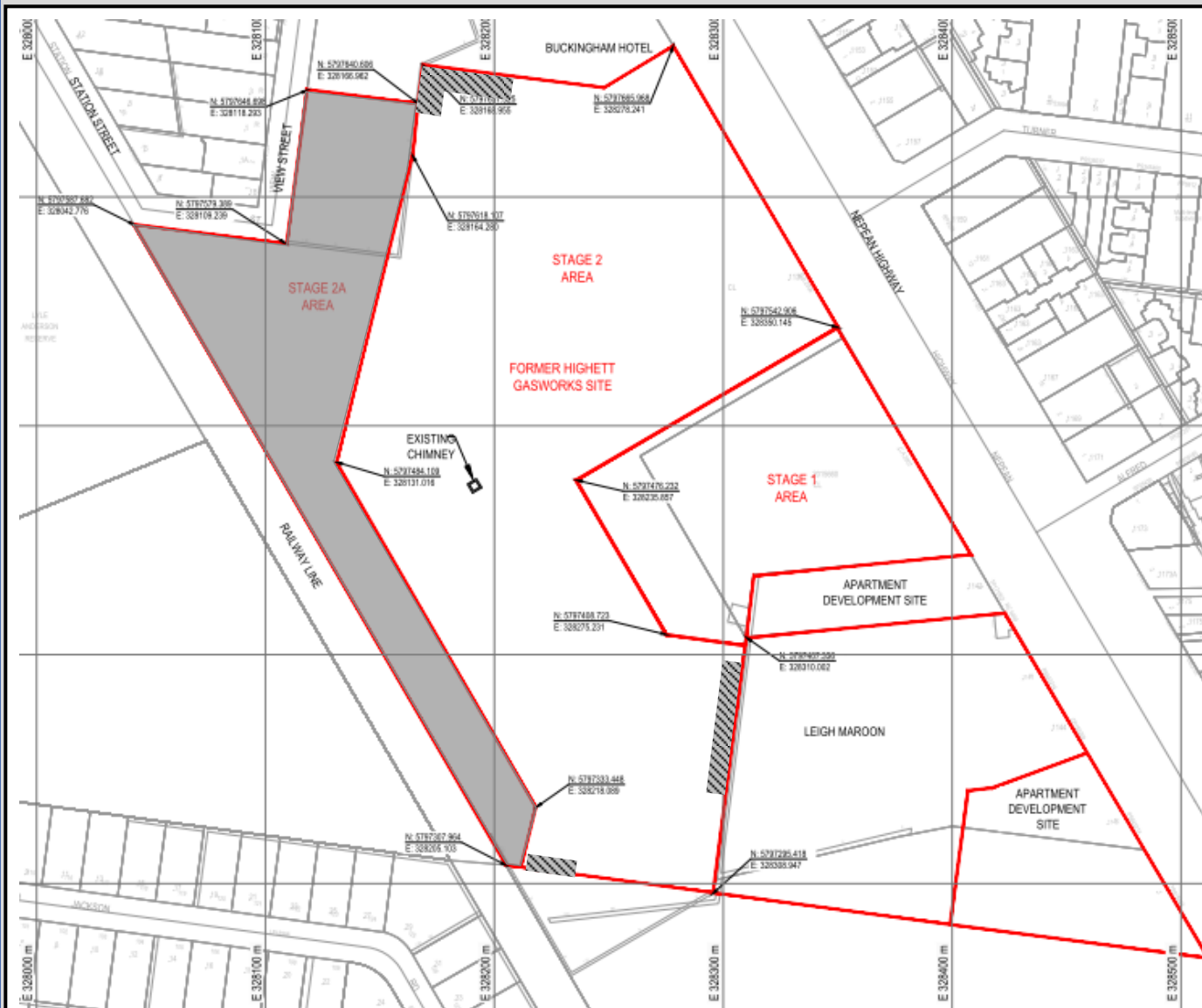
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Southbank Vic 3006
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Facsimile +61 3 9861 1144
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LEGEND

- Beneficial uses of land precluded
- Residual soil impacts at site boundaries requiring management



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**PB PARSONS
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ABN 84 797 323 433

Level 15, 26 Freshwater Place
Southbank Vic 3006
PO Box 19016

Telephone +61 3 9861 1111
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Email: melbourne@pb.com.au

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Glossary

Acronym	Definition
ACM	Asbestos Containing Material
ANZECC	Australian & New Zealand Environment & Conservation Council
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
BaP	Benzo(a)Pyrene
CCME	Canadian Council of Ministers of the Environment
CoC	Chain-of-Custody
COPC	Chemical of Potential Concern
CUTEP	Clean-up to the Extent Practicable
DCNR	Department of Conservation and Natural Resources
DSE	Department of Sustainability and Environment
DTF	Department of Treasury and Finance
EIL	Ecological Investigation Level
EPA	Environment Protection Authority; Environmental Protection Agency
ESA	Environmental Site Assessment
ETC	Enhanced Thermal Conduction
GQRUZ	Groundwater Quality Restricted Use Zone
HIL	Health-based Investigation Level
HRA	Health Risk Assessment
LOR	Limit of Reporting
MAH	Monocyclic Aromatic Hydrocarbon
mBGL	Metres Below Ground Level
mg/kg	Milligram per kilogram
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NSW EPA	New South Wales Environment Protection Authority
OCP	Organochlorine Pesticides
OPP	Organophosphorous Pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PDS	Passive Diffusion Sampling
QA/QC	Quality Assurance/Quality Control
RPD	Relative Percent Difference
SEMP	Site Environmental Management Plan
SEPP	State Environment Protection Policy
SSTL	Site-Specific Target Level
TCE	Trichloroethene
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
1,2,4 TMB	1,2,4 Trimethylbenzene
TPH	Total Petroleum Hydrocarbons
VHC	Volatile Hydrocarbon Compounds

Gasworks infrastructure	Definition
Retort	Vessel for heating coal to produce coal gas.
Scrubbers	Used to remove impurities from the raw gas (which contains tar and other by products) at various points in the process. Impurities removed include: hydrogen sulphide, hydrogen cyanide, ammonia, and metals such as arsenic, nickel and iron. Results in a waste ammoniacal liquor.
Condenser / Separator	To condense and separate the raw gas from the liquid fractions (oils, tars, ammonia liquor and water). Products: raw gas, condensate (oils, tars, ammonia liquor and water), ammoniacal liquor.
Livesey washers	Used to remove residual tar (not removed in the condensers) from the raw gas
Weak ammoniacal liquor	Used to scrub (remove) remaining ammonia, hydrogen sulphide and hydrogen cyanide from the raw gas
Purifiers	Used to remove hydrogen sulphide using either slaked lime or iron oxide (bog ore)
Gasholders	Storage of refined gas or raw gas prior to distribution or purification. Gasholders were set in large pits often partly below ground level to depths of over 4mBGL. The base of the gasholders often accumulated tar and contaminated water.
Gasworks materials and wastes	
Coal	Bituminous coal used
Coke	Carbonisation of coal (in absence of oxygen) to produce coke and gas with waste products including: ammoniacal liquor, and coal tar.
Coke, Clinker, Coal breeze, Lampblack	Solid by products and/or waste products of coal gas manufacture. Often contain PAHs and metals.
Coal tar / tar oils	Semi-solid to liquid by product of the production of coal gas. Often contains: MAHs, PAHs, phenols, cresol, sodium phenoxide, heterocyclic nitrogen compounds and nitrogen compounds, 2-mercaptobenzothiazole, organo-sulfur compounds. May be present as DNAPLs or LNAPLs
Coal gas	Hydrogen, carbon monoxide, hydrogen sulphide
Revivification	Re-oxidisation of spent oxides by spreading them out on the ground and allowing them to weather
Spent oxides	A product of gas purification. Often contain complex cyanides, free cyanides, metals, Prussian blue, acids, and strong sulphurous odours.
Ammoniacal liquor	A by product of the separators, sent to the weak liquor well and used in the ammonia scrubbers. The final ammonia liquor is sent to the strong liquor well. Ammoniacal liquor generally contains free and fixed ammonia, nitrates, sulphates, sulphides, PAHs and phenols.



**FORMER HIGHETT GASWORKS
1138 NEPEAN HIGHWAY HIGHETT
VICTORIA**

GROUNDWATER QUALITY MANAGEMENT PLAN - STAGES 2 AND 2A Rev 2

REPORT



Report Number. 05613598-199-R-Rev2



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GROUNDWATER QUALITY MANAGEMENT PLAN

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GROUNDWATER QUALITY MANAGEMENT PLAN

Site Environmental Manager Details

The following table outlines the contact details for the Site Environmental Manager as defined by the GQMP:

Name	Organisation	Date Appointed	Contact Information
			Phone: Mobile: Email:
			Phone: Mobile: Email:
			Phone: Mobile: Email:
			Phone: Mobile: Email:

The contact details shall be updated in this plan should the Site Environmental Manager change.

Document Revision

The following table outlines the minor revisions made to this document:

Date	Nature of Revision	Editor
3 November 2011	Initial GQMP Issue	Golder Associates
15 November 2011	Revision of GQMP based on Auditor comments	Golder Associates
05 December 2011	Revision of GQMP based on Auditor comments	Golder Associates

Any complete revision of the document will be accompanied by a new revision number, i.e. 004, and date, in the upper right hand corner of all pages. All minor changes will be incorporated into this revision and the above table will be updated.



GROUNDWATER QUALITY MANAGEMENT PLAN

ABBREVIATIONS

ACLCA	-	Australian Contaminated Land Consultants Association
AHD	-	Australian Height Datum
APHA	-	American Public Health Association
CEMP	-	Construction Environmental Management Plan
CUTEP	-	Clean Up to the Extent Practicable
EIP	-	Environment Improvement Plan
EMP	-	Environmental Management Plan
EPA	-	Environment Protection Authority (Victoria)
GQMP	-	Groundwater Quality Management Plan
GQRUZ	-	Groundwater Quality Restricted Use Zone
IWMP	-	Industrial Waste Management Policy
MNA	-	Monitored Natural Attenuation
NATA	-	National Association of Testing Authorities
PAH	-	Polycyclic Aromatic Hydrocarbons
QA	-	Quality Assurance
SEPP	-	State Environment Protection Policy
SoEA	-	Statement of Environmental Audit
TDS	-	Total Dissolved Solids
TPH	-	Total Petroleum Hydrocarbons
USEPA	-	United States Environment Protection Agency



GROUNDWATER QUALITY MANAGEMENT PLAN

1.0 INTRODUCTION

1.1 General

This Groundwater Quality Management Plan (GQMP) has been prepared for implementation in the Stage 2 and 2A areas of the Former Highett Gasworks located at 1138 Nepean Highway, Highett (the site") (refer Figure 1).

The two areas have been the subject to assessment and remediation culminating in the determination of Clean Up to the Extent Practicable (CUTEP) by EPA on 8 November 2010 (Appendix A). It is now expected that Statements of Environmental Audit (SoEA) will be completed in November 2011 by Mr. John Throssell of Parsons Brinkerhoff Pty Ltd. (PB) indicating that Stage 2 is suitable for medium density residential and less sensitive uses and Stage 2A is suitable for commercial and less sensitive uses subject to a number of Conditions.

This GQMP has been developed to satisfy the conditions of the CUTEP and hence likely conditions of the SoEA..

1.2 Objectives

The objective of the GQMP is to inform site users including designers, contractors, owners and occupiers of the site conditions and control mechanisms for the management of known and potential human health and environmental risks associated with residual groundwater and soil vapour contamination at the site. Specifically the GQMP has been developed to:

- comply with the requirements of the EPA CUTEP determination and Environmental Audit conditions;
- assess changes in groundwater conditions that may indicate further contamination of the aquifer (above background levels);
- monitor for natural attenuation of the impacts; and
- ensure onsite groundwater contaminants of concern directly associated with the former use of the site as a gasworks, are not migrating offsite to the extent that offsite beneficial uses are placed at risk.

1.3 Overview

As part of the CUTEP determination, a Groundwater Quality Restricted Use Zone (GQRUZ) has been determined. It is expected that the GQRUZ will extend over the entire Stage 2 and Stage 2A site. The key conditions of the CUTEP determination (Appendix A) can be summarised as follows:

- Groundwater must not be extracted from the site for uses other than clean-up or monitoring.
- A Groundwater Quality Management Plan (GQMP) must be developed and implemented for the site to monitor and manage the residual groundwater contamination;
- The GQMP must indicate that a Section 53V audit is the appropriate mechanism for cessation of groundwater monitoring and management at the site;
- Offsite wells 913007 and 9130010 must be included in the monitoring network.

These items are addressed within this GQMP.



GROUNDWATER QUALITY MANAGEMENT PLAN

2.0 BACKGROUND INFORMATION

2.1 Groundwater Regulatory Framework

2.1.1 State Environment Protection Policy Groundwaters of Victoria

The State Environment Protection Policy (SEPP) Groundwaters of Victoria (SEPP Groundwater) (Reference 1) sets out the beneficial uses to be protected. The SEPP Groundwater classifies groundwater into five segments on the basis of background salinity (TDS) levels. Each segment has defined beneficial uses for protection, and the SEPP Groundwater specifies that all of these beneficial uses must be protected. Therefore, assessment of groundwater contamination must take into account all of these uses.

The SEPP Groundwater indicates that the EPA has the authority to establish Groundwater Quality Restricted Use Zones (GQRUZ) where one or more beneficial uses are precluded due to contamination. It also indicates that if such a zone is established then the groundwater within the zone must be managed to enable the groundwater to be contained within the restricted use zone and that the groundwater must be cleaned up to the extent practicable. The SEPP Groundwater also indicates that the practicability of the clean up must also be periodically reviewed.

2.1.2 Environment Protection Authority Publication 840

EPA Publication 840 "The Clean Up and Management of Polluted Groundwater" (Reference 4) indicates that where polluted groundwater has been identified, the EPA's role is to require clean up. If it is impracticable to clean up groundwater to the level needed to restore beneficial uses, EPA may accept that clean up to the extent practicable has occurred and that, subject to appropriate ongoing management, further clean up is not required. The Publication also establishes a method for determination of the practicability of clean up of the polluted groundwater.

Publication 840 indicates that management of polluted groundwater includes the following key components:

- Clean up objectives (that reflect clean up to the extent practicable);
- Groundwater monitoring;
- Trigger levels;
- A contingency plan;
- Controls on the use of polluted groundwater, including the provision of information to ensure that affected landholders or subsequent landholders are aware of the polluted groundwater and the beneficial uses that are precluded; and
- Periodic review of the practicability of groundwater clean up (to meet the SEPP Groundwater objectives) where this has previously been determined to be impracticable.

2.2 Surface Water Regulatory Framework

The State Environment Protection Policy (SEPP) Waters of Victoria (SEPP Water) (Reference 1) sets out the beneficial uses to be protected. The SEPP Water classifies surface waters into 12 segments based on geographical location. Each segment has defined beneficial uses for protection, and the SEPP Water specifies that all of these beneficial uses must be protected. Therefore, assessment of surface water contamination must take into account all of these uses.



2.3 Summary of Site Conditions

Details of the soil contamination status within Stages 2 and 2A are provided in the Golder Associates report "Environmental Site Assessment and remediation Report, Stage 2 Audit Area, Former Highett Gas Works 1136 Nepean Highway Highett" (Reference 9).

In summary, the site operated as a gas manufacturing facility between 1939 and 1969 and was the last gasworks site to be established in Victoria. The industrial operations associated with the gas manufacturing process have resulted in impacts to both soil and groundwater at the site. The key contaminants identified at the site include Monocyclic Aromatic Hydrocarbons (MAHs), Polycyclic Aromatic Hydrocarbons (PAHs), phenols, Total Recoverable Hydrocarbons (TRH), sulphates and sulphides and cyanide.

During the late 1970s the gasworks was in most part demolished and in the early 1980s a partial remediation of the site was undertaken prior to the site being redeveloped as the Scientific Services Department and Training Centre for the Gas and Fuel Corporation. Based on the available information it is estimated that the volume of previously remediated material was at least 28 000 m³.

Due to limitations in the extent of the remediation due to boundary (Figure 2), proximity to groundwater and remaining gas infrastructure material not meeting the adopted site criteria was assessed as part of a Human Health Risk Assessment (HHRA). This HHRA was based on the risk to indoor users from vapours emanating from the remaining soil. This HHRA found that the soil concentrations remaining at depth was unlikely to present an unacceptable vapour risk whilst the material remaining around the gas infrastructure presents an unacceptable risk.

2.4 Summary of Groundwater Contamination

A substantial amount of groundwater investigation has been undertaken on the site and the hydrogeological conditions on the site are considered to be adequately characterised. Details of the groundwater contamination status are provided in the "Information to Support Clean Up To The Extent Practicable, 1136 Nepean Highway Highett" (Reference 8).

In summary background information of the Brighton Group aquifer indicates that groundwater in general has a TDS of less than 1 000 mg/L, whilst the shallow groundwater at the site indicates TDS concentrations in the range of Segment A2 based on the SEPP.

Based on the adopted criteria groundwater at the site is contaminated with metals, PAHs, MAHs, cyanide, ammonia sulphate and phenol. Whilst offsite wells are contaminated with metals, cyanide, ammonia and sulphate. In general the data suggests that there are three main sources of contamination: the CWG Relief Holder in the northwest corner of the site and the tar dam and stockpiling area in the southern corner of the site.

To assess if natural attenuation of the contaminants of interest is occurring, the physical processes of adsorption and biodegradation were considered. In considering natural attenuation the two main sources of contamination: the northwest corner and the southern corner were considered.

The data from both the northwest and southern corners of the site suggests that groundwater contaminants are being attenuated due to the following evidence down gradient:

- A decrease in the concentrations of key contaminants at the source and downgradient.
- The progressive reducing nature of the groundwater chemistry
- A progressive shift in total ion composition towards a composition more representative of background.



2.5 Regulatory Outcomes for Site

2.5.1 Clean up to the Extent Practicable

Following the site remediation, the Environmental Auditor made a submission to the EPA on 02 June 2010 supporting that CUTEP had been achieved at the site. EPA responded on 08 November 2010 indicating that it had determined that CUTEP had been achieved and by declaring that the site is within a GQRUZ subject to a requirement that groundwater is monitored to support the demonstration of acceptable risks to groundwater following remediation.

Declaration of a Groundwater Quality Restricted Use Zone (GQRUZ) provides a mechanism to prevent groundwater extraction and therefore access to groundwater at the site by site owners, occupiers and third parties. EPA has established in Publication 862 *Groundwater Quality Restricted Use Zone* (July 2002) (Reference 5) that it is its policy when identifying a GQRUZ to “inform the relevant groundwater resource manager and retailer, the relevant local council, and where appropriate, directly affected landholders”. Control of access to groundwater is defined by the Water Act (1989) (Reference 12), which is administered by the Department of Sustainability and Environment (DSE) and Southern Rural Water (SRW). The method for the prevention of groundwater extraction is through Southern Rural Water who is responsible for permitting new wells for groundwater extraction via a licensing system. It is expected that a process initiated by EPA and the water authority will notify relevant stakeholders of the restrictions on groundwater extraction and controls the future access to groundwater at the site.

2.5.2 Statement of Environmental Audit

Mr. John Throssell, Environmental Auditor (Contaminated Land), is expected to issue two Statements of Environmental Audit for the site in November 2011. The SoEAs are expected to indicate that Stage 2 is suitable for medium density residential and less sensitive uses and Stage 2A is suitable for commercial and less sensitive uses subject to a number of Conditions.

3.0 MANAGEMENT RESPONSIBILITIES

3.1 Overall Responsibility

The ‘responsible party’ for the implementation of the GQMP will be the Department of Treasury and Finance or Subsequent Site owners. The responsible party will ensure that procedures in the GQMP and reporting requirements as set out in this document are adhered to.

It is recommended that a person is appointed by the ‘responsible party’ with the responsibility of implementing the GQMP and ensuring its compliance by all site users. It is recommended that such a person would assume the role of Site Environmental Manager for the site.

3.2 Site Owner

The site owner shall ensure that access to all monitoring wells at the site remains possible during the required monitoring periods and that wells shall be protected from damage.

In accordance with Section 53ZX of the Environment Protection Act (1970), all site occupants are required to be provided with a copy of the SoEA and the GQMP to alert them to the condition of the site including the restriction on groundwater use at the site. The site owner shall be responsible for this.

Any future owners and/or occupiers of the site should be informed, by provision of the SoEA, that the groundwater at the site is unsuitable for use.

Any future Conditions of Sale placed on transfer of site ownership must also make reference to the GQMP.



3.3 Site Environmental Manager

For the purposes of this document, the Site Environmental Manager shall be considered to be the party responsible for the day-to-day management of the GQMP. The name and contact details of the appointed Site Environmental Manager shall be nominated in the table on page iii) of this GQMP.

It is the Site Environmental Manager's responsibility to:

- Maintain all site records related to implementation of this GQMP.
- Ensure that the required parties such as the Environmental Consultant or the Environmental Auditor are engaged to implement the requirements of the GQMP.
- Ensure that all records as required under the GQMP are made available to the Environmental Consultant and the Environmental Auditor to complete reporting required under the GQMP.
- Manage the implementation of any recommendations made by those parties in relation to work undertaken in accordance with this GQMP.
- Inform the owner of any non-conformances with the procedures and requirements of this GQMP.
- Ensure that access to the groundwater monitoring wells within the designated monitoring network and ensure that the monitoring points are retained in a serviceable state.
- Provide all site occupants with a copy of the Statement of Environmental Audit and the GQMP to alert them to the condition of the site.

3.4 Site Occupier

It is the responsibility of the site occupier to ensure that access to the groundwater monitoring wells within the designated monitoring network is maintained and to ensure that the monitoring points remain in a serviceable state during their occupation of the site.

3.5 Environmental Consultant

Monitoring, response to issues and review and reporting activities must be conducted by a suitably trained and qualified environmental consultant. It is preferable that an Environmental Consultant be used from a company that is a member of the Australian Contaminated Land Consultants Association (ACLCA).

It is the Environmental Consultant's responsibility to:

- Plan, conduct and report on the GQMP activities in accordance with the GQMP and referenced guidance.
- Make recommendations for action arising from the monitoring.
- Notify Responsible Parties and the appointed Environmental Auditor ("Auditor") if the adopted trigger levels are exceeded.



GROUNDWATER QUALITY MANAGEMENT PLAN

3.6 Environmental Auditor

The role of the Environmental Auditor (which may or may not be one person over the life of the project) is to:

- Assess the data and associated recommendations provided by the Environmental Consultant to identify whether the GQMP has been adhered to.
- Assess whether the requirements for implementing the groundwater contingency plans have been met.
- Inform the EPA that groundwater or vapour contingency plans have been activated should this be the case.
- Review the contingency plans triggered by this GQMP.
- Review any proposed changes to the GQMP including the termination of vapour or groundwater monitoring under the GQMP.

3.7 Environment Protection Authority

It is the responsibility of the EPA to:

- Review the status of the CUTEP and GQRUZ determined for the site.

Determine if and when implementation of the groundwater monitoring under the GQMP can be ceased using the relevant process at the time.

4.0 GENERAL MANAGEMENT

4.1 General Environmental Management

Good environmental management procedures should be followed by all contractors and consultants working on the site. It is the responsibility of the site contractors to manage their works to minimise potential impacts on the site and the surrounding environment. Such procedures shall include:

- Appropriate chemical and fuel storage.
- Refuelling of equipment to reduce the risk of spillage.
- Appropriate waste control and disposal methods.
- Minimising dust generation.
- Minimising offsite tracking of soil.
- Control, management and discharge of site stormwater.

To manage these obligations, it is preferable (and good practice) that site contractors develop a Construction Health Safety and Environmental Management Plan (CHSEMP) for the site. Such a CHSEMP should reflect the requirements of this GQMP as well as EPA guidance such as the general principles outlined in "Environmental Guidelines for Major Construction Sites", Best Practice Environmental Management Series, EPA Publication 480, February 1996.

The above environmental management obligations are common to all development sites in Victoria and so have not been further documented as part of this GQMP.

The environmental management procedures adopted for the works shall be documented by the contractor in accordance and a record kept by the Site Environmental Manager in accordance with this GQMP.



4.2 Occupational Health and Safety

The Statutory Environmental Audit process considers the health and safety effects of remaining chemicals in soil at the site. However, managers, contractors and subcontractors who work on this site remain responsible for all health and safety issues associated with their activities. A Construction Health Safety and Environmental Management Plan (CHSEMP) should be prepared for works on the site with the involvement of an occupational hygienist. The Plan should consider potential risks posed by the soil and groundwater on the site.

As part of the site induction for all workers or people visiting the site, the specific health and safety issues for the site shall be outlined by the Contractor as well as the existence and requirements of this GQMP.

5.0 GROUNDWATER QUALITY MANAGEMENT PLAN

5.1 Aim of Groundwater Monitoring

The aim of the groundwater monitoring as part of this GQMP is to confirm that the groundwater results following completion of site remediation remain stable or reduce from those results obtained to support the completion of the Environmental Audit.

5.2 Extraction of Groundwater

Groundwater must not be extracted from within the site for any other purpose than monitoring or clean up. The extraction of groundwater requires the issuing of a license by the relevant authority in this case Southern Rural Water. The identification by EPA that the site is in a Groundwater Quality Restricted Use Zone (GQRUZ) should prevent the future issuing of any extractive license within the GQRUZ.

Where groundwater is extracted, it must be disposed of in accordance with Victorian EPA guidelines with testing as appropriate.

5.3 Maintenance of Well Network

To protect the groundwater monitoring wells from damage they shall be highlighted and fenced-off where necessary. All contractors and owners shall be made aware of the location of the groundwater monitoring wells by the Site Environmental Manager.

Should any of the monitoring wells become damaged or be found to be in an inappropriate location for the development, the existing well shall be decommissioned in accordance with the Water Act (1989). The well shall be replaced to an equivalent depth, screen interval and construction standard to the damaged/ decommissioned well. Should any changes to this be required, the Environmental Consultant shall review any replacement location or change in construction of the replacement well. The replacement well shall be installed by a licensed driller and registered in accordance with the Water Act (1989). All borelogs for the monitoring well network are included in Appendix B of this GQMP.

Material excavated from the site must be sampled at a rate set by an Environmental Consultant with consideration of EPA Industrial Waste Regulation Guidelines (IWRG) 702 and analysed for parameters shown in Table 2 of EPA IWRG 621. Once the soil is categorised, it may be disposed offsite to a landfill or treatment facility subject to EPA regulations.

Following installation, the well location and measuring point level shall be resurveyed and the GQMP updated with this information and the borelog (Appendix B).



GROUNDWATER QUALITY MANAGEMENT PLAN

5.4 Groundwater Monitoring

5.4.1 Network and Monitoring Frequency

The groundwater monitoring wells to be monitored as part of the GQMP are presented in Table 1 and shown on Figure 3.

All compliance wells in Table 1 shall be dipped for groundwater level on a yearly basis, prior to any sampling. Sampling of the wells will also occur on a yearly basis as identified in Table 1. It is expected that all other wells located on the site have been decommissioned in accordance with the Water Act (1989).

Table 1: Summary of Compliance Well Locations

Well	Easting	Northing	# RL of TOC	Screen Interval (m BGL)	Depth of Borehole (m BGL)
9010001	328083.5	5797528	37.873	5.1-9.1	10
9020001	328113.6	5797469	38.043	5.5-10.1	10.1
9030002	328158.8	5797392	38.236	5.9-9.9	10
9050001	328213.2	5797312	38.01	5.9-9.9	11
9120001**	328276.1	5797613	41.42	9.9-13.9	13.9
9130003	328055.6	5797409	36.207	6.0-10.0	10
9130005	328156.9	5797340	35.537	4.0-10.1	10.1
9130006	328043.3	5797534	35.644	4.2-10.2	10.2
9130007	328139.8	5797278	34.06	4.5-10.5	10.5
9130010	328256.4	5797284	38.072	6.0-10.0	10
9130011	328027.7	5797556	35.645	5.0-11.0	11
9140003	328264.4	5797385	38.301	5.0-10.0	10
9140005	328236.1	5797376	38.16	5.2-8.2	11
9140006	328208.8	5797330	37.952	5.0-10.0	10
9140007	328199.0	5797576	39.953	6.0-11.0	12
9140008	328058.2	5797584	38.473	6.0-10.0	10
9150001	328065.3	5797560	38.014	14.8-17.8	17.8
9150002	328263.1	5797384	38.149	16.4-19.4	19.4
9150003	328235.2	5797376	38.132	17.5-20.5	20.5
BH6	328063.8	5797562	37.933	7.5-10.5	10.5
BHF35	328158.3	5797442	38.327	4.3-10.3	10.3

NOTES:

AHD: Australian Height Datum,
 TOC: Top of Casing
 BGL: Below Ground Level (post remediation surface levels)
 Eastings and Northings, AMG Coordinate System
 # RL to TOC may change for many of the above monitoring wells due to shortening of monitoring wells based on changes in surface topography.
 ** Well considered to be reflective of background conditions

5.4.2 Sampling Procedures

All groundwater monitoring will be undertaken in accordance with EPA's Groundwater Sampling Guidelines (Reference 3) using low flow sampling techniques, including amendments or replacement guidelines that may be published in the future. Procedures used shall include appropriate consideration of sampling methods and decontamination procedures.

A groundwater sampling plan including health, safety and environmental procedures shall be prepared by a suitably qualified environmental consultant prior to the commencement of groundwater sampling.

During each monitoring round, prior to groundwater sampling of any of the nominated groundwater monitoring wells, groundwater depth measurements will be undertaken. Depths will be measured from the same point at the top of each well casing (i.e. to the point to which the wells have been surveyed).



GROUNDWATER QUALITY MANAGEMENT PLAN

During purging and immediately prior to samples being collected from the monitoring wells field parameters of electrical conductivity, temperature, redox potential, dissolved oxygen and pH will be measured and recorded.

All field parameter measurements shall be recorded on a sampling record form such as that presented in Appendix C of the EPA Groundwater Sampling Guidelines (Reference 3). The completed sampling record form shall be included as part of the reporting of the monitoring event.

Samples from all monitoring wells shall be transported to the laboratory under chain-of-custody procedures. A copy of the chain-of-custody forms shall be included as part of the reporting of the monitoring event.

5.4.3 Analytical Plan

Samples from all monitoring wells shall be transported to the analytical laboratory under chain-of-custody procedures. A copy of the chain-of-custody form shall be included as part of the reporting of the monitoring event.

All samples will be analysed for:

- Total Petroleum Hydrocarbons (TPH)
- Monocyclic Aromatic Hydrocarbons (MAH)
- Polycyclic Aromatic Hydrocarbons (PAH)
- Cyanide (total)
- Sulphate
- Metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn)
- Ammonia
- Nitrate
- Phenolic compounds.
- Natural attenuation parameters (nitrate, sulphate, Ferrous Iron, Methane)
- Major anions and cations

5.4.4 Analytical Procedures

The analytical methods will comply with USEPA, APHA, EPA Victoria or equivalent methods. The laboratory as part of their reporting procedures shall state these. All laboratories must be NATA endorsed for the analyses undertaken.

All Certificates of Analysis received from the primary and secondary laboratories shall be presented as part of the reporting for each monitoring event. The reporting limits used by both the primary and secondary laboratories shall be less than or equal to the following:



GROUNDWATER QUALITY MANAGEMENT PLAN

Table 2: Laboratory Reporting Limits

Parameter Group	Maximum Laboratory Reporting Limit (mg/L)
Total Petroleum Hydrocarbons (TPH)	0.02
Monocyclic Aromatic Hydrocarbons (MAH)	0.001
Polycyclic Aromatic Hydrocarbons (PAH)	0.001
Cyanide (total)	0.005
Sulphate	1
Ammonia	0.01
Nitrate	0.01
Phenolic Compounds	0.001

5.4.5 QC Procedures

A data quality plan shall be implemented as part of the monitoring program. As a minimum, the following shall be undertaken:

- Documentation of the sampling methodology undertaken against sampling and field contamination procedures.
- Field duplicates and field splits shall be collected at a rate of 5 percent of Primary samples. All duplicates will be analysed for the same range of analytes as the primary sample.
- A wash blank will also be collected for every day of sampling during each sampling event and will be analysed for the same range of analytes as the primary sample.
- The laboratories used for the groundwater analytical works shall implement a full quality assurance program including the analysis of internal spikes, duplicates and method blanks.
- The QA results shall be reported in terms of completeness. The target completeness shall be 95%. An assessment of the reasons for non-conformances with this target shall be reported and data qualifiers used should issues be found.

5.5 Compliance Targets

The compliance targets have been developed based on the historical data for the site with the view that the groundwater contamination profile should comply with the SEPP Groundwater so that the protected beneficial uses of groundwater for the area are maintained. The compliance targets for the site are shown in Table 7. For analytes copper, nickel, zinc and nitrate where the background concentrations are considered to exceed the criteria outlined in the SEPP, background concentrations¹ shall be considered as part of the compliance target and these are outlined in Table 7 below.

It should be noted that should the regulator requirements alter in the future, these criteria may require revision to ensure that all relevant guidelines are complied with.

Should the compliance targets be reached, no further groundwater monitoring would be expected to be required. This is subject to the requirements of Section 8 of this GQMP.

¹ These concentrations have been based on the maximum observed level in wells 9130009, 9120001 and BH1. Should the concentrations observed in these wells increase in the future the compliance target should be adjusted to reflect these increases.



GROUNDWATER QUALITY MANAGEMENT PLAN

Table 3: Groundwater Compliance Targets

Chemical	Maintenance of Ecosystems (mg/L)	Groundwater Extractive Use Criteria (mg/L)				Background Concentration (mg/L)
	Aquatic (Marine) Ecosystems (95% Protection)	Potable Water Supply	Primary Contact Recreation	Irrigation	Stock Watering	
Inorganics						
Arsenic	0.0023 ^B	0.007	0.05	0.1	0.5	
Cadmium	0.0055 ^E	0.002	0.005	0.01	0.01	
Chromium (Total)	0.0274	0.05	0.05	0.1	1	
Copper	0.0013	2	1	0.2	0.4 ^A	0.053
Lead	0.0044	0.01	0.05		0.1	
Mercury	0.0004 ^B	0.001	0.001	0.002	0.002	
Nickel	0.070	0.1	0.1	0.2	1	0.23
Zinc	0.015 ^D	3.0	5	2	20	0.29
Sulphate (as SO ₄)		250	400			
Ammonia (as N)	0.9	0.5	0.01			
Nitrate (as N)	7.0 ^I	11	10		30	14
Cyanide (Total)	0.004 ^F	0.08	0.1			
Other Organics						
Naphthalene	0.070					
Anthracene	0.0004 ^B					
Phenanthrene	0.0006 ^B					
Fluoranthene	0.001 ^B					
Benzo(a)pyrene	0.0001 ^B	0.00001	0.00001			
Total PAH	0.003 ^H					
TPH (>C ₉)	10 ^H		0.6			
Benzene	0.7	0.001	0.001 ^G			
Toluene	0.18	0.8 ^G	0.8 ^G			
Ethyl Benzene	0.005	0.3 ^G	0.3 ^G			
Xylenes	0.075	0.6 ^G	0.6 ^G			
Styrene		0.03 ^G	0.03 ^G			
2 Chlorophenol	ID		0.3			
2 4 Dichlorophenol	0.16 ^D		0.2			
2 4 6 Trichlorophenol	ID	0.01	0.02			
Pentachlorophenol	0.022	0.01	0.01			
2 3 4 6 Tetrachlorophenol	ID	0.001	0.001			
Phenol	0.40		0.05 ^H			

Notes:

A – the criteria used was the most sensitive criteria for the range of criteria for a variety of livestock.

B – Note that chemicals marked (B) are based on low reliability toxicity and should be used with caution.

D – May not protect key test species from chronic toxicity.

E – The values have been calculated using a hardness of 30 mg/L CaCO₃.

F – Based on ANZECC 2000 data for fresh and marine waters.

G – Based on 1996 Australian Drinking Water Guidelines for health but not protective of aesthetics (Reference 11).

H – NSW EPA Guidelines for Assessing Service Station Sites – value based on odour and aesthetics, due to formation of visible sheen.

I – Further to the adopted criteria for nitrate, it is noted that the Errata slip in ANZECC (2000) states that "Page 3.4-5, Table 3.4.1, Nitrate - "Delete all trigger values and replace with "Under review"". This means that the nitrate (as N) ecosystem criterion of 0.158 mg/L adopted by Golder for this project is now considered uncertain.

Golder has sourced a Memorandum available on the Ministry for the Environment New Zealand website as "Important information for users deriving aquatic ecosystem trigger values for nitrate" dated 30 September 2002 by National Institute of Water & Atmospheric Research Ltd. It recommends a Nitrate-N guideline (95%) of 7.0 mg/L. This criterion was derived using ANZECC (2000) methods and so is considered likely to be suitable for use in Victoria. It has been recommended as part of this report that the Auditor review the basis for the nitrate criteria used for this project with a view to adopting 7.2 mg/L (nitrate as N) as the compliance target.

ID – Insufficient data to derive a reliable trigger value.



GROUNDWATER QUALITY MANAGEMENT PLAN

5.6 Trigger Conditions

The results of the groundwater monitoring shall be reviewed after each compliance sampling event and consider the following changes to site conditions:

- 1) An observed change in groundwater flow direction.
- 2) An observed increase in groundwater concentration of greater than 10 per cent per round over two consecutive compliance monitoring events in any one well for a parameter exceeding the compliance targets outlined in Table 7.

Should any of the above occur; the contingency plan will be triggered and implemented.

The results of monitoring and management shall be reviewed after each sampling event and assessed against the trigger conditions shown in Section 5.7 below. Should any of the trigger conditions be met, the initial actions shown in Section 5.7 shall be enacted.

5.7 Groundwater Contingency Plan

If any of the Trigger Conditions are reached during routine monitoring, the following process shall be undertaken in order to assess the significance of the issue and to implement contingency measures if required.

- 1) Groundwater monitoring frequency (of all compliance wells) shall be increased to monthly for a minimum period of three months to assess if there is a trend in the issues noted.
- 2) If no trend is found and no further issue is noted, then the standard monitoring frequency shall be reinstated.
- 3) Should a trend of non-compliance be found, then the Environmental Consultant shall further assess the issue and develop a management or remediation plan for the groundwater. An Environmental Auditor shall be appointed to assess this plan.
- 4) Upon agreement, the plan shall be implemented.

5.8 Reporting of Groundwater Monitoring

5.8.1 Site Data

A copy of the existing site data used to support the Environmental Audit for the site is attached as Appendix C for use in reporting of subsequent monitoring. Table E presents groundwater level information for wells in the monitoring network together with the groundwater analytical data for wells in the monitoring network.

An electronic database shall be maintained by the Site Owner (initially DTF) of all historic sampling events. As each additional sampling event is conducted, the Environmental Consultant shall update this database for future reference of the Site Owner.



GROUNDWATER QUALITY MANAGEMENT PLAN

5.8.2 Reporting of a Monitoring Event

The monitoring data will be collected and compiled by the Environmental Consultant after each sampling event (yearly). A report along with the tabulated results of all the monitoring wells will be provided to the Site Owner at this time. The Site Owner shall also make a copy of this information available to the site occupier. The report shall set out:

- The scope of monitoring works undertaken.
- The sampling and analytical procedures followed.
- The field data collected and field sampling records.
- The chain-of-custody forms.
- The Certificates of Laboratory Analysis.
- Tabulated data of the groundwater depths and levels.
- Tabulated summaries of the field parameters measured and the groundwater analytical data.
- An assessment of trends in the compliance contaminants.
- An assessment of data quality in terms of completeness using the data quality objectives set out in AS4482.1-2005 (Reference 2). Any problems with the final analytical data shall be identified and corrective action will be taken and documented where such problems are identified.
- An assessment of the data against the compliance and trigger levels set in the GQMP.
- Groundwater elevations including flow direction and calculated gradients and estimated groundwater flow velocities.
- Recommendations for additional action and implementation of contingency actions in accordance with the GQMP.

The reports shall be made available to the Site Owner and Site Occupants.

5.9 Damage or Moving of Groundwater Compliance Wells

The monitoring network may be required to fit into the development plans for the site. If the development requires that any of the monitoring wells need to be moved due to their location, the well should be replaced in a similar location that fits in with the development plans, if possible. The final locations of the monitoring points to be moved will require Auditor agreement prior to installation.

The monitoring network and frequency of sampling shall be periodically reviewed by an Environmental Auditor (Contaminated Land) in accordance with this GQMP and it is expected that with time the number of wells required to be sampled will decrease.

Should any of the monitoring wells become damaged or need to be replaced, the existing well shall be decommissioned in accordance with the Water Act (1989). The well shall be replaced to an equivalent depth, screen interval and construction standard to the damaged well. The replacement well shall be installed by a licensed driller and registered in accordance with the Water Act (1989). The well location and measuring point level shall be resurveyed and this GQMP updated. The borelog for the well shall be completed and form part of the reporting for the sampling event.

The borelogs and well construction details for the monitoring wells to be sampled as part of this GQMP are provided in Appendix B.



GROUNDWATER QUALITY MANAGEMENT PLAN

6.0 REVIEW OF GQMP DATA

6.1 Records of Monitoring and Inspection

The originals of all monitoring reports and actions taken under this GQMP shall be kept in one place at a location nominated by the Site Owner so that the information can be easily reviewed.

6.2 Review by an Environmental Auditor (Contaminated Land)

The monitoring reports prepared by the consultant shall be submitted to an EPA appointed Environmental Auditor (Contaminated Land) for review after the initial two years of monitoring at the site or if any of the trigger conditions are met.

The Environmental Auditor (Contaminated Land) shall review the data and provide an opinion as to whether any significant change has occurred in the status of the vapour or groundwater pollution at the site and assess whether trigger levels have been reached. The Environmental Auditor (Contaminated Land) shall also provide any recommendations for change to the monitoring program or for further actions deemed necessary to be undertaken based on the available information. Any suggested changes as an outcome of the review would require a revision of the GQMP and approval by the Environmental Auditor.

The Auditor shall prepare a review confirming the required actions for the groundwater monitoring and management or recommending alternative actions if appropriate. The time for the next period of Auditor review would also be set at this time by the Auditor.

The outcomes and recommendations of the review shall be provided to the Site Owner and Site Occupants.

6.3 Review by EPA

The EPA may review the practicality of clean up of the groundwater in accordance with clause 19 (3) of the SEPP Groundwater (Reference 13) and require additional assessment, management or remediation actions to be undertaken.

The EPA will also need to be part of any review aimed at ceasing all or some of the monitoring components in the GQMP as set out below.

7.0 CLOSURE OF THE GQMP

The potential exists for the closure and cessation of GQMP activities associated with the groundwater. The requirements for the closure of the groundwater monitoring are as follows:

- 1) All of the compliance targets for groundwater outlined in Table 7 have been met on and off the site in two consecutive monitoring rounds. That is the beneficial uses of the groundwater on and off the site have been restored to the satisfaction of an Environmental Auditor appointed pursuant to the Environment Protection Act 1970 and the EPA. **OR**

Through risk assessment, the risks posed to protected beneficial uses of groundwater on and offsite for which the groundwater concentrations still exceed the compliance targets outlined in Table 7 are shown to be acceptable to the satisfaction of an Environmental Auditor appointed pursuant to the Environment Protection Act 1970 and the EPA.

- 2) By agreement with an Environmental Auditor and the EPA that the aims of the groundwater monitoring as set out in this GQMP have been met. This will need to be demonstrated through completion of an Environmental Audit in accordance with Section 53V of the EP Act.



GROUNDWATER QUALITY MANAGEMENT PLAN

Closure of the GQMP related to groundwater monitoring or other selected activities within the Plan shall be documented by a letter from EPA indicating that GQMP procedures can be ceased at the site. All wells no longer required for monitoring shall be decommissioned in accordance with the Water Act (1989).

8.0 LIMITATIONS

Your attention is drawn to the “Limitations” include in Appendix D. The statements presented in that attachment are intended to advise you of what your realistic expectations of this report should be. That information is not intended to reduce the level of responsibility accepted by Golder Associates, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

9.0 REFERENCES

- Reference 1 Australian and New Zealand Environment and Conservation Council, 1992 (ANZECC), Australian Water Quality Guidelines for Fresh and Marine Waters. Canberra, November 1992.
- Reference 2 Australian Standard AS 4482.1-2005 Guide to the Sampling and Investigation of Potentially Contaminated Soil Part 1 : Non-volatile and Semi-volatile Compounds, 2005
- Reference 3 Environment Protection Authority, Victoria (April 2000). Groundwater Sampling Guidelines, EPA Publication 669
- Reference 4 Environment Protection Authority, Victoria (April 2002) The Clean Up and Management of Polluted Groundwater, EPA Publication 840.
- Reference 5 Environment Protection Authority, Victoria (July 2002) Groundwater Quality Restricted Use Zone, EPA Publication 862.
- Reference 6 Environment Protection Authority, Victoria (June 2009). Environment Protection (Industrial Waste Resource) Regulations 2009
- Reference 7 Golder Associates (2009b) “*Human Health Risk Assessment, Highett Gasworks Site, 1136-1138 Nepean Highway Highett, Victoria*” October 2009 Report No. 05613598/131 Rev1
- Reference 8 Golder Associates (May 2010) “Information to Support Clean Up To The Extent (Version 5, Former Highett Gas Works 1136 Nepean Highway Highett, Victoria)” (05613598-182-R-Rev0)
- Reference 9 Golder Associates (09 July 2010) “Environmental Site Assessment and remediation Report, Stage 2 Audit Area, Former Highett Gas Works 1136 Nepean Highway Highett, Victoria”
- Reference 10 Golder Associates (2011) “Human Health Risk Assessment of Class 2 Material Below Buildings, Former Highett Gasworks, 1136-1138 Nepean Highway Highett, Victoria” January 2011 (05613598-190-R-Rev 0)
- Reference 11 National Health and Medical Research Council & Agriculture and Resource Management Council of Australia and New Zealand (NHMRC) (1996) Australian Drinking Water Guidelines. 1996.
- Reference 12 State Government of Victoria (1989) Water Act, Amendments July 2004.
- Reference 13 State Government of Victoria (1997) State Environment Protection Policy (Groundwaters of Victoria), Victoria Government Gazette No S160 Wednesday 17 December 1997.
- Reference 14 State Government of Victoria (2002) State Environment Protection Policy (Prevention and Management of Contamination of Land) no. s95 4 June 2002.



Report Signature Page

GOLDER ASSOCIATES PTY LTD

A handwritten signature in blue ink, reading "Natalie McKay".

Natalie McKay
Senior Environmental Engineer

A handwritten signature in blue ink, reading "Ian Kluckow".

Ian Kluckow
Principal

NRM/IMK/nrm

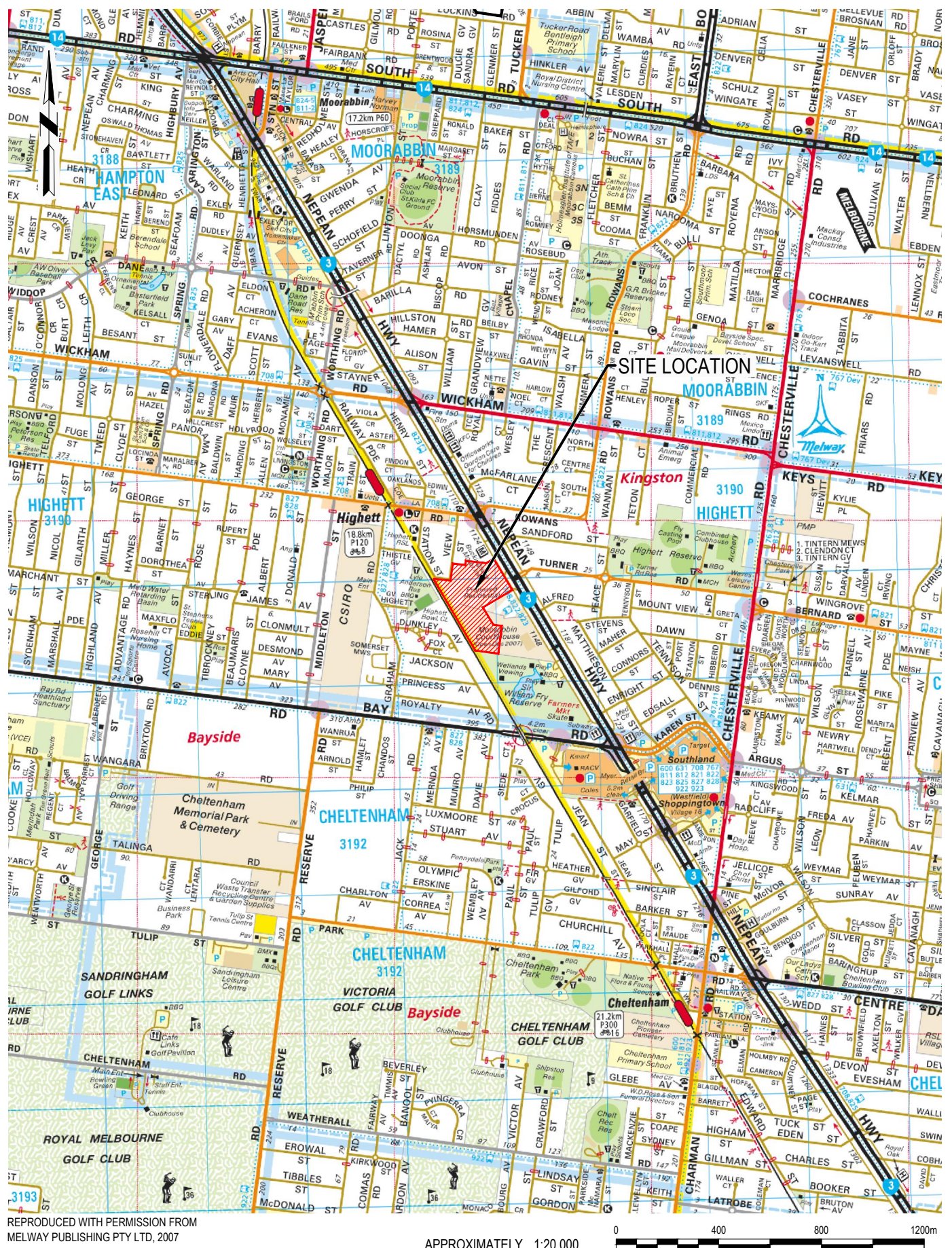
A.B.N. 64 006 107 857

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FIGURES



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CLIENT	DEPT. OF TREASURY & FINANCE
DRAWN	JC/MLL 06.05.10
CHECKED	NRC 06.05.10
SCALE	APPROX. 1:20,000

PROJECT	HIGHETT GASWORKS REMEDIATION
TITLE	SITE LOCALITY PLAN
PROJECT No	05613598/F438
FIGURE No	FIGURE 1

REV No



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Golder Associates

Building 7, Botanica Corporate Park,
570 – 588 Swan Street, Richmond, Victoria 3121
Telephone (03) 8862 3500 Facsimile (03) 8862 3501

CLIENT	DEPT. OF TREASURY AND FINANCE		PROJECT		HIGHETT GAS WORKS REMEDIATION	
DRAWN	JC/MLL	15.11.11	TITLE		REMAINING CONTAMINATION ON SITE BOUNDARY	
CHECKED	NRM	15.11.11	PROJECT No		05613598/F464	FIGURE No FIGURE 2
SCALE	1:500	A3				

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CLIENT DEPT. OF TREASURY AND FINANCE		PROJECT HIGHTT GAS WORKS REMEDIATION	
DRAWN JC/MLL 05.12.11		TITLE GROUNDWATER MONITORING WELL LOCATIONS	
CHECKED NRM 05.12.11			
SCALE 1:500	A3	PROJECT No 05613598/F466	FIGURE No FIGURE 3



APPENDIX A

EPA CUTEF DETERMINATION



8 November 2010

Our Ref: 37308-2

John Throssell
Parsons Brinckerhoff Pty Ltd
P O Box 19016
Southbank VIC 3006

Dear John Throssell,

**CLEAN UP OF GROUNDWATER TO THE EXTENT
PRACTICABLE – 1136 NEPEAN HIGHWAY, HIGHTT**

Thank you for your correspondence dated 27 May 2010, and subsequent additional information, requesting advice as to whether the Environment Protection Authority ("the Authority") is satisfied that groundwater pollution has been cleaned up to the extent practicable at the above site.

Pursuant to Clause 19 of the *State environment protection policy (Groundwaters of Victoria)* ("SEPP (GoV)"), the Authority on 3 November 2010 determined that:

1. groundwater pollution at the site has been cleaned up to the extent practicable; and
2. the site is a Groundwater Quality Restricted Use Zone ("GQRUZ").

In finalising the environmental audit for this site, you must ensure that the following are included in the Statement of Environmental Audit ("SoEA"):

- (1) a condition restricting groundwater use for existing and potential precluded extractive beneficial uses of groundwater;
- (2) a condition with sufficient detail to make clear the required ongoing monitoring and management;
- (3) a condition requiring compliance with a groundwater quality management plan;
- (4) as an attachment to the SoEA, a detailed groundwater quality management plan (GQMP) identifying a s.53V audit as the appropriate mechanism for cessation of the groundwater management and monitoring;
- (5) in the "other related information" section
 - i. a note that the Authority has determined that:
 - a. groundwater has been cleaned up to the extent practicable, and
 - b. the site is a GQRUZ;
 - ii. information relating to the pollution of groundwater such as a list of beneficial uses of groundwater for which you consider the site suitable; and

Lvl 3, 200 Victoria Street
Carlton
Victoria 3053
GPO Box 4395
Melbourne Victoria 3001
T: 03 9695 2722
F: 03 9695 2610
DX 210082
www.epa.vic.gov.au

- iii. a note that, in accordance with clause 19(3) of SEPP (GoV), the Authority may require periodic reassessment of the practicability of groundwater clean up.

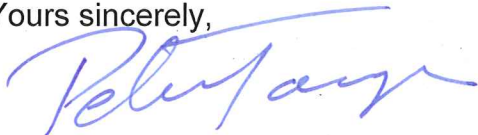
You must also ensure that the environmental audit report clearly delineates the extent of the GQRUZ.

EPA understands that Department of Treasury and Finance (DTF) will remain in control of the site for approximately the next two years. EPA expects that DTF will ensure that responsibility for the GQMP will be formally handed onto future site owners to ensure that the GQMP is appropriately completed.

Off-site wells 9130007 and 9130010 should be included in the GQMP.

If you have any questions, please contact Anne Northway on 03 9695 2579.

Yours sincerely,



PETER DOMINIC TANGE
MANAGER, ENVIRONMENTAL PERFORMANCE UNIT
DELEGATE OF THE AUTHORITY



APPENDIX B

REPORTS OF BOREHOLES AND WELL CONSTRUCTION DETAILS



Log Sheet - Land Remediation Department

GJ.51 of 231

PROJECT: HIGHT 1997

LOCATION: 33.8m. S. of NW corner
5.2m E. of rail fence

PARISH: Moorabbin

SURFACE ELEVATION: 37.643m

EASTING: 328100

DATUM: Ground Level (AHD)

NORTHING: 5797550

DRILL TYPE: Hollow Auger

BCL: 48143

OPERATOR: G. Webb

LOGGED: H. Szabo

BOREHOLE No: B46

STATUS: Monitoring

DATE: 7/10/97

DEPTH: 10.5m

PAGE: 1 of 1

OLD BORE No: n/a

DESCRIPTION	GRAPHIC LOG	DEPTH	SAMPLES	REMARKS	S.W.L.	BORE DETAILS
CRUSHED ROCK, lt brown, dry, coarse, gravelly, becoming sandy CLAY, lt brown, dry, grading to; CLAY, red, brown, yellow, occ grey, hard, dry, sandy		0.0 0.5 1.0 1.5 2.0 2.5 3.0		BORE DETAILS: Riser: 0-7.5m Screen: 7.5-10.5m (3m) Grout: 0-6.5m Bentonite Seal: 6.5-7m (0.5m) Sand: 7-10.5m (3.5m)		
CLAYEY SILT / SANDY SILT, orange, red, occ grey, dry, moist sand, no odour		3.0 3.5 4.0 4.5 5.0 5.5 6.0				
SANDY SILT / SILTY SAND, pink, orange, lt brown @ 7.5m, moist, fine-grained		6.0 6.5 7.0 7.5 8.0 8.5 9.0		8/10/97 5.98m		
		9.0 9.5 10.0	S1	PID 226 ppm limited sample recovered		
SANDY SILT, pink, orange, moist, no vis. contain, strong odour		9.0 9.5 10.0	S2	SPT 15 blows/50mm PID 212 ppm ferric odour		
Groundwater encountered at 9m		10.0 10.5				



REPORT OF BOREHOLE: 9010001

CLIENT: VGPG
PROJECT: Hydrogeological Investigations
LOCATION: Highett
JOB NO: 01613573

POSITION:
SURFACE RL: m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 115 mm HOLE DEPTH: 10.00 m

SHEET: 1 OF 1
DRILL RIG: Edson 2000
DRILLER: STATEWIDE
LOGGED: AA DATE: 3/6/02
CHECKED: *lu* DATE: 2/8/02

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE CONSISTENCY DENSITY	PIEZOMETER DETAILS
			0		9010001/2001 0.1-0.2m R=0A PID=0.0ppm			FILL- CLAY, dark brown	SI-VSI	0.0-4.0, Cement grout
			0.50					FILL- Sandy CLAY, mottled brown and grey		
			1		9010001/2002 1.0-1.1m R=0A PID=0.0ppm					
			1.80					Sandy CLAY, brown		
			2					Clayey SAND, mottled red brown and grey		
			2.40							
			3		9010001/2003 3.0-3.1m R=0A-B PID=0.0ppm			Clayey SAND, mottled red brown and grey		
			3.50							
			4							4.0-4.7m, Bentonite Seal
			5		9010001/2004 5.0-5.1m R=0B PID=0.0ppm					4.7-5.1m, Filter Pack 16/30 Sand 5.1-9.1m, Slotted screen
			6					Clayey SAND, orange pink, fine to medium sand, faint tarry odour		
			6.00							
			7		9010001/2005 7.0-7.1m R=0B PID=0.0ppm					
			8							
			9					Clayey SAND, fine to medium sand, brown		
			9.10							
			9.60							
			10					END OF BOREHOLE @ 10.0m		
			10.00							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for Environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for Geotechnical purposes.

GAP gINT FN. F01d
RLO

SHEET: 1 OF 1

POSITION:
SURFACE RL: m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 115 mm HOLE DEPTH: 10.10 m

DRILL RIG: Edson 2000
DRILLER: STATEWIDE
LOGGED: AA DATE: 5/6/02
CHECKED: *Blw* DATE: 12/18

GAP4 1.GLB FULL PAGE E:\EDATA\01\EDATA\01513573\STAGE_-1\3573G002.GPJ GAP4_1.GDT 02/09/2002 PM

GAP gINT FN. F01d
RLO



REPORT OF BOREHOLE: 9030002

CLIENT: VGPG
 PROJECT: Hydrogeological Investigations
 LOCATION: Highett
 JOB NO: 01613573

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: 115 mm HOLE DEPTH: 10.00 m

SHEET: 1 OF 1
 DRILL RIG: Edson
 DRILLER: STATEWIDE
 LOGGED: AA DATE: 3/6/02
 CHECKED: *lu* DATE: 2/9/2

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE CONSISTENCY DENSITY	PIEZOMETER DETAILS
SA			0					FILL- Sandy GRAVEL, brown, with some ash	M	MD
			0.90		9030002/2001 0.5-0.6m R=1B PID=0.0ppm			FILL- Sandy GRAVEL, with some clay, coal odour	M	St
			1.80					SAND, red brown, fine sand	D-M	MD
			2.50					Sandy CLAY, grey, fine to medium sand, red brown, with some mottled brown sands		
			4.50					Clayey SAND, fine to medium sand, red brown to orange brown, with some grey clay		
			6.80					Clayey SAND, pink orange, fine to medium sand, faint sweet perfume odour	M	St
			8.80		9030002/2002 7.5-7.6m R=1B-C PID=0.0ppm			Clayey SAND, grey, fine to medium sand		
			9.80					END OF BOREHOLE @ 10.0m	W	
			10.00							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for Environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for Geotechnical purposes.

GAP gINT FN. F01d
 RL0



REPORT OF BOREHOLE: 9050001

CLIENT: VGPG
 PROJECT: Hydrogeological Investigations
 LOCATION: Hightett
 JOB NO: 01613573

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: 115 mm HOLE DEPTH: 11.00 m

SHEET: 1 OF 2
 DRILL RIG: Edson
 DRILLER: STATEWIDE
 LOGGED: AA DATE: 3/6/02
 CHECKED: *en* DATE: 29/2

Drilling				Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS	
			0		9050001/2001 0.1-0.2m R=0A PID=0.0ppm				FILL- Clayey SAND, brown with some grey				0.0-4.5m, Cement grout
			1	1.00	9050001/2002 1.0-1.1m R=0A PID=0.0ppm				yellow brown, trace coarse gravel		St		
			1.70						Silty CLAY, dark grey				
			2		9050001/2003 2.0-2.1m R=0A PID=0.0ppm				Clayey SAND, fine to medium sand		MD		
			2.50						SILT, dark grey		F-St		
			3	3.50					Clayey SAND, fine to medium sand, yellow brown				
			4	4.20					Clayey SAND, white to grey white, with mottled yellow brown, fine to medium sand		M		4.5-5.5m, Bentonite Seal
			5	5.30									5.5-10.0m, Filter Pack 16/30 Sand 5.9-9.9m, Slotted screen
			6										
			7								St		
			8										
			9	9.50					Clayey SAND, medium to coarse, orange brown and orange, pale grey clay				
			10										

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GAP gINT FN. F01d
 RLO

PM

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REPORT OF BOREHOLE: 9050001

CLIENT: VGPG
 PROJECT: Hydrogeological Investigations
 LOCATION: Highett
 JOB NO: 01613573

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: 115 mm HOLE DEPTH: 11.00 m

SHEET: 2 OF 2
 DRILL RIG: Edson
 DRILLER: STATEWIDE
 LOGGED: AA DATE: 3/6/02
 CHECKED: *aw* DATE: 2/7/02

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE CONSISTENCY DENSITY	PIEZOMETER DETAILS
			10					Clayey SAND, medium to coarse, orange brown and orange, pale grey clay	M	St
			10.50					Clayey SAND, fine to medium sand, yellow brown, grey clay		
			11	11.00				END OF BOREHOLE @ 11.0m		
			12							
			13							
			14							
			15							
			16							
			17							
			18							
			19							
			20							

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GAP gINT FN, F01d
 RLO



REPORT OF BOREHOLE: 9120001

CLIENT: VGPG
 PROJECT: Hydrogeological Investigations
 LOCATION: Hightett
 JOB NO: 01613573

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: 115 mm HOLE DEPTH: 13.90 m

SHEET: 1 OF 2
 DRILL RIG: Edson 2000
 DRILLER: STATEWIDE
 LOGGED: AA DATE: 5/6/02
 CHECKED: *lu* DATE: 2/5/03

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE CONSISTENCY DENSITY
										PIEZOMETER DETAILS
			0	0.20					TOPSOIL	D
									Silty SAND, fine to medium sand, yellow brown	
			1							
			2							
			2.70							
			3	3.20					Sandy CLAY, grey and brown, with some fine to medium sand	St
			4	4.20					SAND, fine sand, brown	L
			5	5.00					SAND, fine, yellow brown, with some silt	
			6						fine sand, red brown	D
			7	7.20						
			8	7.80					SAND, fine to medium sand, trace grey clay	D-M
			9	8.60					Clayey SAND, yellow brown	
			10						Clayey SAND, fine to medium, red brown and yellow brown	M

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GAP gINT FN. F01d
 RL0

PM

GAP4_1.G.B. FULL PAGE. E:\DATA\01\EDATA\01613573\STAGE_~\13573\G002.GPJ GAP4_1.GDT 02/09/2002



REPORT OF BOREHOLE: 9120001

CLIENT: VGPG
 PROJECT: Hydrogeological Investigations
 LOCATION: Highett
 JOB NO: 01613573

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: 115 mm HOLE DEPTH: 13.90 m

SHEET: 2 OF 2
 DRILL RIG: Edson 2000
 DRILLER: STATEWIDE
 LOGGED: AA DATE: 5/6/02
 CHECKED: *W* DATE: *29/0*

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE CONSISTENCY DENSITY	PIEZOMETER DETAILS
			10					Clayey SAND, fine to medium, red brown and yellow brown		 Slotted screen
			11							
			12							
			13	13.00				Clayey SAND, fine to medium sand, with some coarse sand		
				13.90				END OF BOREHOLE @ 13.9m GROUNDWATER ENCOUNTERED @ 13.0m		
			14							
			15							
			16							
			17							
			18							
			19							
			20							

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GAP gINT FN. F01d
 RL0



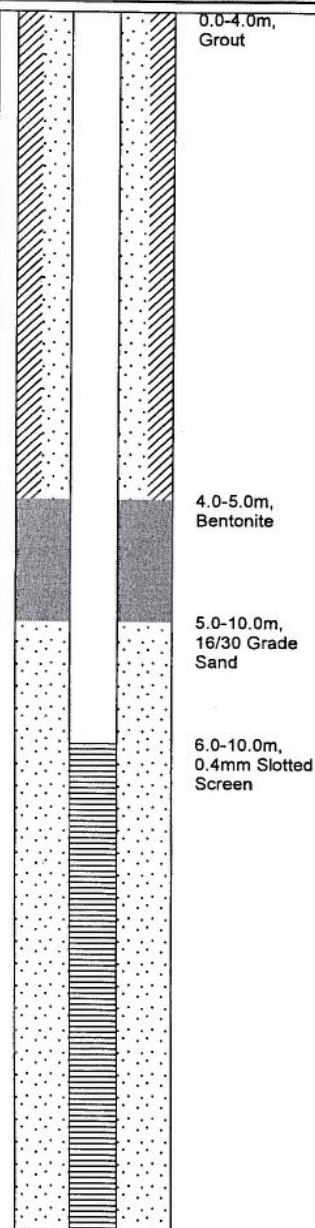
REPORT OF BOREHOLE: 9130003

CLIENT: VGPG
PROJECT: Hightett Gasworks Remediation
LOCATION: Hightett
JOB NO: 01613573

COORDS: 328056 m E 5797408.8 m N AMG84
SURFACE RL: 36.31 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: mm HOLE DEPTH: 10.00 m

SHEET: 1 OF 1
DRILL RIG:
DRILLER: South Western Drilling
LOGGED: NRC DATE: 17/12/02
CHECKED: DATE:

Drilling				Sampling		Field Material Description			
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE CONSISTENCY DENSITY
Solid Auger			0	0.20 36.11				FILL - Silty SAND, brown grey, fine grained sand Silty SAND, red silt, white fine grained sand	
			1						
			2						
			3	2.80 33.51				Clayey SAND, grey brown, fine grained sand	
			4						
			5	4.50 31.81				grey, increased clay content	
			6						
			7						
			8	8.00 26.31				yellow grey, medium grained sand	
			9		9130003/2001 9.00-9.10m R = 0A				
			10	10.00 26.31				END OF BOREHOLE @ 10.00 m GROUNDWATER ENCOUNTERED @ 8.0m	
			11						
			12						



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REPORT OF BOREHOLE: 9130005

SHEET: 1 OF 1

CLIENT: VGP
 PROJECT: Highett Gasworks Remediation
 LOCATION: Highett
 JOB NO: 01613573

COORDS: 328157.3 m E 5797340.1 m N AMG84
 SURFACE RL: 35.63 m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: 125 mm HOLE DEPTH: 10.00 m

DRILL RIG:
 DRILLER: South Western Drilling
 LOGGED: NRC DATE: 24/1/03
 CHECKED: DATE:

Drilling				Sampling		Field Material Description			
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE CONSISTENCY DENSITY
									PIEZOMETER DETAILS
			0	35.53				FILL - PAVERS FILL - Sandy GRAVEL, medium to coarse gravel, brown sand	0.0-2.0m, μ 18 PVC Grout
			1	34.63				SAND, grey brown, fine sand	
			1.40	34.23				grey yellow orange, trace clay	
			2						2.0-3.0m, Bentonite
			3	32.63				Clayey SAND, fine grained, yellow orange sand	3.0-10.0m, 16/30 Grade Sand
			4	31.43				medium grained sand	4.0-10.0m, 0.4mm Slotted Screen
			5						
			6						
			7	28.63				fine to medium grained	
			8		9130005/1 8.00-8.10m R = 0A				
			9						
			10	25.63				END OF BOREHOLE @ 10.00 m GROUNDWATER ENCOUNTERED @ 7.0m	
			11						
			12						

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GAP gINT FN. F01 RL



REPORT OF BOREHOLE: 9130006

SHEET: 1 OF 1

CLIENT: VGP
PROJECT: Highett Gasworks Remediation
LOCATION: Highett
JOB NO: 01613573

COORDS: 328043.8 m E 5797534.4 m N AMG84
SURFACE RL: 35.87 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 125 mm HOLE DEPTH: 10.20 m

DRILL RIG:
DRILLER: South Western Drilling
LOGGED: LJK DATE: 24/1/03
CHECKED: *[Signature]* DATE:

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE CONSISTENCY DENSITY
										PIEZOMETER DETAILS
			0	35.77					FILL- SAND, fine to medium, brown, trace silt, fine to coarse, dark brown pale brown	
			1	34.87					Clayey SAND, fine to coarse, brown, red and grey	
			2	34.37					Clayey SAND, medium to coarse, red brown with some yellow and grey staining	
			3	32.87					increased content of clay	
			4							
			5							
			6	30.27					pale brown	
			7	28.87					pale brown with some pink staining	
			8	27.47					pale red brown	
			9	26.87					pale brown yellow	
			10	25.67					END OF BOREHOLE @ 10.20 m GROUNDWATER ENCOUNTERED @ 9.0m	
			11							
			12							

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GAP gINT FN. F01d
RL2



REPORT OF BOREHOLE: 9130007

SHEET: 1 OF 1

CLIENT: VPGP
 PROJECT: Hightett Gasworks Remediation
 LOCATION: Hightett
 JOB NO: 01613573

COORDS: 328139.8 m E 5797278 m N AMG84
 SURFACE RL: 34.15 m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: 125 mm HOLE DEPTH: 10.00 m

DRILL RIG:
 DRILLER: South Western Drilling
 LOGGED: LJK DATE: 25/1/03
 CHECKED: DATE:

Drilling			Sampling		Field Material Description					PIEZOMETER DETAILS	
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
			0	34.15					FILL- Silty CLAY, brown		
				0.40					SAND, pale orange brown, fine		
			1	33.75							
				1.50					grey		
			2	32.65							
				2.90					Clayey SAND, yellow brown, fine		
			3	31.25							
				4.10					SAND, grey, fine		
			4	30.05							
			5								
			6								
			7								
			8								
			9								
			10	24.15	9130007/1 9.50-9.60m R = 0A				END OF BOREHOLE @ 10.00 m GROUNDWATER ENCOUNTERED @ 6.8m		
			11								
			12								

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GAP gINT FN. F01d
 RL2



REPORT OF BOREHOLE: 9130010

CLIENT: Vic Urban
 PROJECT: Highett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 10.00 m

SHEET: 1 OF 1
 DRILL RIG: Geoprobe
 DRILLER: Numac
 LOGGED: NC DATE: 20/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling		Sampling		Field Material Description and Instrumentation		
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION
				CONSTRUCTION		
Solid Auger		0.20				FILL- Sandy SILT, low plasticity, brown, minor rock and brick inclusions
						FILL- Sandy SILT, low plasticity, dark grey, black, minor brick inclusion
		1.00				FILL- SAND, medium grained, brown
		1.60				FILL- SAND, fine gravel, pale yellow
		2.20				FILL- Clayey SAND, fine to medium gravel, pale brown, Sandy CLAY pockets, yellow/brown, low to moderate plasticity
		3.00				becoming brown @ 3.0m
		3.20				coke/black material @ 3.2m
		4.00				FILL- Clayey SAND, medium grained, orange/brown
		4.20				Clayey SAND, medium grained, pale yellow/pale brown
		4.80				pale orange/brown
						4.5 - 5.5m, Bentonite
						5.5 - 10.0m, 16/30 Sand
						6.0 - 10.0m, PVC 0.4mm Slotted Screen
		6.50				SAND, medium grained, brown
		7.00				SAND, medium grained, pinky brown
		8.20				brown
		8.50				Clayey SAND, medium to coarse grained, pinky brown
		9.00				grey/brown, medium to coarse grained
		10.00				END OF BOREHOLE @ 10.00 m

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GAP GINT FN. F05
 RL2



REPORT OF BOREHOLE: 9130011

CLIENT: Vic Urban
 PROJECT: Highett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 11.00 m

SHEET: 1 OF 2
 DRILL RIG: Geoprobe
 DRILLER: Numac
 LOGGED: NC DATE: 20/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION	
		0	0.15			FILL- Silty CLAY, low plasticity, brown Sandy CLAY, moderate plasticity, orange/brown, with trace grey		0.0 - 3.6m, Grout	
		1							
		2							
		3							
		3.40				Sandy CLAY, moderate plasticity, pale brown/orange		3.6 - 4.6m, Bentonite	
		4							
		4.60				Clayey SAND, medium grained, grey/orange, brown		4.6 - 11.0m, 8/16 Sand	
		5						5.0 - 11.0m, PVC 0.4mm Slotted	
		5.50				Clayey SAND, medium grained, pale brown/pinky brown			
		6				pinky brown sand content increasing			
		7							
		8				very orange/brown			
		8.50							
		9							

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9130011

CLIENT: Vic Urban
 PROJECT: Highett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 11.00 m

SHEET: 2 OF 2
 DRILL RIG: Geoprobe
 DRILLER: Numac
 LOGGED: NC DATE: 20/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling		Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (Us)
		10				Clayey SAND, medium grained, pale brown/pinky brown	
		11	11.00			END OF BOREHOLE @ 11.00 m	
		12					
		13					
		14					
		15					
		16					
		17					
		18					
		19					
		20					

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9140003

CLIENT: Vic Urban
 PROJECT: Hightett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 10.00 m

SHEET: 1 OF 1
 DRILL RIG: Geo Probe
 DRILLER: Numac
 LOGGED: NC DATE: 13/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling		Sampling		Field Material Description and Instrumentation		
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION
						AIRLIFT YIELD (L/s)
						CONSTRUCTION
		0				FILL - Clayey SAND, medium grained, pale brown, minor rock inclusions
		0.50				Silty CLAY, moderate plasticity, brown/grey/red
		1				Sandy CLAY, low plasticity, brown/grey/red
		1.10				Clayey SAND, medium grained, grey/red/brown
		1.70				Clayey SAND, medium to coarse grained, yellow/brown/trace grey
		2				Clayey SAND, medium grained, orange/brown, grey, clay pockets
		3				pale brown/grey
		3.00				SAND, medium grained, yellow/brown
		4				SAND, medium to coarse grained, orange/brown
		4.00				
		5				
		5.20				
		6				
		6.50				
		7				
		8				
		8.20				
		9				
		10				
		10.00				

END OF BOREHOLE @ 10.00 m

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9140005

CLIENT: Vic Urban
 PROJECT: Highett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 11.00 m

SHEET: 1 OF 2
 DRILL RIG: Boart Longyear
 DRILLER: Numac
 LOGGED: NC DATE: 12/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling	Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (Us)	CONSTRUCTION
Air Blade		0				FILL- Silty CLAY, moderate plasticity, brown, crushed rock pieces		0.0 - 3.4m, Grout, PVC 80, 50mm
		0.30				Silty CLAY, moderate plasticity, yellow grey, siltstone pieces		
		1						
		1.20				Sandy CLAY, low to moderate plasticity, red, brown, grey		
		1.50				Sandy CLAY, low to moderate plasticity, yellow/brown/grey		
		2				SAND, medium grained, yellow medium to coarse grained		
		2.20						
		3				grey/brown		
		3.50				Clayey SAND, medium to coarse grained, grey, brown		3.4 - 4.4m, Bentonite fine chips/granuals
		4				Clayey SAND, medium grained, pale brown/grey		4.4 - 8.2m, 16/30 Sand
		4.00						
		5						5.2 - 8.2m, PVC Slotted
		6				SAND, medium to coarse grained, orange/brown		
		6.00						
		7				SAND, medium to coarse grained, orange/brown		
		7.20						
		8						
		9						
		10						
		10.00						

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GAP gINT FN, F05
 RL2



REPORT OF BOREHOLE: 9140005

CLIENT: Vic Urban
 PROJECT: Highett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 11.00 m

SHEET: 2 OF 2
 DRILL RIG: Boart Longyear
 DRILLER: Numac
 LOGGED: NC DATE: 12/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (Us)	CONSTRUCTION
Air Blade		10					SAND, medium to coarse grained, orange/brown grey/brown		
		11	11.00				END OF BOREHOLE @ 11.00 m		
		12							
		13							
		14							
		15							
		16							
		17							
		18							
		19							
		20							

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9140006

CLIENT: Vic Urban
 PROJECT: Highett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 10.00 m

SHEET: 1 OF 1
 DRILL RIG: Geoprobe
 DRILLER: Numac
 LOGGED: NC DATE: 14/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling	Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (Us)	CONSTRUCTION
Solid Auger		0				FILL- Silty CLAY, moderate plasticity, dark brown		0.0 - 3.5m, Grout
		1						
		1.50				FILL- SAND, fine grained, light brown		
		2				FILL- Clayey SAND, fine to medium grained, dark grey		
		2.20						
		3				FILL- Clayey SAND, fine to medium, grey/brown		
		3.10						
		4						3.5 - 4.5m, Bentonite
		4.40				FILL- Clayey SAND, fine to medium grained, pale brown, grey		4.5 - 10.0m, 16/30 Sand
		5						5.0 - 10.0m, PVC Slotted
		5.60				FILL- Clayey SAND, fine grained, orange/brown		
		6						
		7						
		7.50				Clayey SAND, medium grained, orange/brown		
		8						
		9						
		10	10.00					

END OF BOREHOLE @ 10.00 m

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9140007

CLIENT: Vic Urban
 PROJECT: Highett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 12.00 m

SHEET: 1 OF 2
 DRILL RIG: Geo Probe
 DRILLER: Numac
 LOGGED: NC DATE: 14/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling	Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
Solid Auger		0				FILL- Silty SAND, medium grained, dark brown, brick chips and frequent minor rock inclusions		0.0 - 4.2m, Grout
		1.20				FILL- Silty SAND, medium to coarse grained, red/brown pockets of Silty CLAY, red/brown low plasticity		
		2.00				Clayey SAND, fine to medium grained, pale brown/grey pockets of Sandy CLAY, low to moderate plasticity, grey/pale brown		
		2.50				SAND, fine to medium grained, orange/brown pockets of Clayey SAND, grey/yellow low plasticity		
		3.00				red, brown		
		3.50				clay content increasing, slightly pinky/red/brown		
		4.00				pale pinky/brown		4.2 - 5.2m, Bentonite
		4.60				SAND, medium grained, orange/brown, minor pockets Clayey SAND		
		5.20				red/brown		5.2 - 11.0m, 16/30 Sand
		6.00				very orange/red/brown		6.0 - 11.0m, PVC 0.4mm Slotted
		9.00				SAND, medium to coarse grained, dark yellow/brown		
		40						

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9140007

CLIENT: Vic Urban
 PROJECT: Hightett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 12.00 m

SHEET: 2 OF 2
 DRILL RIG: Geo Probe
 DRILLER: Numac
 LOGGED: NC DATE: 14/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling	Field Material Description and Instrumentation		
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)
Solid Auger		10				SAND, medium to coarse grained, dark yellow/brown	
		11					
		12	12.00			END OF BOREHOLE @ 12.00 m	
		13					
		14					
		15					
		16					
		17					
		18					
		19					
		20					

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9140008

CLIENT: Vic Urban
 PROJECT: Highett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 10.00 m

SHEET: 1 OF 1
 DRILL RIG: Geoprobe
 DRILLER: Numac
 LOGGED: NC DATE: 14/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION	
Solid Auger		0				FILL- Silty CLAY, low plasticity, brown		0.0 - 4.6m, Grout	
		1							
		1.80							
		2				Clayey SAND, medium grained, red/brown Clayey SAND, pocket grey/brown, moderate plasticity			
		3							
		4				SAND, medium grained, orange, brown			
		4.50							
		5				Clayey SAND, medium grained, red/brown		4.6 - 5.6m, Bentonite	
		5.50				pale brown			
		6							
		6.20							
		6.40				SAND, medium grained, yellow/brown, with Clayey SAND pockets, grey, low plasticity pale brown		5.6 - 10.0m, 16/30 Sand	
		7							
		7.00				SAND, medium to coarse grained, orange/brown, trace Clayey SAND pockets		6.0 - 10.0m, PVC 0.4mm Slotted	
		8							
		8.50							
		9				clay becoming less clay @ 9.0m			
		10							
		10.00							

END OF BOREHOLE @ 10.00 m

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9150001

CLIENT: Vic Urban
 PROJECT: Hightett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 17.80 m

SHEET: 1 OF 2
 DRILL RIG: Geo Probe
 DRILLER: Numac
 LOGGED: NC DATE: 14/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling	Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
Solid Auger		0				FILL- Clayey SAND, medium grained, dark brown, minor rock inclusions, Sandy CLAY pockets, brown, moderate plasticity		0.0 - 13.3m, Grout
		1.10				FILL- Sandy CLAY, low to moderate plasticity, dark brown, minor rock inclusions		
		1.80				FILL- SAND, fine grained, brown		
		2.60				FILL- Sandy CLAY, low to moderate plasticity, dark brown		
		5.50				FILL- SAND, medium grained, pinky brown		
		7.60				SAND, medium to coarse grained, pale brown		
		8.00				pinky brown		
		9.50				SAND, fine grained, pale brown		

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9150001

CLIENT: Vic Urban
 PROJECT: Hightett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 17.80 m

SHEET: 2 OF 2
 DRILL RIG: Geo Probe
 DRILLER: Numac
 LOGGED: NC DATE: 14/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling	Field Material Description and Instrumentation		
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)
							CONSTRUCTION
Solid Auger		10				SAND, fine grained, pale brown	
		10.50				very wet	
Hollow Auger		11					
		12					
		13					
		14					13.3 - 14.3m, Bentonite Granals
		15					14.3 - 17.8m, 16/30 Sand
		16					14.8 - 17.8m, PVC Slotted
		16.80					
		17				Sandy SILT, fine grained, low plasticity, brown	
		17.80				END OF BOREHOLE @ 17.80 m	
		18					
		19					
		20					

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9150002

CLIENT: Vic Urban
 PROJECT: Hightett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 19.40 m

SHEET: 1 OF 2
 DRILL RIG: Boart Longyear
 DRILLER: Numac
 LOGGED: NC DATE: 13/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling	Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
		0				FILL- Clayey SAND, medium grained, pale brown, minor rock inclusions		0.0 - 10.9m, Grout
		0.50				Silty CLAY, moderate plasticity, brown, grey and red		
		1.10				Sandy CLAY, low plasticity, brown, grey and red		
		1.70				Clayey SAND, medium grained, grey, red and brown		
		3.00				Clayey SAND, medium to coarse grained, yellow/brown, trace grey, low clay content		
		4.00				Clayey SAND, medium grained, orange, brown, grey, clay pockets		
		5.20				pale brown/grey		
		6.30				SAND, medium grained, yellow/grey		
		8.00				SAND, medium to coarse grained, orange/brown		
		10						

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This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

GAP gINT FN. F05
RL2



REPORT OF BOREHOLE: 9150002

CLIENT: Vic Urban
 PROJECT: Highett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 19.40 m

SHEET: 2 OF 2
 DRILL RIG: Boart Longyear
 DRILLER: Numac
 LOGGED: NC DATE: 13/5/08
 CHECKED: JKS DATE: 3/10/08

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION	
		10				SAND, medium grained, yellow/grey			
		11	11.00			coarse grained, yellow/brown			10.9 - 16.0m, Collapse Bentonite
		12							
		13							
		14	14.00			coarse grained, sandy, brown/pink/grey inclusions			
		15							
		16							16.0 - 19.4m, 16/30 Sand
		17							16.4 - 19.4m, PVC Slotted
		18	17.90			SAND, coarse grained, yellow/brown with black rock pieces			
			18.30			ROCK LAYER, difficult to drill, Sandy SILT, medium grained, very wet, brown			
		19							
			19.40			END OF BOREHOLE @ 19.40 m			
		20							

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GAP gINT FN, F05
 RL2



REPORT OF BOREHOLE: 9150003

CLIENT: Vic Urban
 PROJECT: Hightett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 20.50 m

SHEET: 1 OF 3
 DRILL RIG: Boart Longyear
 DRILLER: Numac
 LOGGED: NC DATE: 12/5/05
 CHECKED: DATE:

Drilling				Sampling	Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (Us)	CONSTRUCTION
Solid Auger		0				FILL- Sandy GRAVEL, low plasticity, black/brown		0.0 - 10.0m, Grout
		0.50				FILL- Silty CLAY, moderate plasticity, yellow/brown		
		1						
		1.50				FILL- Clayey SAND, medium grained, brown, minor red rock chips		
		2				Sandy CLAY, low plasticity, yellow/brown		
		2.20				SAND, fine grained, orange/brown		
		2.50				SAND, fine to medium grained, yellow/brown yellow/light brown		
		2.70				medium brown		
		3				Clayey SAND, medium grained, grey/brown		
		3.20				SAND, medium grained, grey		
Hollow Auger		4						
		4.50				SAND, fine to medium grained, pale grey/brown, slight clay content		
		5				Clayey SAND, medium grained, pale brown		
		5.50				SAND, medium grained, yellow/brown		
		6				very hard @ 5.0m		
		6.00				Odour @ 6.0 to 7.0m and continues		
		7				SAND, fine to medium grained, pale yellow/brown		
		7.00						
		8				Clayey SAND, medium grained, pale yellow/brown		
		8.00						
		9						
		9.60				Clayey SAND, medium grained, grey with hint of green		
		10						

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9150003

CLIENT: Vic Urban
 PROJECT: Highett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 20.50 m

SHEET: 2 OF 3
 DRILL RIG: Boart Longyear
 DRILLER: Numac
 LOGGED: NC DATE: 12/5/05
 CHECKED: DATE:

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (Us)	CONSTRUCTION	
		10				Clayey SAND, medium grained, grey with hint of green		10.0 - 17.7m, Bentonite ???	
		10.40				pale brown/pale grey			
		10.90							
		11				SAND, medium grained, dark grey, sharp odour on nose, unidentified odour continues			
		12							
		13							
		13.30				SAND, medium grained, dark grey, very wet			
		13.60				SAND, medium grained, grey			
		14							
		15	15.00			very wet			
		16							
		17	17.00			grey/brown			
		17.20				brown		17.7 - 20.5m, 16/30 Sand, PVC Slotted screen	
		18							
		19	19.00			Sandy SILT, low plasticity, brown silt content increasing			
		20							

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GAP gINT FN. F05
 RL2



REPORT OF BOREHOLE: 9150003

CLIENT: Vic Urban
 PROJECT: Hightett Gas Works
 LOCATION: 1136 Nepean Highway
 JOB NO: 05613598

POSITION:
 SURFACE RL: m DATUM: AHD
 INCLINATION: -90°
 HOLE DIA: mm HOLE DEPTH: 20.50 m

SHEET: 3 OF 3
 DRILL RIG: Boart Longyear
 DRILLER: Numac
 LOGGED: NC DATE: 12/5/05
 CHECKED: DATE:

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL / ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
		20			x	x	Sandy SILT, low plasticity, brown silt content increasing END OF BOREHOLE @ 20.50 m		
		20.50			x	x			
					x	x			
					x	x			
		21							
		22							
		23							
		24							
		25							
		26							
		27							
		28							
		29							
		30							

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GAP gINT FN. F05
 RL2



APPENDIX C

SUMMARY OF EXISTING GROUNDWATER DATA

Table E
Summary Of Analytical Results - Regional Groundwater
 Victorian Government Property Group Former Highett Gasworks

reported in mg/L unless stated otherwise.

Golder Associates							Metals																			Anions and Cations											
					pH (units)	Total Dissolved Solids	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Cobalt	Molybdenum	Selenium	Tin	Antimony	Boron	Barium	Beryllium	Manganese	Iron	Calcium	Magnesium	Sodium	Potassium	Sulphate (as SO4)	Chloride	Bicarbonate (as CaCO3)	Carbonate (as CaCO3)	Ammonia (as N)	Nitrate (as N)	Conductivity		
Laboratory Reporting Limits																																					
Aquatic (Marine) Ecosystems							0.0023	0.0055	0.0274	0.0013	0.0044	0.0004	0.07	0.015	0.001	0.023	0.003	0.035			5.1			0.08									0.9	0.158			
Potable Water Supply					6.5-8.5		0.007	0.002	0.05	2	0.01	0.001	0.1	3			0.01							0.1				250				0.5	11				
Primary Contact Recreation					6.5 – 8.5		0.05	0.005	0.05	1	0.05	0.001	0.1	5		0.05	0.01				1	1		0.1			300	400	400			0.01	10				
Irrigation					4.5 – 9		0.1	0.01	0.1	0.2		0.002	0.2	2	0.05	0.01	0.02				0.5	0.1		2													
Stock Watering					6 – 8.5		0.5	0.01	1	0.4	0.1	0.002	1	20	1	0.15	0.02				5					1000							30				
Status	Location	Sample Date	Sample Number	RL of Groundwater (mAHD)																																	
Existing	BH6	7-Oct-97	BH6	31.66	4.8	810	0.003	<0.002	<0.005	0.03	0.015	<0.001	<0.005	0.074														140			<0.05	5					
		7-Jan-99	BH6-7/01/1999	31.32	5.6	800	0.002	<0.001	<0.01	<0.01	<0.01	<0.001	<0.01	0.14													320			0.6	1200						
		22-Mar-99	BH6-23/03/1999	31.29		790																										0.84					
		21-Mar-07	BHF6/50200307	30.30	6.7		0.029	<0.001	<0.01	<0.01	<0.01	<0.001	0.04	0.02													270				8.3	0.02					
		27/05/2008	BH6/50270508		6.6	870	0.02	<0.002	<0.01	<0.01	<0.01	<0.001	0.05	0.03													13	13	240	1.2	360	82	170	<2	6.3	0.04	
		10-Jul-09	BH6/50	29.74	7.2	870	0.01	<0.0002	<0.001	<0.001	<0.001	<0.0001	0.053	0.016																			0.09				
Existing	BHF35	19-Mar-99	BHF35-19/03/1999	31.57	670	0.01	<0.001	0.04	0.02	<0.01	<0.001	<0.01	0.07	<0.01	<0.01	0.008	<0.01	<0.01				<0.01										0.1	0.15				
		17-Jun-02	9080100-5001	31.26	5.9	630	0.043	<0.0002	<0.01	<0.001	<0.001	<0.0001	<0.005	0.057									40			0.36	13	140	0.1	450	45	28	<2	0.1			
		19-Jul-02	BHF35-0702	31.20	5.8	610	0.011	<0.0002	<0.01	<0.001	<0.001	<0.0001	0.006	0.014									29			2	14	170	<0.05	330	44	20	<2	<0.1	1.7		
		1-Aug-03	1010035/50010803	30.94	5.9	650	0.039	<0.0002	<0.01	<0.001	<0.001	<0.0001	0.011	0.2									0.01			0.48	13	160	0.1	300	40	36	<2	0.2	<0.01		
		6-Apr-04	1010035/50050404	30.81			0.035	<0.0002	0.002	<0.001	<0.001	<0.0001	0.1	0.35																		0.1	0.06				
		21-Mar-07	BHF35/50200307	30.59	5.9		0.011	<0.001	<0.01	<0.01	<0.01	<0.001	0.05	0.03																	0.2	<0.01					
		27-May-08	BH35/50270508	30.29	6.1	600	0.02	<0.002	<0.01	<0.01	<0.01	<0.001	0.03	0.02												3.1	11	170	0.4	360	56	13	<2	0.3	1.1		
		29-Jun-09	BHF35/50260609	30.12	6.2	590	0.024	<0.0002	<0.001	<0.001	<0.001	<0.0001	0.044	0.007	0.006	<0.001	0.004	<0.001	<0.001	0.39	0.006	<0.001	0.036	22					330	56	43	<2		0.18			
OFFSITE - DOWNGRADIENT																																					
Existing	9130003	3-Jan-03	913003/50030103	31.03	5.8	130	<0.001	<0.0002	<0.01	<0.001	<0.001	<0.0001	<0.005	0.05												0.95	0.73	37	0.1	28	23	6	<2	<0.1			
		3-Feb-03	9130003/50310103	31.01	5.9	190	<0.001	<0.0002	<0.01	0.003	<0.001	<0.0001	<0.005	0.014												0.39	0.84	41	0.1	26	27	6	<2	<0.1			
		29-Jul-03	9130003/50280703	30.97	6	190	<0.001	<0.0002	<0.01	0.002	0.006	<0.0001	0.02	0.1												0.27	0.77	42	0.1	23	25	4	<2	<0.1	5.9		
		25-Jan-05	9130003/50250105	30.87	5.5		<0.001	<0.0002	<0.01	0.003	<0.001	<0.0001	0.006	0.024															22				<0.1	3.6			
		8-Mar-07	9130003/50070307	30.37	6.2	160	0.001	<0.001	<0.01	<0.01	<0.01	<0.001	0.04	0.02															23				<0.1	4.3			
		22-Mar-07	9130003/50210307	30.29																																	
		2-Jun-08	9130003/50020608		5.4	210	<0.01	<0.002	<0.01	<0.01	<0.01	<0.001	0.01	<0.01													0.19	0.63	36	<0.5	23	30	12	<2	<0.1	4.4	
		26-Jun-09	9130003/50250609	29.89	5.7	130	<0.001	<0.0002	<0.001	<0.001	<0.001	<0.0001	0.029	0.036															23	30	17	<2		4.2			
Existing	9130005	3-Feb-03	9130005/50310103	31.32	7.3	2300	<0.001	<0.0002	<0.01	0.014	<0.001	<0.0001	<0.005	0.051												17	54	950	0.3	700	580	370	<2	0.1			
		30-Jul-03	9130005/50290703	31.07		1900	<0.001	<0.0001	0.009	0.002	0.005	<0.0002	0.041	0.13												8.7	31	590	0.1	800	200	380	<2	<0.1	<0.01		
		25-Jan-05	9130005/50240105	31.01	6.9		<0.001	<0.0002	0.014	0.004	<0.001	<0.0001	<0.005	0.038															790				0.2	0.36			
		7-Mar-07	9130005/5006307		6.1		0.001	<0.001	<0.01	<0.01	<0.01	<0.001	<0.01	0.03																		<0.1	0.03				
		22-Mar-07	9130005/50210307	30.56																																	
		30-May-08	9130005/50300508	30.34	7.5	1900	<0.01	<0.002	<0.01	<0.01	<0.01	<0.001	0.01	0.02													9.3	27	600	0.2	800	180	380	<2	<0.1	0.12	
		26-Jun-09	9130005/50250609	29.71	7.4	1800	<0.001	<0.0002	<0.001	<0.001	<0.001	<0.0001	0.12	0.064															760	200	430	<2		0.12			
		Existing	9130006	3-Feb-03	9130006/50310103	30.84	5.7	530	<0.001	<0.0002	<0.01	0.014	<0.001	<0.0001	<0.005	0.052												1	4.1	180	0.1	110	210	8	<2	<0.1	
30-Jul-03	9130006/50300703			30.70	5.1	530	<0.001	<0.0002	<0.01	0.003	<0.001	<0.0001	<0.005	0.2												0.26	2.8	160	0.1	81	180	6	<2	<0.1	1.9		
1-Aug-03	9130006/59310703				4.5	470	<0.005	<0.0002	<0.005	0.004	0.003	<0.0001	<0.005	0.17															110	230	<3			6.6			
28-Jan-05	9130006/50270105			30.81	5		<0.001	<0.0002	<0.01	0.016	0.004	<0.0001	0.006	0.066															98				<0.1	0.53			
8-Mar-07	9130006/50070307			30.32	5.6	450	0.002		<0.01	<0.01	<0.01	<0.001	0.03	<0.01															140				<0.1	0.8			
22-Mar-07	9130006/50210307			30.21																																	
2-Jun-08	9130006/50020608			29.90	5.1	470	<0.01	<0.002	<0.01	<0.01	<0.01	<0.001	0.02	0.03													0.49	2.1	150	<0.5	140	130	10	<2	<0.1	1.1	
30-Jun-09	9130006/5029069			29.71	5.8	460	<0.001	<0.0002	<0.001	<0.001	0.002	<0.0001	0.039	0.006															140	130	11	<2		0.9			
Existing	9130011	2-Jun-08	9130011/50020608	30.01	5.6	620	<0.01	<0.002	<0.01	<0.01	<0.001	0.04	0.02													3.1	5.3	200	0.4	260	210	24	<2	<0.1	0.93		
		2-Jun-08	9130011/50020608_1	30.01																									140								
		30-Jun-09	9130011/5029069	29.82	5.2	470	<0.001	<0.0002	0.006	<0.001	<0.001	<0.0001	0.039	0.008															170	120	24	<2		0.4			

[illegible]

Table E
Summary Of Analytical Results - Regional Groundwater
Victorian Government Property Group Former Highbury Gasworks

reported in mg/L unless stated otherwise.

 Golder Associates					PAH																			Total Petroleum Hydrocarbons					Monocyclic Aromatic Hydrocarbons							OCF	Inorganics																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
					Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthrene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(g)pyrene	Dibenzo(a,h)anthracene	Benzo(ghi)perylene	Indeno(1,2,3-cd)pyrene	Total PAH	TRHC-C9	TRHC10-C14	TRHC15-C28	TRHC29-C36	TRP>C9	Benzene	Toluene	Ethyl Benzene	Xylenes	Styrene	Cumene	1,2,4 Trimethylbenzene	Total MAHs	HCB	Cyanide,total	Fluoride	Sulphate	Sulphide (H2S)	Ferrous Iron																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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Aquatic (Marine) Ecosystems					0.07	0.0006										0.0004	0.001	0.0001					0.003	10					0.7	0.18	0.005	0.075					0.004																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
Potable Water Supply																								0.0001										0.001							0.001	0.8	0.3	0.6	0.03					0.08																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
Primary Contact Recreation																								0.0001										0.6							0.001							0.8	0.3	0.6	0.03					0.1					1.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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Status	Location	Sample Date	Sample Number	RL of Groundwater (mAHD)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
Existing	BH6	7-Oct-97	BH6	31.66	17	<0.01	<0.01	<0.001	0.023	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	17						0.081							0.06	0.01	0.14					<0.1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
		7-Jan-99	BHG-7/01/1999	31.32	0.85	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.87						7							5.8	0.049	1.1	3.2	<0.001	0.13	<17.28																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
		22-Mar-99	BHG-23/03/1999	31.29	11	0.24	0.005	0.014	0.012	0.012	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	12	18.3					14							5.5	0.048	1.1	2.8	<0.001	0.11	<23.559																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
		21-Mar-07	BHF6/50200307	30.30	3.8	0.031	0.002	0.003	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	3.8	6.6					6.4	0.4	<0.1	<6.9	8.2							0.94	0.034	0.1	0.24	<0.001	0.024	<9.539		0.04																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
		27/05/2008	BHG/50270508		3.5	0.054	0.002	0.004	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	3.6	6.1					4.8	0.5	<0.1		6.9							0.50	0.028	0.32	0.23	<0.001	0.028		0.027																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
		10-Jul-09	BHG/50	29.74	1.7	0.029	0.001	0.003	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.7	3.8					2.3	0.3	<0.1	2.7	5.2							0.27	0.024	0.092	0.069	<0.001	0.024		0.017																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
Existing	BHF35	19-Mar-99	BHF35-19/03/1999	31.57	0.61	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.61						0.085							0.016	0.006	0.032	0.016	<0.001	<0.001	<0.157		0.01																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
		17-Jun-02	9080100-5001	31.26	0.37	0.003	0.004	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.38	0.2					3.6	1.2	<0.1	<4.9	0.14							0.032	0.009	0.055	<0.001	<0.001	0.013	<0.251	<0.001	0.01																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
		19-Jul-02	BHF35-0702	31.20	0.008	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	<0.04					2.2	0.9	<0.1	<3.2	0.073							0.015	0.004	0.024	<0.001	<0.001	0.004	<0.122	<0.001	0.014					<0.1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
		1-Aug-03	1010035/50010803	30.94	0.243	0.0016	0.0034	0.0026	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.251	0.12					3	1.4	<0.1	<4.5	0.17							0.038	0.01	0.061	<0.001	<0.001	0.012	<0.293	<0.001	<0.005	<0.1	<0.1	18																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
		6-Apr-04	1010035/50050404	30.81																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			

Table E
Summary Of Analytical Results - Regional Groundwater
Victorian Government Property Group Former Hihett Gasworks

reported in mg/L unless stated otherwise.

					Volatile Halogenated Organics																			
					1,1 Dichloroethane	Dichloromethane	Trichloromethane	1,2 Dichloroethane	Bromodichloromethane	Vinylchloride	Chlorobenzene	1,1,2 Trichloroethane	Chlorodibromomethane	1,2 Dichloropropane	1,1,1 Trichloroethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	1,1,2,2 Tetrachloroethane	1,1 Dichloroethene	1,2 Dichloroethene (cis)	1,2 Dichloroethene (trans)	Tetrachloroethene	Trichloroethene
Laboratory Reporting Limits																								
Aquatic (Marine) Ecosystems					0.25	4		1.9		0.1	0.055	1.9		0.27		0.06	0.4	0.7			0.07	0.33		
Potable Water Supply																								
Primary Contact Recreation						0.004		0.01		0	0.3			1.5		0.04		0.03	0.06		0.01	0.03	0.003	
Irrigation																								
Stock Watering																								
Status	Location	Sample Date	Sample Number	RL of Groundwater (mAHD)																				
BACKGROUND																								
Existing	9120001	19-Jun-02	9120001-5001	31.29	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
		17-Jul-02	9120001-0702	31.24	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
		25-Jul-03	9120001/50240703	31.24	<0.001	<0.01	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
		9-Mar-07	9120001/50090307	30.55																				
		21-Mar-07	9120001/50190307	30.53																				
		25-May-08	9120001/50250508																					
		26-May-08	9120001/50260508																					
		30-Jun-09	9120001/5029069	30.10																				
Existing	9130010	30-May-08	9130010/50300508																					
		30-Jun-09	9130010/5029069	30.07																				
ONSITE																								
Existing	9010001	21-Jun-02	9010001-5001	31.03	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
		19-Jul-02	9010001-0702	31.00	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
		25-Jul-03	9010001/50250703	30.85	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
		28-Jan-05	9010001/50270105	30.84	<0.005	<0.05	<0.005	<0.005	<0.005	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
		21-Mar-07	9010001/50200307	30.35																				
		29-May-08	9010001/50290508	30.05																				
		29-Jun-09	9010001/50260609	29.88																				
		Existing	9020001	20-Jun-02	9020001-5001	31.13	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
19-Jul-02	9020001-0702			31.10	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
25-Jul-03	9020001/50250703			30.91	<0.001	<0.01	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
28-Jan-05	9020001/50270105			30.92																				
9-Mar-07	9020001/50090307			30.27																				
21-Mar-07	9020001/50190307			30.38																				
28-May-08	9020001/50280508			30.14																				
28-May-08	9020001/50280508_1			30.14																				
Existing	9030002	20-Jun-02	9030002-5001	31.17	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
		19-Jul-02	9030002-0702	31.19	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
		1-Aug-03	9030002/50010803	30.84	<0.001	<0.01	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
		28-Jan-05	9030002/50280105	31.03																				
		9-Mar-07	9030002/50090307	30.45																				
		21-Mar-07	9030002/50190307	30.45																				
		29-Jun-09	9030002/50260609	30.63																				
		Existing	9050001	20-Jun-02	9050001-5001	31.89	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
19-Jul-02	9050001-0702			32.00	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1-Aug-03	9050001/50310703			31.80	<0.001	<0.005	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
16-Mar-07	9050001/50150307			31.86																				
28-May-08	9050001/280508																							
28-May-08	9050001/280508_1																							
09-Jul-09	9050001/50			31.25																				
Existing	9140003			30-May-08	9140003/50300508	30.54																		
		06-Jul-09	9140003/50	30.36																				
Existing	9140005	28-May-08	9140005/280508	31.89																				
		09-Jul-09	9140005/50	30.90																				
Existing	9140006	28-May-08	9140006/280508	30.47																				
		28-May-08	9140006/280508_1	30.47																				
		09-Jul-09	9140006/50	30.22																				
Existing	9140008	27-May-08	9140008/50270508	30.00																				
		08-Jul-09	9140008/50	29.84																				
Existing	9150001	27-May-08	DeepWell1/50270508	29.98																				
		08-Jul-09	9150001/50	29.68																				
Existing	9150002	30-May-08	DEEPWELL2/50300508	30.35																				
		03-Jul-09	9150002/50	30.12																				
Existing	9150003	28-May-08	DEEPWELL3/280508	30.34																				
		28-May-08	DEEPWELL3/280508_1	30.34																				
		09-Jul-09	9150003/50	30.19																				

Table E
Summary Of Analytical Results - Regional Groundwater
Victorian Government Property Group Former Hihett Gasworks

reported in mg/L unless stated otherwise.

					Volatile Halogenated Organics																			
					1,1 Dichloroethane	Dichloromethane	Trichloromethane	1,2 Dichloroethane	Bromodichloromethane	Vinylchloride	Chlorobenzene	1,1,2 Trichloroethane	Chlorodibromomethane	1,2 Dichloropropane	1,1,1 Trichloroethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	1,1,2,2 Tetrachloroethane	1,1 Dichloroethene	1,2 Dichloroethene (cis)	1,2 Dichloroethene (trans)	Tetrachloroethene	Trichloroethene
Laboratory Reporting Limits																								
Aquatic (Marine) Ecosystems					0.25	4		1.9		0.1	0.055	1.9			0.27		0.06	0.4	0.7		0.07	0.33		
Potable Water Supply																								
Primary Contact Recreation					0.004		0.01		0	0.3					1.5		0.04		0.03	0.06		0.01	0.03	0.003
Irrigation																								
Stock Watering																								
Status	Location	Sample Date	Sample Number	RL of Groundwater (mAHD)																				
Existing	BH6	7-Oct-97	BH6	31.66																				
		7-Jan-99	BHG-7/01/1999	31.32																				
		22-Mar-99	BHG-23/03/1999	31.29																				
		21-Mar-07	BHF6/50200307	30.30																				
		27/05/2008	BHG/50270508																					
		10-Jul-09	BHG/50	29.74																				
Existing	BHF35	19-Mar-99	BHF35-19/03/1999	31.57	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		17-Jun-02	9080100-5001	31.26	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		19-Jul-02	BHF35-0702	31.20	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		1-Aug-03	1010035/50010803	30.94	<0.001	<0.01	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		6-Apr-04	1010035/50050404	30.81																				
		21-Mar-07	BHF35/50200307	30.59																				
		27-May-08	BH35/50270508	30.29																				
		29-Jun-09	BHF35/50260609	30.12																				
OFFSITE - DOWNGRADIENT																								
Existing	9130003	3-Jan-03	913003/50030103	31.03	<0.001	<0.01	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		3-Feb-03	9130003/50310103	31.01	<0.001	<0.01	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		29-Jul-03	9130003/50280703	30.97	<0.001	<0.005	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		25-Jan-05	9130003/50250105	30.87																				
		8-Mar-07	9130003/50070307	30.37																				
		22-Mar-07	9130003/50210307	30.29																				
		2-Jun-08	9130003/50020608																					
		26-Jun-09	9130003/50250609	29.89																				
Existing	9130005	3-Feb-03	9130005/50310103	31.32	<0.001	<0.01	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		30-Jul-03	9130005/50290703	31.07	<0.001	<0.005	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		25-Jan-05	9130005/50240105	31.01																				
		7-Mar-07	9130005/5006307																					
		22-Mar-07	9130005/50210307	30.56																				
		30-May-08	9130005/50300508	30.34																				
Existing	9130006	26-Jun-09	9130005/50250609	29.71																				
		3-Feb-03	9130006/50310103	30.84	<0.001	<0.01	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		30-Jul-03	9130006/50300703	30.70	<0.001	<0.005	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		1-Aug-03	9130006/59310703		<0.001	<0.05		<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		28-Jan-05	9130006/50270105	30.81																				
		8-Mar-07	9130006/50070307	30.32																				
		22-Mar-07	9130006/50210307	30.21																				
		2-Jun-08	9130006/50020608	29.90																				
Existing	9130011	30-Jun-09	9130006/5029069	29.71																				
		2-Jun-08	9130011/50020608	30.01																				
		2-Jun-08	9130011/50020608_1	30.01																				
		30-Jun-09	9130011/5029069	29.82																				

Table E
Summary Of Analytical Results - Regional Groundwater
 Victorian Government Property Group Former Highett Gasworks

reported in mg/L unless stated otherwise.

[illegible]

Table E
Summary Of Analytical Results - Regional Groundwater
Victorian Government Property Group Former Hihett Gasworks

reported in mg/L unless stated otherwise.

					Chlorinated Hydrocarbons																													
					1 1 1 2 Tetrachloroethane	1 1 Dichloropropene	1 2 3 Trichloropropene	1 2 Dibromo 3 chloropropene	1 2 Dibromoethane	1 3 Dichloropropene	1 3 Dichloropropene (cis)	1 3 Dichloropropene (trans)	2 2 Dichloropropene	2 Chlorotoluene	4 Chlorotoluene	Bromochloromethane	Bromobenzene	Bromoform	Dibromomethane	Benzalchloride	Benzotrithloride	2-chloronaphthalene	Hexachlorobutadiene	Hexachlorocyclopentadiene	Hexachloroethane	Pentachlorobenzene	1 2 3 Trichlorobenzene	1,2,4-Trichlorobenzene	1 3 5 Trichlorobenzene	1 2 3 4 Tetrachlorobenzene	1 2 3 5 Tetrachlorobenzene	1 2 4 5 Tetrachlorobenzene		
Laboratory Reporting Limits																																		
Aquatic (Marine) Ecosystems					0.08																													
Potable Water Supply																																		
Primary Contact Recreation					0.0007																													
Irrigation																																		
Stock Watering																																		
Status	Location	Sample Date	Sample Number	RL of Groundwater (mAHD)																														
Existing	BH6	7-Oct-97	BH6	31.66																														
		7-Jan-99	BH6-7/01/1999	31.32																														
		22-Mar-99	BH6-23/03/1999	31.29																														
		21-Mar-07	BHF6/50200307	30.30																														
		27/05/2008	BH6/50270508																															
		10-Jul-09	BH6/50	29.74	0.010 <0.001																													
Existing	BHF35	19-Mar-99	BHF35-19/03/1999	31.57																														
		17-Jun-02	9080100-5001	31.26	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
		19-Jul-02	BHF35-0702	31.20	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001			
		1-Aug-03	1010035/50010803	30.94	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001			
		6-Apr-04	1010035/50050404	30.81																														
		21-Mar-07	BHF35/50200307	30.59																														
		27-May-08	BH35/50270508	30.29																														
		29-Jun-09	BHF35/50260609	30.12	0.13 <0.001																													
OFFSITE - DOWNGRADIANT																																		
Existing	9130003	3-Jan-03	913003/50030103	31.03	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
		3-Feb-03	9130003/50310103	31.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001			
		29-Jul-03	9130003/50280703	30.97	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001			
		25-Jan-05	9130003/50250105	30.87																														
		8-Mar-07	9130003/50070307	30.37																														
		22-Mar-07	9130003/50210307	30.29																														
		2-Jun-08	9130003/50020608																															
		26-Jun-09	9130003/50250609	29.89	<0.001 <0.001																													
Existing	9130005	3-Feb-03	9130005/50310103	31.32	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
		30-Jul-03	9130005/50290703	31.07	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
		25-Jan-05	9130005/50240105	31.01																														
		7-Mar-07	9130005/5006307																															
		22-Mar-07	9130005/50210307	30.56																														
		30-May-08	9130005/50300508	30.34																														
		26-Jun-09	9130005/50250609	29.71	<0.001 <0.001																													
Existing	9130006	3-Feb-03	9130006/50310103	30.84	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
		30-Jul-03	9130006/50300703	30.70	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
		1-Aug-03	9130006/59310703		<0.001	<0.001	<0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001						
		28-Jan-05	9130006/50270105	30.81																														
		8-Mar-07	9130006/50070307	30.32																														
		22-Mar-07	9130006/50210307	30.21																														
		2-Jun-08	9130006/50020608	29.90																														
		30-Jun-09	9130006/5029069	29.71																														
		Existing	9130011	2-Jun-08	9130011/50020608	30.01																												
				2-Jun-08	9130011/50020608_1	30.01																												
30-Jun-09	9130011/5029069			29.82																														

Table E
Summary Of Analytical Results - Regional Groundwater
Victorian Government Property Group Former Highbury Gasworks

reported in mg/L unless stated otherwise.

[illegible]



APPENDIX D

LIMITATIONS

LIMITATIONS

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solutions@golder.com
www.golder.com

Golder Associates Pty Ltd
Building 7, Botanicca Corporate Park
570 – 588 Swan Street
Richmond, Victoria 3121
Australia
T: +61 3 8862 3500

Environmental Audit Report Stages 2 and 2A, 1136-1138 Nepean Highway Highett 3190 Victoria (CARMS #37308-2)

December 2011

Department of Treasury and Finance

**PARSONS
BRINCKERHOFF**

*Parsons Brinckerhoff Australia Pty Limited
ABN 80 078 004 798*

Level 15
28 Freshwater Place
Southbank VIC 3006
Australia
Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email melbourne@pb.com.au

*Certified to ISO 9001, ISO 14001, AS/NZS 4801
A+ GRI Rating: Sustainability Report 2010*

Executive summary

This Environmental Audit report has been prepared as required under Section 53W(1) of the 1970 *Environment Protection Act* (the Act) in support of the attached Statements of Environmental Audit regarding the former Highett gasworks property located at 1136-1138 Nepean Highway, Highett VIC 3190. Currently, the site is owned by the Department of Treasury and Finance (DTF) and is likely to be developed as mixed medium to high density residential properties. DTF have initiated a voluntary audit to meet due diligence prior to sale of the property, and have engaged John Throssell of Parsons Brinckerhoff Pty Ltd (PB), an Environmental Auditor appointed under the Act, to conduct a Statutory Environmental Audit (Audit).

The south east corner of the site was transferred to Department of Justice (DoJ) in 2005 and became known as Stage 1.

In 2006 a Statement of Environmental Audit (CARMS 37308-1) was issued for Stage 1 of the site and is now occupied by the DoJ Moorabbin Courthouse. The remainder of the site became known as Stage 2.

In 2010, the Stage 2 audit area was further divided into Stage 2 (eastern portion of the site) and Stage 2A (western portion of the site). The boundary between the two Stages was based upon the extent of known soil impacts associated with the existing gas main easement located along the western boundary of the site) and the amount of space required to remediate this area (Stage 2A) once the gas easement infrastructure is removed in the future.

This report has been prepared in accordance with Section 53X of the Act and other Victorian Environment Protection Authority (EPA) guidelines (EPA Publications 759.1; 865.6; 1147; 860.1) and should be read in conjunction with the existing investigation reports (see **Section 1.3** for list of reports). This audit report addresses both Stages 2 and 2A, and a separate Statement of Audit has been issued for each Stage. The Statements of Audit include a groundwater quality management plan (GQMP) that addresses both Stage 2 and 2A and there is also a requirement for an Environmental Management Plan (EMP) to address residual soil impacts.

Particulars of the audit are summarised in the table below:

Summary of audit information

	Stage 2	Stage 2A
EPA file reference number	CARMS # 37308-2	CARMS # 37308-2
Auditor	John Throssell*	John Throssell*
Auditor term of appointment	7 October 2011 to 7 May 2012	7 October 2011 to 7 May 2012
Name of person requesting audit	Department of Treasury and Finance	Department of Treasury and Finance
Relationship to premises	Owner	Owner
Date of request	5 December 2001	5 December 2001
Date EPA notified of audit	5 December 2001 (David Adams) EPA notified of termination of Mr Adams as Auditor and engagement of Mr Throssell as replacement Auditor occurred 16 October 2007	5 December 2001 (David Adams) EPA notified of termination of Mr Adams as Auditor and engagement of Mr Throssell as replacement Auditor occurred 16 October 2007

	Stage 2	Stage 2A
Completion date of audit	15 December 2011	15 December 2011
Reason for audit	Property transaction due diligence	Property transaction due diligence
Current land use zoning	Residential 1 Zone (R1Z), formerly Public Use Service and Utility (PUZ 1)	Residential 1 Zone (R1Z), formerly Public Use Service and Utility (PUZ 1)
EPA region	Melbourne Metro	Melbourne Metro
Municipality	Kingston	Kingston
Dominant – Lot of plan	Certificate of Title Volume 9598 Folio 389. Plan of Consolidation No. 150995, Parish of Moorabbin. Crown Allotment 2006 on TP835477B. This title includes Stage 1 (on which the Moorabbin Courthouse has been built). This area has been issued with a Statement of Environmental Audit in 2006 and is not part of this Audit.	Certificate of Title Volume 9598 Folio 389. Plan of Consolidation No. 150995, Parish of Moorabbin. Crown Allotment 2006 on TP835477B. This title includes Stage 1 (on which the Moorabbin Courthouse has been built). This area has been issued with a Statement of Environmental Audit in 2006 and is not part of this Audit.
Additional – Lot on plan(s)	Various easements (gas & drainage)	Various easements (gas & drainage)
Site name		
▪ Street No.	1136 - 1138	1136 - 1138
▪ Street Name	Nepean	Nepean
▪ Street Type	Highway	Highway
▪ Suburb	Highett	Highett
▪ Postcode	3190	3190
GIS coordinates (GDA94)		
▪ Latitude	37° 57' 5.6" S	37° 57' 6.4" S
▪ Longitude	145° 02' 46.6" E	145° 02' 42.0" E
Site area (hectares)	~4.7 ha (Stage 2 and 2A = 6.33 ha)	~1.63 ha (Stage 2 and 2A = 6.33 ha)
Members and categories of support team utilised	Alex Blount (contaminant transport and assessment of exposure pathways and risk) Alan Wade (Hydrogeology)	Alex Blount (contaminant transport and assessment of exposure pathways and risk) Alan Wade (Hydrogeology)
Outcome of the audit	Statement of Environmental Audit	Statement of Environmental Audit
Further work or requirements	Implementation of a groundwater quality management plan (GQMP). Environmental management plan (EMP) for areas of residual soil impacts.	Implementation of a groundwater quality management plan (GQMP). Environmental management plan (EMP) for areas of residual soil impacts.
Nature and extent of continuing risk	Groundwater: Elevated petroleum hydrocarbons (including total petroleum hydrocarbons (TPH), benzene, toluene ethylbenzene, and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), total phenols, metals, ammonia, sulphate and free cyanide in groundwater pose a potential risk to groundwater users and Port Phillip Bay. Soil: Residual hydrocarbons (including PAHs) and inorganics (including metals (lead,	Groundwater: Elevated petroleum hydrocarbons (including total petroleum hydrocarbons (TPH), benzene, toluene ethylbenzene, and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), total phenols, metals, ammonia, sulphate and free cyanide in groundwater pose a potential risk to groundwater users and Port Phillip Bay. Soil: Residual hydrocarbons (including PAHs) and inorganics (including metals (lead,

	Stage 2	Stage 2A
	arsenic) and sulphates) in soil along parts of the site boundary and below the water table pose a potential risk to site occupants.	arsenic) and sulphates) in soil at depths of less than 1 metre, along parts of the site boundary and below the water table pose a potential risk to site occupants.
Site aquifer formation	Shallow unconfined Quaternary aquifer	Shallow unconfined Quaternary aquifer
Average depth to groundwater	Approximately 6m below ground level across the site.	Approximately 6m below ground level across the site.
Groundwater segment	A2 (variable)	A2 (variable)
Groundwater flow direction	West, north west towards Port Phillip Bay	West, north west towards Port Phillip Bay
Past use/site history	Industrial use	Industrial use
Surrounding land use	Residential, recreational/open space and commercial	Residential, recreational/open space and commercial
Proposed future use	Medium to high density residential	Medium to high density residential

* DTF appointed Dr David Adams of Parsons Brinckerhoff (PB) to conduct a Statutory Environmental Audit (Audit) at this site on 5 December 2001. Dr Adams withdrew from the Audit in October 2007 and Mr John Throssell also of PB was appointed to complete the Audit of the site on 16 October 2007.

1. Introduction

The Department of Treasury and Finance (DTF) is currently divesting the property located at 1136 Nepean Highway, Highett (**Figure 1, Appendix A**) (“the site”). The 6.33 hectare site had been used for many years as a coal gas manufacturing plant, and is to be redeveloped for residential / commercial use. DTF engaged VicUrban to project manage the site. Golder & Associates Pty Ltd (Golder) were engaged to undertake environmental assessment works of the site and Thiess Services (Thiess) were engaged to manage the remediation of the site. Golder previously performed environmental assessment and remediation works at the site under the instruction of Gascor (formerly the Gas and Fuel Corporation), which subsequently transferred the site to DTF.

Dr David Adams of Parsons Brinkerhoff (PB) was first engaged by the owner of the site in March 2005. Dr Adams terminated the audit in October 2007 and John Throssell was retained by the site owner to complete the audit. John Throssell was appointed an EPA Auditor under the Environmental Protection Act 1970 (Vic) on 24 July 2007.

This Audit report has been prepared in accordance with Section 53X of the Act and relevant EPA guidelines, specifically EPA Publication 759.1 (2007), Environmental Auditor (Contaminated Land) Guidelines for Issue of Certificates and Statements of Environmental Audit. Cognisance has also been given to the relevant State Environmental Protection Policies (SEPPs), waste management policies, guidelines and other relevant guidance documents.

Table 1.1 below is a list of relevant parties/entities associated with the site.

Table 1.1 List of parties

Organisation	Role
Department of Treasury and Finance	Site Owner
EPA Victoria	Statutory authority
VicUrban	Project Manager
Thiess Services	Remediation and site manager
Golder Associates	Site assessor
John Throssell	Environmental Auditor

1.1 Division of audit areas

The site was divided into Stages 1 and 2 circa 2005. Stage 1, a parcel of land located on the southeastern boundary of the site and identified as Crown Allotments 2007 and part of 2006 of TP835477B (1.2 ha in total), was defined to facilitate the completion of an environmental audit and subsequent sale to the Department of Justice (DoJ) (see **Figure 2, Appendix A** for location of Stage boundaries in relation to Crown Allotments). A Statement of Audit for Stage 1 was issued in March 2006 (CARMS# 37308-1), and approximately 0.91 ha of Stage 1 (Lot 2007) was subsequently developed by the Department of Justice as the new Moorabbin Courthouse. Not all of the Stage 1 audit area was developed by DoJ and the remainder of Stage 1 (part 2006) is to be developed in conjunction with Stage 2. Stage 1 is not included as part of this audit. See **Appendix B** for Certificate of Title.

Stage 2 (Crown Allotment 2006, TP835477B), was further divided into Stages 2 and 2A in 2010 and are approximately 4.7 and 1.63 ha in area respectively. Stage 2A, located along the western boundary of the site, was defined based partly on the presence of residual contaminated soil beneath active gas infrastructure and allows for the space required by plant and equipment to remediate this area in the future. The gas main infrastructure and associated soil impacts are due to be removed in 2012 – 2013 (see **Figures 1 and 2, Appendix A** for survey data on the location of Stage boundaries and how they relate to Crown Allotments). It is noted that the Stage 2 /2A division is not a formal subdivision of the site, rather a line of convenience to facilitate the remediation and audit process for the site.

1.1.1 Structure of Audit report

The changes in audit area boundaries throughout the lifetime of the project (as noted above) are reflected in the reporting provided by Golder. The Stage 1 audit area was investigated, remediated and reported on as a separate entity from the rest of the site. The remainder of the site was initially assessed, remediated and reported on as one audit area ('Stage 2') until 2010 when the decision was made to further divide the area into Stage 2 and Stage 2A.

In this audit report the 'site' will refer to the combined Stages 2 and 2A audit areas and will be discussed as one 'site' throughout **Sections 1 to 7** of this report. This will include discussions relating to the assessment and remediation phases of the project. Discussion of the final site conditions (**Section 8**) will be specific to the individual audit areas (Stage 2 and Stage 2A) and will be referred to thus. Similarly Sections 9 and 10 will identify the individual audit areas where appropriate.

Table 1.2 Report structure

Section	Title	Comment
1	Introduction	Stages 2 & 2A combined
2	Site details	Stages 2 & 2A combined
3	Potential sources of contamination	Stages 2 & 2A combined
4	Beneficial uses	Stages 2 & 2A combined
5	Soil assessment and remediation	Stages 2 & 2A combined
6	Groundwater assessment	Stages 2 & 2A combined
7	Auditor review	Stages 2 & 2A combined
8	Final site conditions	Stages 2 & 2A discussed separately
9	Risk assessment	Stages 2 & 2A discussed separately
10	Conclusions	Stages 2 & 2A discussed separately

1.2 Purpose

The purpose of this Audit is to determine if the site is suitable for 'any beneficial use' and in doing so, determining the site's suitability for the intended medium/high-density residential and commercial land-uses.

1.3 Reports supporting this Audit

The Auditor relied upon investigation reports prepared by a number of entities including the Land Remediation Department of the former Gas and Fuel Corporation of Victoria, the Department of Treasury and Finance, Thiess Services and Golder Associates. Site investigations and remediation activities have taken place on the site since the mid 1990s up until 2009. **Table 1.3** below is a list of reports relevant to this audit. Copies of these reports can be found in **Appendix C** and a summary of these reports can be found in **Appendix D**.

Table 1.3 List of previous environmental investigation reports

Year	Report title
1994	Gas & Fuel, Jun-94a. Potential of Offsite Migration of Residuals from the Former Gas Manufacture Plant site, 1136 Nepean Highway, Highett, Victoria.
1994	Gas & Fuel, Jun-94b. Site Description of the Highett Ex-GMPS, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria.
1995	Golder Associates, 05-Apr-95. Preliminary site Contamination Assessment Former Gasworks Site, 1136 Nepean Highway, Highett.
1996	Gas & Fuel, May-96. Highett Environmental Site Audit, Gas Technology Centre, 1136 Nepean Highway, Highett, Victoria.
1997	Golder Associates, Nov-97. Draft report on Site contamination assessment, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria.
1997	Gas & Fuel, Dec-97. Groundwater Monitoring Results at the Former Gas Manufacture Plant Site, 1136 Nepean Highway, Highett, Victoria.
1999	Golder Associates, Feb-99a. Site Characterisation Assessment, Former Gasworks Site, 1136 Nepean Highway, Highett, Report No. 98613658/021 Vol 1
1999	Golder Associates, Feb-99b. Site Characterisation Assessment, Former Gasworks Site, 1136 Nepean Highway, Highett, Report No. 98613658/021 Vol 2
1999	Golder Associates, Feb-99c. Site Characterisation Assessment, Former Gasworks Site, 1136 Nepean Highway, Highett, Report No. 98613658/021 Vol 3
1999	Golder Associates, 11-Mar-99. Amendments to Site characterization Assessment, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria.
1999	Golder Associates, May-99a. Soil Contamination Data From Further Groundwater Monitoring Wells, Former Gasworks Site, 1136 Nepean Highway, Highett, Report No. 98613683/077
1999	Gas & Fuel, May-99b. Groundwater Monitoring Results at the Former Gas Manufacture Plant Site, 1136 Nepean Highway, Highett.
1999	Gas & Fuel, May-99c. Groundwater Monitoring Results at the Former Gas Manufacture Plant Site, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria.
2000	Connolly Environmental, Jul-00. Report to Department of Treasury and Finance, Review of Contamination Status, Former Gasworks Site, 1136 Nepean Highway, Highett.
2001	Golder Associates, 16-Jan-01. Tender Information For Site investigation Stage 1 Former Highett Gasworks, 1136 Nepean Highway, Highett, Victoria.

Year	Report title
2001	Golder Associates, 14-Jan-01. Tender information for Laboratory Services Former Highett Gasworks, Former Gasworks Site, 1136 Nepean Highway, Highett.
2001	Golder Associates, 14-Sep-01. Tender Information for Environmental Auditor Services Former Highett Gasworks including Performance Specification for Remediation of the former Highett Gasworks (Revision 1), September 2001 Report No. 01613573/002
2001	Golder Associates, Sep-01. Performance specification for Remediation of the former Highett Gasworks (Revision 1), September 2001 Report No. 01613573/004
2001	Golder Associates, Sep-01. Historical Review and Data Summary for Remediation of the former Highett Gasworks, September 2001 Report No. 01613573/002
2002	Golder Associates, Aug-02. Hydrological Investigation to Support Remediation, Former Highett Gasworks, 1136 Nepean Highway, Highett Report No. 01613573/059
2002	Golder Associates, Sep-02. Soil Contamination Assessment to Support Remediation, Former Highett Gasworks, 1136 Nepean Highway, Highett Report No. 01613573/058
2002	Golder Associates, 06-Nov-02. Remediation Risks and Strategy, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria.
2003	Golder Associates, 05-Mar-03. Offsite Groundwater Investigations, Former Highett Gasworks, 1136 Nepean Highway, Highett, Report No. 01613573/087
2003	Golder Associates, Jul-03. Workplan Further Contamination Assessment, Highett Gasworks Remediation, 1136 Nepean Highway, Highett, Victoria.
2003	Golder Associates, 01-Oct-03. Additional Groundwater Investigation, Former Highett Gasworks, 1136 Nepean Highway, Highett, Vic, Report No. 01613573/112
2003	Golder Associates, 03-Dec-03. Information to Support Clean Up To The Extent Practicable, Former Highett Gasworks 1136 Nepean Highway Highett, Report No. 01613573/126
2004	Golder Associates, 18-Feb-04. Soil Remediation Practicability Assessment, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria.
2004	Golder Associates, Aug-04. Further Soil Contamination Investigation to Support Environmental Audit, Former Highett Gasworks Report No. 01613573/151
2004	Golder Associates, 28-Apr-04. Addendum to Information to Support Clean Up To The Extent Practicable, Former Highett Gasworks 1136 Nepean Highway Highett, Report No. 01613573/138
2005	Golder Associates, 04-Mar-05. Interim Groundwater Monitoring Round 1, Former Highett Gasworks 1136 Nepean Highway Highett Report No. 01613573/174
2005	Thiess Services, Jul-05. Management Plan for Highett Gasworks Remediation Project, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria.
2005	Golder Associates, Dec-05. Report No 1 - Data Quality Assurance. Period 20 Sept to 02 Dec 2005. Vol 1
2006	Supplementary Groundwater Assessment, Stage 1 Audit Area, 10 Jan 2006, Former Highett Gasworks, 1136-1138 Nepean Highway, Highett. Report No. 05613598/014.
2006	Golder Associates, 15-May-06. Initial Results of Soil Treatment, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria. Report No. 05613598/032.
2006	Golder Associates, 16-May-06. Discoloured soil within excavation 142, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria. Report No. 05613598/030.
2006	Golder Associates, 23-Jun-06. Further Information on treated material, Former Highett Gasworks, 1136-1138 Nepean Highway, Highett. Report No. 05613598/044.
2006	Golder Associates, 17-Aug-06. Reuse of sulphate impacted soil, Former Gasworks Site, 1136 Nepean Highway, Highett. Report No. 05613598/045

Year	Report title
2006	Golder Associates, Mar-06. Report No 2 - Data Quality Assurance. Period 03 Dec 2005 to 28 Feb 2006
2006	Golder Associates, Jun-06. Report No 3 - Data Quality Assurance. Period 01 Mar to 31 May 2006
2006	Golder Associates, Oct-06. Report No 4 - Data Quality Assurance. Period 01 Jun to 31 Aug 2006. Vols 1 & 2
2007	Golder Associates, 18-Jun-07. Interim Groundwater Assessment, March 2007, Stage 2 Audit Area, Former Highett Gasworks 1136 Nepean Highway Highett Report No. 05613598/079
2007	Golder Associates, 30-Jan-07. Report No 5 - Data Quality Assurance. Period 01 Sep to 30 Nov 2006
2007	Golder Associates, May-07. Report No 6 - Data Quality Assurance. Period 01 Dec 2006 to 28 Feb 2007
2007	Golder Associates, 18-Jul-07. Report No 7 - Data Quality Assurance. Period 01 Mar to 31 May 2007
2007	Golder Associates, 24-Oct-07. Report No 8 - Data Quality Assurance. Period 01 Jun to 31 Aug 2007
2008	Golder Associates, 31-Jan-08a. Information to Support Clean Up To The Extent Practicable (version 2), Former Highett Gasworks, 1136 Nepean Highway, Highett Report No. 05613598/091
2008	Golder Associates, 31-Jan-08b. Report No 9 - Data Quality Assurance. Period 01 Sep to 31 Dec 2007
2008	Monarc Environmental, 18-Jun-08. Soil Contamination Investigation along the Proposed Gas Main Alignment, Sir William Fry Reserve. For Alinta Asset Management
2008	Golder Associates, 18-Jul-08. Draft Environmental Assessment & Remediation Report, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria.
2008	Golder Associates, 11-Sep-08. Draft Human Health Risk Assessment, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria. Report No. 05613598 131 R Rev0.
2008	Golder Associates, 26-Sep-08. Gas Main Easement Investigation, Former Highett Gasworks, 1136 Nepean Highway, Highett (05613598/132)
2008	Golder Associates, 06-Oct-08. Report On Groundwater Investigation – May 2008, Stage 2 Area, Former Highett Gasworks, 1136 Nepean Highway Highett, Report No. 05613598/129
2009	Golder Associates, 20-Mar-09. Summary of Round one of Soil Vapour Assessment, Former Gasworks Site, 1136 Nepean Highway, Highett. Report no 05613598 150 L Rev0
2009	Golder Associates, 26-Aug-09. Report No 10 - Data Quality Assurance. Period 01 Jan to 31 Aug 2009
2009	Golder Associates, 20-Oct-09. Revised Human Health Risk Assessment Highett Gasworks Site, 1136-1138 Nepean Highway Highett, Victoria October 2009 Report No. 05613598/131 Rev1.
2009	Golder Associates, 22-Oct-09. Environmental Assessment and Remediation Report, Stage 2 Audit Area, Former Highett Gasworks, 1136-1138 Nepean Highway, Highett, Victoria. Report no 05613598 130 Rev0
2009	Golder Associates, 28-Oct-09. Factual Groundwater report - June 2009, Stage 2 Area, Former Highett Gasworks 1136 Nepean Highway Highett, Report No 05613598 154 Rev0

Year	Report title
2009	Golder Associates, 05-Nov-09. Information to support cleanup to the extent practicable (version 3), Former Gasworks Site, 1136 Nepean Highway, Highett, report No. 05613598 112 Rev0
2009	Golder Associates, 17-Dec-09. Stage 2 area Level 1 Geotechnical Inspections and Testing, Former Gasworks Site, 1136 Nepean Highway, Highett. Report no 05613708 002 Rev0
2010	Golder Associates, 19-Jan-10. Addendum to Factual Groundwater report - June 2009; total Cyanide, Stage 2 Area, Former Highett Gasworks 1136 Nepean Highway Highett. Report no 05613598 172 Rev0
2010	Golder Associates, 02-Feb-10. Revised Human Health risk Assessment, Highett Gasworks Site, 1136-1138 Nepean Highway Highett, Victoria. Report No 05613598 131 rev 2
2010	Golder Associates, 12-Mar-10. Information to Support Clean Up to the Extent Practicable, 1136-1138 Nepean Highway Highett, Victoria. Report No 05613598 112 R Rev0
2010	Golder Associates, 14-May-10. Information to Support Clean Up to the Extent Practicable, 1136-1138 Nepean Highway Highett, Victoria. Report No 05613598 178 R Rev0
2010	Golder Associates, 27-May-10. Information to Support Clean Up to the Extent Practicable (version 5), 1136-1138 Nepean Highway Highett, Victoria. Report No 05613598 182 R Rev0
2010	Golder Associates, 08-Jul-10. Environmental Assessment and Remediation Report, Stage 2 Audit Area, Former Gasworks Site, 1136 Nepean Highway, Highett. Report no 05613598 177 R Rev0
2010	Golder Associates, 24-Sep-10. Environmental Management Plan - Stages 2 and 2A, Former Gasworks Site, 1136 Nepean Highway, Highett. Report no 05613598 144 R RevA
2011	Golder Associates, 13-Jan-11. Environmental Assessment and Remediation Report, Stage 2 Audit Area, Former Gasworks Site, 1136 Nepean Highway, Highett. Report no 05613598 177 R Rev1
2011	Golder Associates, 18-Jan-11. Human Health Risk Assessment of Class 2 Material Below Buildings. Former Gasworks Site, 1136 Nepean Highway, Highett. Report Number: 05613598-090-R-Rev0.
2011	Golder Associates, 19-Jan-11. Environmental Management Plan Rev 1 - Stages 2 and 2A, Former Gasworks Site, 1136 Nepean Highway, Highett. Report no 05613598 144 R RevB
2011	Golder Associates, 13-Apr-11. Environmental Management Plan Rev 2 - Stages 2 and 2A, Former Gasworks Site, 1136 Nepean Highway, Highett. Report no 05613598 144 R RevC
2011	Golder Associates, 22-Jul-2011a. Environmental Assessment and Remediation Report, Stage 2 Audit Area, Former Gasworks Site, 1136 Nepean Highway, Highett. Report no 05613598 177 R Rev2
2011	Golder Associates, 22-Jul-2011b. Environmental Assessment and Remediation Report, Stage 2 Audit Area, Former Gasworks Site, 1136 Nepean Highway, Highett. Report no 05613598 177 R Rev2

2. Site details

The former gasworks site was divided into three areas to expedite the Audit process as shown in **Figure 2 (Appendix A)**:

- Stage 1 audit area (1.2 ha): forms the south east corner of the former Gasworks site and was issued with a Statement of Environmental Audit in 2006. Approximately 0.91 ha of Stage 1 was sold to DoJ for the development of the Moorabbin Court House complex.
- Stage 2 audit area (4.7 ha): covers the remaining eastern area of the former gasworks site.
- Stage 2A audit area (1.63 ha): covers the remaining western portion of the site.

In total, the area under audit (Stages 2 and 2A) occupies 6.33 ha and is described as Crown Allotment 2006 on TP835477B of Plan of Consolidation No. 150995, Parish of Moorabbin. (Volume 9598 Folio 389), and is provided in **Appendix B**.

The site is irregular in shape and is situated between Nepean Highway to the east and Frankston Railway line to the west. Immediately to the south of the site is Sir William Fry Reserve (SWFR) which was once part of the former Highett gasworks. To the north of the site are Buckingham International Hotel, Station and View Streets and residential homes. Across the Frankston Railway line, are a mixture of commercial/recreational properties (including Highett Bowling Club) and residential homes (**Figure 3, Appendix A**). To the south of Sir William Fry Reserve (SWFR) is an active service station/carwash located on the corner of Bay Road and Nepean Highway. On the south side of Bay Road is the Westfield owned Southland Shopping Centre. The CSIRO Material Science and Engineering Highett laboratories are located in Graham Street, approximately 300 meters west of the site.

The site also contains a number of high pressure gas and transmission mains (with associated sensing lines and regulators) running east to west through the centre of the site and north to south along the western site boundary. These account for approximately 0.57ha of easements (see **Figure 4, Appendix A**).

At the time of writing, it is understood that the remaining operational gas infrastructure is likely to be decommissioned during 2012 - 2013 when the new gas lines, located along the western boundary running from View Street in the north to Sir William Fry Reserve in the south, are commissioned (**Golder, 27-May-10**).

2.1 Site history

The former Highett gasworks operated as a gas manufacturing facility for 30 years between 1939 and 1969. The site was developed by the Brighton Gas Company and was the last gasworks site to be built in Victoria.

During this time the site included: several houses; a Valve Room; Office Building; three Purifiers; two Retort Houses; a Coke Plant; two Tar Treatment Plants; a Tar Dam; a Gas Holder; Meter Room; Coal Store; Town Gas Compressors; Carburetted Water Gas (CWG) Plant; a Relief Holder; a Workshop and Amenities Block; Oil Tanks; various liquor and effluent tanks and ponds. See **Figure 5, Appendix A** for historic gasworks layout.

In December 1952 a fire and explosion occurred when a tar dehydration tank on the side of No 1 retort house burst into flames. The tank boiled over, splashing hot tar onto red-hot clinkers or ash which had been emptied earlier from a furnace (**Golder, 27-May-10**).

During the 1970s the gasworks was largely demolished. In the late 1970s and early 1980s the site was redeveloped as the Scientific Services Department and Training Centre for the Gas and Fuel Corporation. 'Partial soil remediation' was undertaken during this time of redevelopment and approximately 28,000m³ of material was remediated (removed from the site). See **Figure 6, Appendix A** for historic Training Centre layout (**Gas & Fuel, 01-May-96**).

The Scientific Services Laboratory was located on the southern portion of the site and included: Chemistry and Physics Laboratories (including cooling towers which used chromium as an anti-corrosive); Administration area; Laboratory Services building, building for testing of coal tar enamels (the former Oil Gas Plant); general stores building with wind tunnel for appliance testing (the former No 1 Coal Store); maintenance equipment store & small incinerator; Amenities Block (the former Amenities Block); Solar Hut used for research into solar power; and General Office. The Scientific Services Laboratory provided research and testing facilities for gas appliances, materials used in the gas industry (including pipes and metal components), chemical testing and quality control of natural gas and LPG as well as miscellaneous services such as meter calibration and noise/vibration studies (**Gas & Fuel, 01-May-96**).

The Training Centre was located on the north portion of the site and included a number of buildings and a project department. Of the original gasworks structures in this area only the northern Store building remained. The training Centre provided facilities for training of plumbers and gasfitters (**Gas & Fuel, 01-May-96**).

In the 1980-1990s the majority of buildings were demolished.

Currently only the chimney of the Boiler/Town Gas Compressor complex remains onsite and is protected by a heritage overlay (HO11) (see **Appendix E** for planning scheme and heritage overlay) (**Golder, 27-May-10**).

2.1.1 Offsite gasworks related properties

It is noted that the original gasworks site was spread over a wider area than the current audit boundary. As shown on **Figure 7, (Appendix A)** and the original title, Sir William Fry Reserved was part of the site and contained three gasholders (holder Nos. 2 to 4), the last of which (Holder No. 4) was demolished in 1988. An LPG storage area was also located on Sir William Fry reserve (see **Figures 8 and 9, Appendix A**). It is noted that the foundations of gasholder No. 4 appears to now contain an ornamental lake.

The old gasworks also extended across the railway line to the northwest near Graham and Jackson Roads. This land is now used for recreation and residential use (public housing) and is adjacent to the Highett Bowling Club to the north. An Ammoniacal Liquor cooling pond (33 metres long by 13 metres wide) was located on the northern corner of the Graham Road site. It was connected to the works by a culvert under the railway line (**Gas & Fuel, 01-Jun-94b**).

While these properties are likely to contain residual gasworks wastes, they are located down or across hydraulic gradient of the audit site and are therefore unlikely to impact groundwater beneath the site.

It is noted that the three properties adjacent to the eastern boundary of the site (1142 to 1148 Nepean Highway which include the former Fleet Marine and Leigh Mardon properties) did not appear to be part of the historic gasworks site.

2.2 Planning considerations

The site is currently zoned Residential 1 Zone (R1Z) with an environmental audit overlay (EAO) (the site was previously zoned Public Use Zone service and utility - PUZ1). Current understanding of proposed site use is medium to high density residential consistent with R1Z zoning stipulated in the Kingston Planning Scheme and Schedule 12 of the Design and Development Overlay (DDO12 – H6(a – e) (see **Appendix E**). The immediate neighbouring land uses are listed in Table 2.1 below.

Table 2.1 Surrounding landuses

Boundary	Zone	Distance from site	Use	Description
Western boundary	PUZ 4	Boundary	Public Use Zone Transport	City-Frankston Rail Line
	R1Z	<50m	Residential 1 Zone	Jackson Street & residential dwellings
	PPRZ	<50m	Public Park and Recreation Zone	Lyle Anderson Reserve and Highett Bowling Club
	CA	300m	Commonwealth Land	CSIRO Highett campus
Eastern boundary	RDZ 1	Boundary	Road Zone Category 1	Nepean Highway
	PUZ 7	Boundary	Public Use Zone Other Public Use	1140 Nepean Highway Moorabbin Justice Centre
	R1Z	Boundary	Residential 1 Zone	1142 to 1148 Nepean Highway
	Formerly PUZ1, now R1Z	Boundary	Public use zone 1 – service and utility. Now Residential 1 Zone	1142 Nepean Highway Fleet Marine (boat retailer) Demolished between July and October 2010
	Formerly B3Z, now R1Z	Boundary	Business 3 Zone. Now Residential 1 Zone	1144 Nepean Highway A.B. Note (printers). This was owned by Leigh Mardon (printers) and is referred to as such throughout this report.

Boundary	Zone	Distance from site	Use	Description
				Still operational as of January 2011
	Formerly B3Z, now R1Z	Boundary	Business 3 Zone. Now Residential 1 Zone	1148 Nepean Highway Demolition commenced between 20 November and 24 December 2010
Southern boundary	PPRZ	Boundary	Public Park and Recreation Zone	Sir William Fry Reserve (was once part of the gasworks)
	RDZ 1	400m	Road Zone Category 1	Bay Road
	B4Z	450m	Business 4 Zone	1150 Nepean Hwy Fueltown (auto mechanics, carwash, fuel retailer)
Northern boundary	R1Z	Boundary	Residential 1 Zone	View Street , Station Street & residential dwellings
	R1Z	Boundary	Residential 1 Zone	The Buckingham Motor Inn

2.3 Topography and surface drainage features

The site slopes from the northeast to the southwest with a surface elevation of between 41.3mAHD and 37.5mAHD and an average gradient of approximately 1.5% to facilitate surface drainage across the site (see **Figure 10, Appendix A**).

There are no surface water bodies located onsite. A number of ponds/ornamental lakes (fed by stormwater) exist on Sir William Fry Reserve to the south of the site. Aerial photographs sourced from GoogleMaps and NearMaps indicate that these ornamental lakes are often dry in drought conditions. Given the depth to groundwater beneath the audit site (average 6mBGL) and the shallow nature of these lakes, it is unlikely they receive base flow from groundwater and are therefore not considered a receptor for groundwater contamination. Therefore the nearest surface water body is Port Phillip Bay located approximately 3.7km to the west of the site.

2.4 Regional geology and hydrogeology

The Geological Survey of Victoria 1:63,360 scale Ringwood map sheet (Geological Survey of Victoria, 1981) indicated that the site is located on Tertiary aged Red Bluff Sands and Quaternary aged sand ridges.

The regional geology and hydrogeology of the Highett area is summarised in **Table 2.2**.

Table 2.2 Regional geology / hydrogeology

Aquifer	Age	Geological name	Top of formation & Thickness	Description	Hydrogeological information
	Quaternary	Sand ridge sediments	<10m	Discontinuous veneer of sandy and clayey sediments often disturbed by anthropomorphic	Discontinuous

Aquifer	Age	Geological name	Top of formation & Thickness	Description	Hydrogeological information
				influences such as landfilling and urban development	
Tertiary aquifer (unconfined to semi-confined)	Tertiary - Pliocene	Red Bluff Sands of the Brighton Group Formation	Near ground surface to ~25m	Terrestrial. Poorly sorted ferruginous fine to coarse grained sands with minor poorly sorted gravels at depth. Approximately 25m thick in the Highett area.	Flow direction: west to south west Hydraulic conductivity (horizontal): 10-8 to 10-6 m/s Hydraulic conductivity (vertical): likely to be lower than horizontal conductivity due to layered nature of the formation
	Tertiary – Miocene	Fyansford Formation	~25 – 40+m, can be up to 48m thick	Marine. Calcareous silt and clay with minor limestone beds. Approximately 48m thick in the Highett area.	Considered to be of low hydraulic conductivity
Silurian bedrock Aquifer	Silurian	Melbourne Mudstone	+40m in the area	Siltstone / mudstone / sandstone bedrock. Top of bedrock at approximately 70m+ depth beneath the Highett area.	

2.5 Site geology and hydrogeology

The site geology and hydrogeology was characterised by the drilling and installation of both shallow and deep groundwater wells which penetrated the top and base of the Brighton Group Aquifer respectively. Shallow wells were drilled to between 8 and 12 mBGL while deep wells progressed to between 17 and 21 mBGL. Based upon intrusive investigations conducted by Golder, the site geological profile is summarised in **Table 2.3** below.

Table 2.3 General site geological profile

Depth	Description	Comment
0 to 3m	FILL: sands, silty clays, clayey sand and gravels, crusted rock, some building materials/wastes (brick, concrete, slag and ash)	Fill can be up to 12m deep in some excavations. There is potential for a thin veneer (up to 2m thick) of Quaternary aged sands to be present in the northeast corner of the site.
3 to 20m	Natural fine to medium Sandy CLAYS and clayey SANDS grading to coarse sands and gravels at depth	Brighton Group Generally becoming coarser with depth and more clay rich to the west

Depth	Description	Comment
~21m	Sandy SILT, brown	Potential top of Fyansford Formation or Silurian aged bedrock

A summary of local and site groundwater quality and occurrence is contained in **Table 2.4** below. It is noted that the June 2008 GME was the last site wide monitoring event with a total of 33 wells gauged and sampled while the July 2008 GME provides the most comprehensive major ion data for the site. Only 24 selected wells were sampled in 2009.

Table 2.4 Summary of site hydrogeology

Characteristic	Description
Depth to groundwater (June 2008):	Shallow wells: 3.857 mBGL (9130007) to 10.153 mBGL (9130009) Deep wells: 7.789 mBGL (9150003) to 9.035 mBGL (9150001)
Direction of groundwater flow:	West to north west towards Port Phillip Bay. (Figures 11 and 12, Appendix A)
Hydraulic gradient:	Horizontal gradient: an average across the site of approximately 0.002 (relatively flat). Local groundwater mounding in the southern portion of the site generates a northerly to north westerly trending horizontal hydraulic gradient, ranging between 0.003 and 0.004. Vertical hydraulic gradient in the southern portion of the site where groundwater mounding occurs is approximately 0.09 (downward) The vertical hydraulic gradient decreases to approximately 0.04 (downward) away from the groundwater mound (in the northwest corner of the site)
Hydraulic conductivity (June 2008):	Well yields measured during the August 2003 sampling round ranged from 0.06 to 0.3 l/min. Results indicate higher hydraulic conductivities in the centre and northern areas of the site, with generally lower hydraulic conductivities in the south and south east areas. It is anticipated that preferential flow will be occurring through the more hydraulically conductive material. A clayey sand would typically be expected to have permeability in the order of 10^{-6} m/s. This is within the anticipated published range for the Brighton Group Formation 10^{-6} m/s. An effective porosity of 0.1 has been assumed.
Groundwater velocity:	Using the data presented above, regional groundwater flow toward the west is estimated to be 0.37 – 3.7 m/year. The localised groundwater flow to the north in the vicinity of the southern groundwater mound is estimated to be occurring at a rate of approximately (1.28 – 12.8 m/year).
Nearest surface water body:	Permanent: Port Phillip Bay ~4km west of the site Ornamental: Water features in Sir William Fry Reserve ~20m south of the site
Total dissolved solids (TDS) (June 2008): (Figure 13, Appendix A)	Shallow wells: 210 mg/L (9130003) to 4,400 mg/L (9130010) (laboratory results) 127.4 mg/L (9130003) to 3,965 mg/L (9130010) (based on field EC in uS/cm *0.65) Deep wells: 710 mg/L (9150003) to 2,500 mg/L (9150002) (laboratory results) 951.6 mg/L (9150003) to 2,301 mg/L (9150002) (based on field EC in uS/cm *0.65)

Characteristic	Description
Groundwater physical chemistry	
pH (June 2008):	Shallow wells: 3.89 (9020001) to 8.36 (9130002) Deep wells: 5.99 (9150003) to 6.27 (9150001)
Redox potential (Eh) (June 2008):	–100 mV to 510 mV. The majority of negative Eh readings corresponded with visual or olfactory evidence of hydrocarbon contamination generally located on the western portion of the site.
Dissolved Oxygen (DO) (June 2008):	0.09 mg/L to 2.08 mg/L
Appearance & odour	Light to moderate turbidity with brown, yellow, orange, or grey/black colour. Odour varies from sulphur to hydrocarbon to phenolic.
Groundwater type (July 2008):	In general the groundwater is sodium-chloride dominant but often with magnesium and sulphate enrichment (Na-Cl to NaMg-SO ₄ Cl).
Nominated groundwater segment:	A2
Groundwater use:	Known uses include: Watering of golf courses, other small scale irrigation, industrial and commercial applications. Potential uses (from the state water data warehouse) include: domestic, stock watering, irrigation, and industrial applications.

The auditor has reviewed the information provided and is satisfied with both the quality of the data and the conclusions reached by Golder relating to the geology and hydrogeology of the site.

2.5.1 Background groundwater quality

Background groundwater quality was assessed by Golder using up-gradient monitoring wells. These were considered to be monitoring well 9130009 (offsite to the east), 9120001 (onsite, north east boundary), BH1 (onsite eastern boundary) (**Figure 11, Appendix A**). Data from the background wells are summarised in **Table 2.5** below.

Table 2.5 Summary of background conditions

Location	Date	SWL (mTOC)	pH	Temp (C)	EC (uS/cm)	TDS range	DO (mg/L)	Sulphate (mg/L)	Nitrate (mg/L)	Comment
9130009	02-06-08	10.178	5.28	10.4	1300	710 - 950	6.15	240	14	Clear, no odour
9120001	29-06-09	11.263	4.56	14.2	401	170 - 230	2.08	11	12	Red/brown, no odour
BH1	14-12-05	10.335	4.99	17.8	1963	800 - 910	-	17	6	Brown, no odour

The TDS observed within these wells during the monitoring period 1999 to 2008 ranged between 170 and 950 mg/L (**Golder, 27-May-10**) which places the groundwater in segment A2 of the Groundwaters of Victoria SEPP.

The Auditor is satisfied with the information provided by Golder regarding background groundwater quality.

2.5.2 Victorian groundwater bore database

A search of the Victorian groundwater database undertaken by Golder (**Golder, 27-May-10**) identified the following 55 registered bores located within 1 km of the site. Four of these wells are registered for domestic and stock purposes and the deepest well (85mBGL) is registered for industrial use. Well depths vary between 3.2 and 85 mBGL and the majority of wells are registered for investigation purposes.

3. Potential sources of contamination

A review of potential sources of contamination to either groundwater and/or soil was conducted by the Auditor and was based upon information provided by the Gas and Fuel Corporation report (**Gas & Fuel, 01-Jun-94b**). The review identified both onsite and offsite activities as discussed below.

3.1 Onsite sources

The former Highett gasworks site presents a number of potential buildings, structures or processes that may result in detrimental environmental impacts. The three main processing plants onsite included the Coal Carbonisation Plant (CCP), Carburetted Water Gas Plant (CWGP) and the Oil Gas Plant (**Gas & Fuel, 01-Jun-94b**).

Table 3.1 below summarises the structures and processes that took place on the site and the types of wastes produced (**Gas & Fuel, 01-Jun-94b**). For ease of understanding, the site has been divided into zones as indicated on **Figure 5 (Appendix A)**.

Table 3.1 Summary of onsite gasworks related contaminants of concern

Zone and Structure	Description	Contaminants
Zone 1 Liquor tanks. Redeveloped as a car park in 1978-1991.	Two liquor tanks and wells (precise contents unknown) c.1940s. Tar pumps were reported to be present beneath one or both of the liquor tanks and may have been used to the transfer of product to trucks.	Likely to have contained: Tar oils; ammoniacal liquors produced by coal carbonisation plant; various tar distillates; various waste light to heavy oils used in the Carburetted Water Gas and Oil Gas processes; Liquid blow downs from aqueous sulphur removal systems (depending on the process used this liquor may contain arsenic and/or nickel and/or iron).
	Relief gas holder (post 1951 and pre 1956). Typically part of the CWGP process, used as an interim gas holder following primary cleaning of the gas and condensing treatment. The gas from the relief holder was then typically passed through a secondary condenser, washing and scrubbing system. Thus, more residual gas contaminants are likely to have been suspended in the gas contained in this holder which may mean that more tar sludge collected in the base of this holder. The depth of this holder is unknown.	Tar sludge/oils: PAHs, MAHs, TPHs, BTEX, CN, sulphate, heavy metals
	Effluent pond (c. 1940s). Purpose and construction of this pond is unknown. These types of ponds are usually the final holding point for treated effluent prior to discharge to sewer. Aerial photographs suggest the ponds were constructed as part of the original coal carbonisation plant and before the CWGP. A second pond was constructed in the late 1950s.	These ponds may have received effluent of variable quality: ammonia, cyanide, tars, oils

Zone and Structure	Description	Contaminants
Zone 2 Carburetted Water Gas Plant. CWGP redeveloped as a car park post 1981.	CWGP (constructed 1951-1956, demolished 1979-1981). Process involved reacting steam with hot coal or coke in a generator chamber to produce a water gas (mixture of hydrogen and carbon monoxide). The water gas was enriched in a second vessel (carburettor) by the addition of a petroleum hydrocarbon spray (naphtha, crude oil) which was converted to a gas in the third vessel (superheater). The carburetion process resulted in a higher energy capacity gas (via the generation of higher percentage hydrogen as well as methane). The gas from the superheater was separated and the immediately quenched in the wash box to cool the gas and condense the tar. An emulsion of tar/oil/water was generated as a waste. The emulsion composition was dependent upon the carburettor oil used (e.g. naphtha to crude oil). The washed water gas was then purified to remove sulphide. Ash and clinker were also waste products of the CWGP. Equipment associated with the CWGP included a multi-film washer, oil trap, washers and tar separator.	Ash, clinker, tar, naphtha, crude oil
Zone 3 Coal Carbonisation Plant No. 1. Much redeveloped as part of the Scientific Services Laboratory post 1989.	CCP No 1 (assumed to have been constructed in 1939). Incorporates the coke plant, No. 1 retort house and coal store. CCP No 1 demolished 1981-1989. Process involved the carbonisation of bituminous coal in a closed vessel (retort or coke oven) and heated. The gas is then quenched and purified to remove sulphide, cyanide and ammonia before entering the distribution system.	Coal tar condensate, coke, cyanide, sulphate, ammonia.
Zone 11 Coal Carbonisation Plant No. 2. Much redeveloped as part of the Scientific Services Laboratory post 1989.	CCP No 2 (assumed to have been constructed by 1951). Incorporates the coke plant, No. 2 retort house and coal store. CCP No 2 demolished 1981-1989. Processes as for CCP No. 1	As above
Zone 4 Gas purifiers. Much redeveloped as part of the Scientific Services Laboratory post 1981.	Three gas purifier boxes. No.1 and No. 2 purifiers were built prior to 1955; No. 3 was built between 1951 and 1956. The boxes were removed between 1978 and 1981. The purifiers removed sulphur and cyanide from the gas and trapped some hydrocarbons that passed through the upstream scrubbing processes. The boxes were filled with iron oxide or lime and produced spent oxides (ferro-cyanide complexes) or spent lime wastes identified by their blue (Prussian blue), turquoise and purple colouring.	Sulphur, cyanide, ferro-cyanide complexes.

Zone and Structure	Description	Contaminants
Zone 5 Intense cooling plant. Post 1979 remained as general open space with improvements and access road.	Constructed between 1951-1956. Removed between 1972-1979. Likely to be part of the gas cooling process.	Tars, oils and ammonia.
Zone 6 Gas Holder No. 1. Post 1979 remained as general open space with improvements and access road.	Built prior to 1951 (likely c. 1939). Demolished 1978-1979. Actual design unknown, however most holders extent 5 to 8m below ground and accumulate tar sludges in the base. Upon demolition, many holders are filled to ground level with materials (building wastes) sourced from the site.	Tar sludge/oils: PAHs, MAHs, TPHs, BTEX, CN, sulphate, heavy metals
Zone 7 Tar Dam. Redeveloped as part of the Scientific Services Laboratory.	Tar dam (likely to have been constructed c. 1939) and tar treatment plant (present in 1951 and removed by 1956 – use unknown). Tar dam - Approximately 30m long and 15m wide, depth unknown. Tar treatment plant – use unknown but may have been part of tar reprocessing/distillation or separation of tar and ammoniacal liquor.	Tar sludge/oils: PAHs, MAHs, TPHs, BTEX, CN, sulphate, heavy metals, ammonia
Zone 8 Oil gas plant (OGP), ammonia plant, boiler and gas compressors. Redeveloped as part of the Scientific Services Laboratory.	Built prior to 1951. Demolished 1981-1989 except sub-station which was demolished later. OGP – similar process to the CWGP with similar wastes generated (oil/tar/water emulsion) but with lampblack rather than coal tars generated. Boiler room – to produce gas manufacturing stream and possibly clinker for commercial sale. Meter room and Town gas compressors – for metering gas flow and gas pressurisation. An oily-water blow down likely from the compressors. Ammonia plant – possibly used to concentrate weak ammonia waste liquors. Waste water from this plant may have been piped offsite to the south of the railway line.	PCBs, clinker, oily-water blow down, ammonia
Zone 9 Workshop and amenities. Workshop demolished to make way for the Training Centre, amenities block still present at time of Training Centre.	Activities in the workshop are unknown.	Potential for degreasers and solvents to have been used in this area. Wastes may have included metals, waste oils and lubricants and solvents.

Zone and Structure	Description	Contaminants
Zone 10 Oil tanks and tar treatment plant. Redeveloped as part of the Training Centre between 1978 and 1981.	Oil tanks –present onsite in 1956 along with the CWGP and were removed between 1978-1981. Tar treatment plant – first appears in the 1956 aerial photograph. Oil tanks - 10 above ground tanks which were covered with earth and had overhead piping to the CWGP and OGP. Tar treatment plant – use unknown Possible secondary treatment of tar to produce commercial products ranging from light aromatics through to heavy oils and bitumen.	Tar sludge/oils: PAHs, MAHs, TPHs, BTEX, CN, sulphate, heavy metals
Zone 12 Administration area	Characterised by a general absence of gas manufacturing activities or processes. Includes two villas in the north east; a house in the north corner; a valve room; general office building; and numerous areas of open land.	Likely to have generated domestic type wastes including detergents, food waste, septic waste and office waste.

3.2 Offsite sources

The Former Gasworks site is located in an area of mixed commercial, industrial and residential uses. Historically light industrial and commercial businesses have existed along the eastern boundary of the site bordering the Nepean Highway. These businesses have included boat retail and repair, and secure printers and are currently undergoing redevelopment. To the west of the site is the CSIRO Highett complex and to the south is Westfield Southland Shopping Centre (**Figure 14, Appendix A**).

Table 3.2 below provides an Auditor review of nearby completed audit reports within 500m of the site. **Figure 14 (Appendix A)** shows the location of properties within 500m of the site that have been issued with either a Certificate or Statement of Audit.

Table 3.2 Summary of audits and other information

Reference	Conditions / Comments	Potential contaminants of concern	Location
CARMS #21041-1A. 1993. 1112 Nepean Highway, Highett (corner of Highett Rd and Nepean Hwy)	Suitable for commercial/industrial use.	Pockets of residual hydrocarbon impacted soil are likely to remain beneath the site.	Less than 200m north of the site. Likely to be across hydraulic gradient, therefore unlikely to impact on the audit site.
N.J. Withers of ICF PTY LTD	Past use as a service station / automotive mechanics workshops.		
Statement	All USTs removed by October 1993.		
	Maximum depth of excavation / investigation: 4.3m.		
CARMS #34201-1A. 1998. Southland Development Project – Stage 1. Corner of Nepean Highway and Bay Road, Cheltenham.	Suitable for residential, children's-day care centres, preschools, primary schools and other commercial purposes.	Levels of contaminants (nickel, chromium, manganese, copper, zinc, arsenic) plus soil pH exceed the adopted ecosystem protection criteria but are not above National Environmental	~300m southeast of the site.
Dr Wayne Drew of CMPS&F	Past landuses include: Cheltenham Community Market, Lucas Industries Pty Ltd (manufacturing automotive and electrical components as well as		Likely to be across or down hydraulic gradient, therefore unlikely to impact on the audit site.

Reference	Conditions / Comments	Potential contaminants of concern	Location
Statement	substation) and former antique shop (containing asbestos).	Health Forum (NEHF), 1996, Setting 'A' (which includes residential, children's-day care centres, preschools, primary schools and other commercial purposes).	
CARMS #36024-1A. March 1999. 7-13 Graham Road Highett, Victoria – Stage 1 R.A. Graham of Sinclair Knight Merz Certificate	Past landuses included: vehicle detailing by Ken Morgan Toyota (including USTs and TIT), All Good Interiors (office refurbishers, including a warehouse storing furniture and whitegoods).	None identified.	~300m west of the site. Located down hydraulic gradient, therefore unlikely to impact on the audit site.
CARMS #36024-2A. August 1999. 7-13 Graham Road Highett, Victoria – Stage 2 R.A. Graham of Sinclair Knight Merz Statement	Past landuses included: Screen printing (Creanova Pty Ltd) and electronic circuit board manufacture (Farrow McRae Pty Ltd)	Localised areas contain low pH soils and concentrations of copper (and to a lesser extent chromium, arsenic and zinc) above environmental (ANZECC B) thresholds of potential concern but not above human health investigation levels NEHF (1998) 'A' guidelines for low density residential use.	~300m west of the site. Located down hydraulic gradient, therefore unlikely to impact on the audit site.
CARMS #34201-2A. 2000. Southland development site. 1156 Nepean Highway, Cheltenham, Victoria (corner of Bay Rd and Nepean Hwy) Anthony Lane of Lane Consulting Statement	The groundwater at the site shall not be used for any purpose including drinking, garden watering and swimming pool make up.	The groundwater at this site is polluted by trichloroethylene (TCE) to the extent that several beneficial uses of the groundwater are precluded. The soil contains contamination that exceeds the ANZECC-B (ecological) criteria in some locations. This groundwater and soil contamination does not pose any significant risk to the environment or human health.	~300m southeast of the site. Likely to be across or down hydraulic gradient, therefore unlikely to impact on the audit site.
CARMS #44791-1. 2001. Corner Highett and Graham Roads, Highett, Vic (286 Highett Road) Anthony Lane of Lane Consulting Certificate	Past landuses included: Former Air Force Aeronautical Engineering Support Facility (Department of Defence)	Asbestos & lead dust	~300m northwest of the site. Located down hydraulic gradient, therefore unlikely to impact on the audit site.
CARMS #60341-1. 2007. 284 Highett Road, Highett, Victoria Warren Pump of URS Australia Pty Ltd Certificate	Past landuses include: Commonwealth Aircraft Corporation Ltd Factory, Lincoln Mills (Australia) Ltd factory (possible textile factory).	Potential corrosive soil and/or groundwater conditions: elevated sulphate & low pH.	~300m northwest of the site. Located down hydraulic gradient, therefore unlikely to impact on the audit site.

Reference	Conditions / Comments	Potential contaminants of concern	Location
CARMS #67683-1. 2011. 1142 Nepean Highway, Highett, Victoria. Nick Owen of Bureau Veritas Statement	Former Fleet Marine boat retailer	Groundwater: heavy metals, cyanide, nitrate, ammonia, 1,1 DCA and 1,1 DCE Soil: heavy metals, hydrocarbons, cyanide	Adjacent to eastern boundary of audit site boundary. Up hydraulic gradient and therefore has potential to impact upon the audit site.
CARMS #18435-3. 2011. 98-116 Cavanagh Street, Cheltenham, Victoria. Phil Sinclair of Coffey Environments. Statement	Former sand quarry (1933-1985) Solid inert landfill (1976 – 1989)	Soil: heavy metals, PAHs Waste: degradable organic material, soil, timber, building rubble Methane: Site is an ongoing source of methane generation (landfill gas) Groundwater: cyanide, ammonia, manganese, selenium, iron	~600m south east of audit site. Potential to be up hydraulic gradient and therefore impact upon the audit site.
Other information			
Karkarook Park; Keys Road Reserve; GR Bricker Reserve; Le Page Reserve; Kingston Heath Golf Club; Kingston Heath Reserve; Victoria Golf Club; Cheltenham Park; Cheltenham Recreational Reserve; Cheltenham Golf Club. Various other locations in Highett, Cheltenham and Moorabbin. City of Kingston local history website: http://localhistory.knigston.vic.gov.au/htm/article/294.htm	Many of these parks and reserves were former sand mines, the voids of which were then used to dispose of municipal waste of varying quality and quantity. Often these landfills where then rehabilitated as local parks or golf courses.	Various: metals, nutrients, hydrocarbons	Some within 500m of the site to the east. Some potentially located up hydraulic gradient of the audit site with a potential to impact on the audit site.

The information provided in the above listed reports indicates that the regional groundwater quality may be naturally corrosive to footings of buildings and structures and the Brighton Group sediments may be acid generating and therefore elevated in some metals and inorganics such as arsenic, copper, chromium, zinc and sulphate/sulphide.

All of these sites may be potential sources of contamination to both soil and groundwater. Former gasworks land to the south and west of the current site boundary are likely to contain contaminants of concern similar to those found onsite. Commercial/industrial properties to the east of the site may have used various fuels, oils, lubricants and solvents as well as some metals (for dyes, inks and plates) cyanide, ammonia and nitrate.

3.3 Auditor review of site details and potential sources of contamination

The auditor considers that the information presented in the various historic reports is adequate for the purpose of this audit. The scope and findings of the auditors review are detailed in **Table 3.3** below.

Table 3.3 Quality of site history reviews

Objective	Comments	Report	Auditor findings
Title plan/clear description of Audit site	Current Certificate of title located in Appendix B . Updated title plan will be provided once site is sold	Golder, 22-Jul-11	Acceptable
Zone planning information provided	Re-zoned as residential 1 zone in approximately 2009	Golder, 22-Jul-11	Acceptable
Beneficial uses to be protected identified	Beneficial uses of land and groundwater identified in both the Environmental Assessment and Remediation Report and Information to Support Clean Up to the Extent Practicable report.	Golder, 22-Jul-11 Golder, 27-May-10	Acceptable
Historic uses of audit site	The Gas & Fuel Corporation report Site Description of the Highett Ex-GMPS summaries historic gasworks related activities and the Highett Environmental Site Audit, Gas Technology Centre report summaries activities associated with the former Training and Technology Centre when the site was redeveloped in the 1980s.	Gas & Fuel, 01-Jun-94b Gas & Fuel, 01-May-96	Acceptable
Historic uses offsite	The Highett Environmental Site Audit, Gas Technology Centre report notes that adjoining land to the south and to the west (across the railway line) was once part of the gasworks. The report also notes the presence of light industrial/commercial properties to the east and south of the site.	Gas & Fuel, 01-May-96	Acceptable
Aerial photographs inspected	Two aerial photographs from 1958 and 1966	Gas & Fuel, 01-Jun-94b	Acceptable
Geological survey maps inspected	Geological Survey of Victoria (1981) 1:63,360 Ringwood Map Series No 849 Zone 7.	Golder, 27-May-10	Acceptable
Groundwater database inspected	Groundwater bore data sourced from Groundwater Management System (DSE) April 2009	Golder, 22-Jul-11 Golder, 27-May-10	Acceptable
Site inspected and description provided	Numerous site inspections conducted by the auditor and/or auditor assistant	See Section 7.3 of this report	Acceptable

Objective	Comments	Report	Auditor findings
Site interviews conducted	Gas & Fuel Corporation had access to site files and personnel relating to the former gasworks	Gas & Fuel, 01-Jun-94b	Acceptable
Description of current and historical structures	Historic structures relating to both the gasworks and Training and Technology Centre are summarised in various reports including the 1994 Gas & Fuel report. Current structures are summarised in the most recent Environmental Assessment and Remediation Report by Golder Associates.	Historic: Gas & Fuel, 01-Jun-94b Current: Golder, 22-Jul-11	Acceptable
Potentially contaminating uses identified	Gasworks related process and activities Gas & Fuel Corporation Training and Technology Centre activities	Historic: Gas & Fuel, 01-Jun-94b	Acceptable

4. Beneficial uses

As required in the conduct of a Statutory Environmental Audit, all potential beneficial uses were considered including potential beneficial uses of the land, groundwater and surface water. The term 'Beneficial Use' is defined in the *Environment Protection Act 1970* as those beneficial uses to be protected for various elements, as set out within the relevant State Environment Protection Policies (SEPPs). The elements considered in this Audit have been evaluated below.

4.1 Land

With respect to the environment, the SEPP-*Prevention and Management of Contamination of Land* (SEPP PMCL, 2002) identifies the following beneficial uses that would need to be protected for unrestricted use of the site (i.e. Certificate of Environmental Audit), including those beneficial uses in context with the proposed mixed use, commercial / medium to high density residential development. **Table 4.1** below identifies the beneficial uses of land.

Table 4.1 Protected beneficial uses of land

Beneficial use	Land use						
	Parks & Reserves	Agriculture	Sensitive use		Recreation/ Open space	Commercial	Industrial
			High-density	Other			
Maintenance of ecosystems							
Natural ecosystems	✓						
Modified ecosystems	✓	✓	✓	✓	✓		
Highly modified ecosystems		✓	✓	✓	✓	✓	✓
Human health	✓	✓	✓	✓	✓	✓	✓
Buildings & structures	✓	✓	✓	✓	✓	✓	✓
Aesthetics	✓	✓	✓	✓	✓	✓	
Production of food, flora & fibre	✓	✓		✓			

Notes:

1. The above table is a reproduction of Table 1 from the PMCL SEPP (June, 2002).
2. Shading denotes the beneficial uses required to be protected for the purpose of the proposed development.

The Auditor notes that in accordance with the SEPP PMCL, the proposed development (medium to high density residential, with minimal access to soil) is classified as a sensitive land-use (other). Therefore beneficial uses that must be protected include; maintenance of modified and highly modified ecosystems, human health, buildings & structures, aesthetics and production of food, flora and fibre. In accordance with the SEPP PMCL, '*Maintenance of Natural Ecosystems*' is not required to be protected for the proposed development however; cognisance is given to this beneficial use in order to consider unrestricted use of the site.

4.1.1 Soil screening criteria and target soil profiles

To assist in the onsite management and reuse of soil Golder Associates and the Auditor agreed (see **Appendix G**) on a set of soil screening criteria and target soil profiles. These are protective of human health and the environment for the given landuses (either Commercial or Medium to High Density Residential). Screening criteria for the site were divided into three classes:

- **Class 1.** Soils considered to present a low risk to human health or the environment, and therefore can be used as surface soils anywhere on the site. Class 1 soils are to be used in the upper 1.0m in proposed open areas.
- **Class 2.** Soils considered suitable for sites with commercial/industrial land uses. These soils are also suitable for subsurface soils for both commercial and medium density residential use where workers might be exposed during maintenance or earthworks activities. Class 2 soils are proposed to be used below 1.0m depth in open areas, and at any depth under proposed building envelopes, roads and pavement areas.
- **Class 3.** Soils considered not suitable for any site use. These must be treated onsite to meet Class 1 or Class 2 criteria or disposed offsite to an EPA licensed landfill or approved/licensed treatment facility.

The agreed target soil profile is summarised in **Table 4.2** below.

Table 4.2 Target soil class profiles for proposed land uses

Depth (mBGL)	In proposed open areas	Under proposed building envelopes, roads and pavement areas
1-1.0	Class 1	Class 2
>1.0	Class 2	Class 2

The criteria for Class 1 and 2 soils are generally based on National Environment Protection Measure (NEPM) "Assessment of Site Contamination" for Exposure Scenario A ("standard" residential human health exposure setting) and Scenario F (commercial/industrial human health exposure setting) respectively (NEPM, 1999). In addition, Class 1 soils take into account the NEPM EILs. The proposed contaminant criteria are provided in **Table 4.3**.

Human Health and Maintenance of Ecosystems (modified to highly modified)

Class 1:

- NEPM Health Investigation Levels: NEPM HIL-A (standard residential setting with garden/accessible soil). It is noted that the criterion for total phenols is based on Golder specific criteria for residential surface soil where there is a potential for consumption of home grown produce (this has been agreed to by the Auditor, see **Appendix G**). The PCB criterion has been set to avoid any issue associated with the requirement to prepare an Environmental Improvement Plan (EIP) for PCB contaminated wastes; therefore the criterion is protective of human health.
- NEPM Ecological Investigation Levels (Interim Urban): NEPM-EIL
- NSW EPA (1994) Guidelines for service station sites – for sensitive land use (where no NEPM criteria are available, for example, TPH, BTEX). It is noted that the criteria for

toluene, ethyl benzene and xylenes are protective of terrestrial organisms in soil and there are likely to be applicable for the protection of ecosystems and human health.

- US EPA Regional Screening Levels: Protection of groundwater SSLs (November 2010).

Class 2:

- NEPM Health Investigation Levels: NEPM HIL-F (industrial/commercial setting)
- NSW EPA (1994) Guidelines for service station sites – for sensitive land use (where no NEPM criteria are available, for example, TPH, BTEX).
- US EPA Regional Screening Levels: Residential soil & Industrial soil (November 2010).

Buildings and structures:

- AS2159-1995 Piling – Design and Installation. Standards Australia, 1995. The Land SEPP states that “contamination must not cause the land to be corrosive to or adversely affect the integrity of structures or buildings materials”. Where structures are likely to come into contact with extreme soils, criteria for pH, chloride and sulphate can be adopted from the Piling Code, AS 2159-1995.
- NEPM Ecological Investigation Levels (Interim Urban): NEPM-EIL

Aesthetics:

- The SEPP (PMCL) currently states that “*contamination must not cause the land to be offensive to the senses of human beings*”. Currently there are no concentration based aesthetic criteria for soil however, while aesthetic observations are subjective, it is considered that if there is discolouration or noticeable odours from the soil, or if waste materials such as rubble, slag or similar wastes are present, then a potential aesthetic concern exists.
- The criterion for ammonia has been set based upon the odour threshold of 1000mg/kg.

Production of food, flora and fibre

- The SEPP (PMCL) states that “*contamination must not adversely affect the produce quality or yield or effect the level of any indicator in food, flora and fibre produced at the site (or that may be produced), such that the level of the indicator is greater than that specified by the Australia New Zealand Food Authority, Food Standards Code*”.
- In consideration of the above, the Auditor has primarily assessed the protection of the beneficial use: Production of food, flora and fibre with reference to the phytotoxicity based interim urban EILs (NEPM, 1999). The Auditor also notes that the conditions of the development overlay for the site limits access to soil and therefore the potential for this beneficial use is unlikely to be realised.

Table 4.3 below lists the agreed screening levels used to classify the soil prior to remediation. **Table 4.4** indicates how the agreed screening levels relate to the criteria used to assess the beneficial uses of land.

Table 4.3 Soil classification screening levels in milligrams per kilogram (mg/kg)

Analyte	Class of Material		
	Class 1	Class 2	Class 3
	Maximum Concentration (mg//kg)		
Organics			
TPH C ₆ -C ₉	100	100	>100
TPH C ₁₀ -C ₃₆	1000 ^E	1000 ^E	>1000 ^E
Benzene	1 ^E	1 ^E	>1 ^E
Toluene	3.1 ^E	3.1 ^E	>3.1 ^E
Ethyl Benzene	1.4 ^E	1.4 ^E	>1.4 ^E
Total Xylenes	14 ^E	14 ^E	>14 ^E
Total PAHs	20	100	>100
Naphthalene	-	-	-
Pyrene	-	-	-
Benzo(a)pyrene	1	5	>5
Total Phenols	120 ^A	42500	>42500
Total VHCs	-	-	-
Aldrin + Dieldrin	10	50	>50
Chlordane	50	250	>250
DDT+DDD+DDE	200	1000	>1000
Heptachlor	10	50	>50
Total PCBs ^B	2	2	>2
Inorganic			
Antimony	-	-	-
Arsenic	20*	500	>500
Barium	-	-	-
Beryllium	-	-	-
Cadmium	3*	100	>100
Cobalt	100	500	>500
Chromium ^C	100	500	>500
Copper	100*	5000	>5000
Cyanide	250	1250	>1250
Iron	-	-	-
Mercury ^D	1*	50	>50
Molybdenum	40	40	>40
Nickel	60*	3000	>3000
Lead	300	1500	>1500
Selenium	10	10	>10
Tin	50	50	>50

Analyte	Class of Material		
	Class 1	Class 2	Class 3
	Maximum Concentration (mg//kg)		
Vanadium	-	-	-
Zinc	200*	35000	>35000
Sulphate	2000	2000	>2000
Ammonia	1000	1000	1000
pH	5 – 10+ No less than 4 @ <1m depth	5 – 10+ No less than 3 @ >1m depth	Any

-- No investigation level available

A Golder specific criteria for residential surface soil where there is a potential for consumption of home grown produce.

B This criterion has been set to avoid any issue associated with the requirement to prepare an Environmental Improvement Plan (EIP) for PCB contaminated wastes. Depending on the total mass of PCB wastes on the site, higher contaminant concentrations may be achievable without the need for the EIP.

C Assumes all chromium present as hexavalent chromium. Higher criteria could be acceptable if chromium is in more reduced forms.

D Assumes all mercury present as methyl mercury. Higher criteria could be acceptable if mercury is in inorganic forms.

E NSW EPA Service Station threshold values for sensitive landuses for BTEX and TPH C10-C36 (NSW EPA, 1994)

* Class 1 criteria where NEPM EILs are lower than NEPM A

Table 4.4 Relationship between Soil Classes and Protection of Beneficial Uses

Analyte	Class of Material			Beneficial uses				
	Class 1	Class 2	Class 3	Ecosystem	Human health	Human health	Buildings &	Production of
				Protection	(Sensitive)	(Commercial)	Structures	food
				(mg/l/kg)				
Organics								
TPH C ₆ -C ₉	100	100	>100	65	100	100		65
TPH C ₁₀ -C ₃₆	1000	1000	>1000	1000	1000	1000		1000
Benzene	1	1	>1	1	1	1		1
Toluene	3.1	3.1	>3.1	3.1	3.1	3.1		3.1
Ethyl Benzene	1.4	1.4	>1.4	1.4	1.4	1.4		1.4
Total Xylenes	14	14	>14	14	14	14		14
Total PAHs	20	100	>100		20	100		
Naphthalene*	-	-	-	0.00047	3.6	18		0.00047
Pyrene*	-	-	-	120	1700	17000		120
Benzo(a) pyrene*	1	5	>5	0.24	1	5		0.24
Total Phenols*	120	42500	>42500	6.3	8500	42500		6.3
Trimethylbenzenes (as 1,2,4-)*	-	-	-	0.021	62	260		0.021
Total VHCs	-	-	-	-	-	-		-
Aldrin + Dieldrin	10	50	>50	0.2	10	50		0.2
Chlordane	50	250	>250	-	50	250		-
DDT+DDD+DDE	200	1000	>1000	-	200	1000		-
Heptachlor	10	50	>50	-	10	50		-
Total PCBs ^B	2	2	>2	1	10	50		1
Inorganics								
Antimony**	-	-	-	20	20	20		20

Analyte	Class of Material			Beneficial uses				
	Class 1	Class 2	Class 3	Ecosystem	Human health	Human health	Buildings &	Production of
				Protection	(Sensitive)	(Commercial)	Structures	food
				(mg/l/kg)				
Arsenic	20	500	>500	20	100	500		20
Barium	-	-	-	300	300	300		300
Beryllium	-	-	-	-	20	100		-
Cadmium	3	100	>100	3	20	100		3
Cobalt	100	500	>500	-	100	500		-
Chromium	100	500	>500	1	100	500		1
Copper	100	5000	>5000	100	1000	5000		100
Cyanide*	250	1250	>1250	7.4	250	1250		7.4
Iron	-	-	-					
Mercury	1	50	>50	1	15	50		1
Molybdenum*	40	40	>40	3.7	10	40		3.7
Nickel	60	3000	>3000	60	600	3000		60
Lead	300	1500	>1500	600	300	1500		600
Selenium*	10	10	>10	0.95	390	5100		0.95
Tin	50	50	>50	50	50			50
Vanadium	-	-	-					
Zinc	200	35000	>35000	200	7000	35000		200
Sulphate	2000	2000	>2000	2000			2000	2000
Ammonia	1000	1000	1000					
pH	5 – 10+	5 – 10+	Any					
	>4	>3					5-10+	

Notes:

* Beneficial use criteria taken from US EPA regional screening levels for residential & industrial soils and protection of groundwater SSLs (for ecosystem protection)

4.2 Groundwater

The protected beneficial uses of groundwater are defined in the SEPP *Groundwaters of Victoria* (1997) (SEPP GoV), by the inherent capacity of the groundwater (i.e. TDS concentrations) at the site, to support specific uses.

Background information on the Brighton Group aquifer indicates a TDS of less than 1000 mg/L. Based upon the TDS concentration of 890mg/L in background well 9130009, groundwater at the site is considered to fall primarily within Segment A2 (501 to 1,000 mg/L) as defined by the SEPP (GoV).

Based on the TDS range of 230 to 3900mg/L reported at the site (in the June 2008 GME) it is considered that groundwater beneath the site falls under Segment A2. The beneficial uses protected under Segment A2 are summarised in **Table 4.5** below.

Table 4.5 Protected beneficial uses of groundwater

Beneficial use	Segment (mg/L)				
	A1	A2	B	C	D
	(0 -500)	(501-1,000)	(1,001-3,500)	(3,501-13,000)	(>13,000)
Maintenance of ecosystems	✓	✓	✓	✓	✓
Potable water supply					
▪ Desirable	✓				
▪ Acceptable		✓			
Potable mineral water supply	✓	✓	✓		
Agriculture, parks and gardens	✓	✓	✓		
Stock watering	✓	✓	✓	✓	
Industrial water use	✓	✓	✓	✓	✓
Primary contact recreation (e.g. bathing, swimming)	✓	✓	✓	✓	
Buildings and structures	✓	✓	✓	✓	✓

Notes:

1. The above table is a reproduction of Table 2 from the GoV SEPP (1997).
2. Shading denotes the required beneficial uses to be protected under Segment A2.

4.2.1 Groundwater beneficial use criteria

The following assessment criteria were adopted by Golder during the assessment of groundwater:

Maintenance of aquatic ecosystems:

- For the protected beneficial use of 'maintenance of aquatic ecosystems', the SEPP GoV refers to the relevant SEPP for surface waters. The nearest surface water body is Port Phillip Bay and therefore the relevant SEPP is SEPP WoV Schedule F6 Waters of Port Phillip Bay 1997
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000 - 95% marine aquatic ecosystems protection (ANZECC & ARMCANZ, 2000).

Potable Water Supply, Stock Watering, Irrigation:

- State Environmental Protection Policy (SEPP) Groundwaters of Victoria (SEPP (GoV))
- Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992)
- Australian Drinking Water Guidelines (NHMRC & ARMCANZ, 1996)

Stock Watering and Irrigation:

- The SEPP GoV refers to those criteria specified for livestock and irrigation in the ANZECC 1992.

Primary Contact Recreation:

- State Environmental Protection Policy (SEPP) Groundwaters of Victoria (SEPP (GoV))
- ANZECC 1992, Australian Water Quality Guidelines for Fresh and Marine Waters, guideline criteria for raw water for drinking water purposes for toxicants
- NHMRC and ARMCANZ 1996. Australian Drinking Water Guidelines

Industrial Water Use:

- Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992) has many criteria, however for the purposes of this report it is assumed that the criteria for "primary contact recreation" would be adequately protective of people who might encounter the groundwater from this site in most industrial scenarios.

Building and Structures:

- AS2159-1995 Piling – Design and Installation. Standards Australia, 1995.
- Buildings and structures – SEPP GoV states that "introduced contaminants shall not cause groundwater to become corrosive to structures or building materials". No specific criteria are available for these indicators. However, Australian Standard AS2159 suggests that if pH is below 5.0 (i.e. trending towards acidic conditions), further consideration and discussion may be required.

Table 4.6 below lists the groundwater beneficial use criteria relevant for Segment A2 groundwater.

Table 4.6 Groundwater and surface water investigation levels in milligrams per litre (mg/L)*

Beneficial Use	Maintenance of Ecosystems (mg/L)	Groundwater Extractive Use Criteria (mg/L)			
Chemical	Aquatic (Marine) Ecosystems (95% protection)	Potable Water Supply	Primary Contact Recreation	Irrigation	Stock Watering
pH	6.0 -8.5	6.5-8.5	6.5-8.5	4.5-9.0	6 -8.5
Inorganics					
Arsenic	0.0023 ^B	0.007	0.05	0.1	0.5
Barium	-	-	1	0.1	-
Boron	5.1 ^B	-	1	0.5	5
Cadmium	0.0055 ^E	0.002	0.005	0.01	0.01
Chromium (total)	0.0274	0.05	0.05	0.1	1
Cobalt	0.001	-	-	0.05	1
Copper	0.0013	2	1	0.2	0.4 ^A
Lead	0.0044	0.01	0.05	-	0.1
Manganese	0.08 ^B	0.1	0.1	2	-
Mercury	0.0004 ^B	0.001	0.001	0.002	0.002
Molybdenum	0.023 ^B	-	0.05	0.01	0.15
Nickel	0.07	0.1	0.1	0.2	1
Selenium	0.003 ^B	0.01	0.01	0.02	0.02
Tin	0.035 ^B	-	-	-	-
Zinc	0.015 ^D	3.0	5	2	20
Calcium	-	-	-	-	1000
Sodium	-	-	300	-	-
Sulphate (as SO4)	-	250	400	-	-

Beneficial Use	Maintenance of Ecosystems (mg/L)	Groundwater Extractive Use Criteria (mg/L)			
Chemical	Aquatic (Marine) Ecosystems (95% protection)	Potable Water Supply	Primary Contact Recreation	Irrigation	Stock Watering
Chloride	-	-	400	-	-
Ammonia (as N)	0.9	0.5	0.01	-	-
Nitrate (as N) ^N	14 ^L	11	10	-	30
Cyanide (total)	0.004 ^F	0.08	0.1	-	-
Fluoride	-	-	1.5	-	2
Other Organics					
Anthracene	0.0004 ^B	-	-	-	-
Benzo(a)pyrene	0.0001 ^B	0.00001	0.00001	-	-
Fluoranthene	0.001 ^B	-	-	-	-
Pheneathrene	0.0006 ^B	-	-	-	-
Naphthalene	0.07	-	-	-	-
Total PAHs	0.003 ^I	-	-	-	-
TPH C ₆ -C ₉	10 ^I	-	0.6	-	-
TPH C ₁₀ -C ₃₆	10 ^M	-	0.6 ^M	-	-
Benzene ^M	0.7	0.001	0.001 ^H	-	-
Toluene	0.18	0.8 ^H	0.8 ^H	-	-
Ethylbenzene	0.005	0.3 ^H	0.3 ^H	-	-
Xylenes	0.075	0.6 ^H	0.6 ^H	-	-
Styrene	-	0.03 ^H	0.03 ^H	-	-
Endrin	0.00008	0.001	-	-	-
Endosulfan 1	0.0001	-	-	-	-
Total PCB	ID	-	0.0001	-	-

Beneficial Use	Maintenance of Ecosystems (mg/L)	Groundwater Extractive Use Criteria (mg/L)			
Chemical	Aquatic (Marine) Ecosystems (95% protection)	Potable Water Supply	Primary Contact Recreation	Irrigation	Stock Watering
1,1 Dichloromethane	0.25 ^{BF}	-	-	-	-
Dichloromethane	4 ^{BF}	-	0.004	-	-
1,2 Dichloroethane	1.9 ^{BF}	-	0.01	-	-
1,1,1 Trichloroethane	0.27 ^{BF}	-	-	-	-
1,1,2 Trichloroethane	1.9	-	-	-	-
1,1,2,2, Tetrachloroethane	0.4	-	-	-	-
Vinyl Chloride	0.1 ^{BF}	-	0.0003	-	-
Chlorobenzene	0.055 ^{BF}	0.3	0.3 ^H	-	-
1,2 Dichlorobenzene	ID	-	1.5	-	-
1,4 Dichlorobenzene	0.06 ^{BF}	-	0.04	-	-
1,2,4 Trichlorobenzene	0.08 ^D	-	-	-	-
1,1 Dichloroethene	0.7 ^{BF}	-	0.03 ^G	-	-
1,2 Dichloroethene (cis) (DCE)	-	-	0.06	-	-
Tetrachloroethene (PCE)	0.07 ^{BF}	-	0.01	-	-
Trichloroethene (TCE)	0.33 ^{BF}	-	0.03	-	-
Carbon Tetrachloride	ID	-	0.003	-	-
Hexachlorobutadiene	ID	-	0.0007	-	-
Phenol	0.4	-	0.05 ^I	-	-
2 Chlorophenol	ID	-	0.3	-	-
2,4 Dichlorophenol	0.16 ^D	-	0.2	-	-
2,4,6 Trichlorophenol	ID	0.01	0.02	-	-
Pentachlorophenol	0.022	0.01	0.01	-	-

Beneficial Use		Maintenance of Ecosystems (mg/L)	Groundwater Extractive Use Criteria (mg/L)			
Chemical		Aquatic (Marine) Ecosystems (95% protection)	Potable Water Supply	Primary Contact Recreation	Irrigation	Stock Watering
2,3,4,6 Tetrachlorophenol		ID	0.001	0.001	-	-
*	Except where noted					
-	No investigation level available.					
A	The criteria used were the most sensitive criteria for the range of criteria for a variety of livestock					
B	Values based on low reliability toxicity and should be used with caution					
D	May not protect key test species from chronic toxicity					
E	The values have been calculated using a hardness of 30 mg/L CaCO ₃					
F	Based on ANZECC 2000 data for fresh and marine waters.					
G	Based on more recently published guidelines in Australian Drinking Water Guidelines (NHMRC & ARMCANZ, 1996)					
H	Based on 1996 Drinking Water Guidelines for health but not protective of aesthetics.					
J	NSW EPA Guidelines for Assessing Service Station sites – value based on odour and aesthetics, due to formation of visible sheen.					
K	Major ions which occur naturally in groundwater (among others).					
L	Due to the low reliability of ANZECC ecosystem nitrate criteria for both fresh and marine waters, the Auditor has reviewed background nitrate conditions at the site which range between 6 and 14mg/L nitrate (as N) the auditor believes that a criterion of 14mg/L is more reflective of these background conditions than the low reliability ANZECC criterion adopted by Golder (7.2 mg/L for nitrate as N, contained in the ANZECC 2000 memorandum for freshwater ecosystem protection). Additionally, it is unlikely that groundwater impacts emanating from the site will affect Port Phillip Bay and therefore the Auditor has adopted a value of 14mg/L for nitrate.					
M	It is noted that risk based criteria were calculated by Golder to assess vapour migration from groundwater; in particular TPH >C10 & benzene					
N	See discussion regarding nitrate as N in section 4.2.1 above					
ID	Insufficient data to derive a reliable trigger value					
ND	Not determined, insufficient background data to calculate					

4.3 Surface water

The SEPP GoV refers to the relevant SEPP for surface waters, in this case the SEPP Waters of Victoria – Schedule F6 Waters of Port Phillip Bay 1997 (SEPP WoV F6), which lists the beneficial uses of waters at the groundwater discharge point that need to be protected. The site is located within the inshore segment and the beneficial uses protected under the Inshore Segment of Schedule 6, are shown in **Table 4.7** below:

Table 4.7 Surface water protected beneficial uses

Beneficial use	Segment					
	Aquatic reserves	Corio	Hobsons	Werribee	Inshore	General
Maintenance of aquatic ecosystems and associated wildlife						
- Natural ecosystems	✓					
- Substantially natural ecosystems with some modification					✓	✓
- Highly modified ecosystems with some habitat values		✓	✓	✓		
Water based recreation						
- Primary contact	✓	✓	✓		✓	✓
- Secondary contact	✓	✓	✓	✓	✓	✓
- Aesthetic enjoyment	✓	✓	✓	✓	✓	✓
Production of molluscs for human consumption						
- Natural populations	✓					✓
- Aquaculture	✓				✓	✓
Commercial and recreational use of edible fish and crustacean	✓	✓	✓	✓	✓	✓
Navigation and shipping	✓	✓	✓	✓	✓	✓
Industrial water use		✓	✓	✓	✓	✓

The Auditor is satisfied that the beneficial uses of the likely receiving surface water body (Port Phillip Bay) are appropriately protected by the application of the groundwater quality levels presented in **Table 4.6**. It is considered unlikely that groundwater impacts emanating from the site will reach Port Phillip Bay, for the following reasons:

- The estimated groundwater flow velocity (0.37 – 3.7 m/year) is such that it is unlikely contamination will reach the Bay within 1000 years, by which time it will have been attenuated to such a degree as to have no real impact on the Bay;
- There is likely to be significant natural attenuation, retardation and biodegradation of groundwater contaminants before reaching Port Phillip Bay over 3.5km down hydraulic gradient of the site; and

- Groundwater contaminant levels offsite (down hydraulic gradient) are reported to be significantly lower than onsite, providing evidence of natural attenuation within the aquifer.

4.4 Auditor review of appropriateness of assessment of beneficial uses

The Auditor is satisfied that the beneficial uses of Land, Groundwater and Surface water have been appropriately assessed and will be protected by the application of the soil and groundwater quality objectives presented in **Sections 4.1 and 4.2** above.

5. Site assessment and soil remediation

Stages 2 and 2A were assessed and remediated as a single Stage (known as Stage 2) and were subject to a number of phases of investigation including:

1. Initial assessment – a combination of gridded and targeted sampling conducted from 1994 to approximately 2004. Various entities undertook site assessment works including Gas and Fuel, Gascor and Golder Associates (**Figure 15, Appendix A**).
2. Site Remediation and Validation Services as contained in Golder (2001) Performance Specification for Remediation of the Former Highett Gasworks (Revision 1), September 2001 Report No. 01613573/002. This included:
 - a) Baseworks (areas of known soil impacts to be removed/remediated);
 - b) Additional works (excavations) – chasing out services and contamination (**Figure 16, Appendix A**); and
 - c) Remediation and validation (**Figures 17 and 18, Appendix A**).

5.1 Outline of site investigation/remediation strategy and site management

The Site Performance Specification (**Golder, Sep-01**) (hereon referred to as the 'Specification') provided the strategy for assessment and clean-up of the site, and the Thiess Site Management Plan (known as the Construction Environmental Management Plan – CEMP) provided the detailed plans for various processes and activities associated with the remediation of soil onsite.

It is noted that at the time of publication of the Specification, the favoured remediation strategy was the use of onsite repositories. Therefore the Golder Specification does not outline the Enhanced Thermal Conduction process (ETC) that was ultimately used at the site; this is included in the Thiess CEMP.

5.1.1 Site performance specification (Golder, 2001)

The objective of the Specification was to define a strategy which complied with all relevant Victorian and Federal legislation, policies, guidelines and standards, and to provide sufficient information to satisfy the Auditor that clean up objectives have been achieved.

Table 5.1 below provides a summary of pertinent points outlined in the Specification.

Table 5.1 Summary of performance specification for remediation

Sub heading	Summary
Introduction	Includes a brief history of the site, the aim and scope of the document, and the relevant regulatory and site specific publications. It is noted that the specification is designed around the proposed redevelopment of the site for two separate developments – Lot 1 (southern portion of the site): Commercial & Lot 2(northern portion of the site): Medium density residential.
Overall strategy for	The overall strategy for remediation of the site was:

Sub heading	Summary
clean up	■ Undertaken sufficient clean up and validation to: ▶ Provide a site suitable for the intended Medium Density Housing and Commercial (classified as “Business 3” in the 2001 Local Planning Scheme) land use; and ▶ Demonstrate that the site has been remediated to the extent practicable; ■ Re-use contaminated soil onsite where possible; and ■ Assess the condition of groundwater and remediate or manage groundwater to achieve a Certificate or Statement of Audit. <i>Auditor comments:</i> <i>It is noted that at the time of drafting of the Specification, the intention was to develop an onsite repository for storage of excavated materials deemed not suitable for re-use (ie Class 3 materials), and no active remedial treatment (such as enhanced thermal treatment) was proposed.</i> <i>The strategy for groundwater was based on the removal of sources of identified groundwater impact. In 2001 the main sources of impacts were identified as the former Tar Dam, the former Liquor Tank and the Carburetted Water Gas Plant.</i> <i>Thiess Services was contracted by the Department of Treasury and Finance through VicUrban to undertake the remediation works.</i>
Classification of soils	Provides a definition of material classes and uses based on the degree of risk to the health of future onsite users based on mixed commercial and residential uses. Criteria for asbestos, ammonia, sulphate and phenol were based on a qualitative assessment (including, odour, risk to foundations, visual impact). The contaminant criteria were applied to either averages or 95% UCL on the mean (where enough data available) of the domain and depth interval of interest. ‘Hotspots’ were defined as locations with contaminant concentrations up to 5 times the criteria for a domain and depth interval in which it was located.
Remediation process	Data requirements: a final soil sampling density of one sample per 30m grid size. Soil remediation decision process: based on the soil classifications nominated above: Class 1 can remain at any depth; Class 2 can remain at depths greater than 1m but must be remediated if above 1mbgl; Class 3 must be remediated or removed. Some potential hotspots may remain in situ based on the following: ■ Potential hotspots will be assessed based on the risk posed to contaminant migration to groundwater and may remain in situ if the risk to groundwater is considered to be acceptably low. Demonstration of acceptable risks to groundwater will be shown when: ▶ The soil contaminants are of acceptably low mobility (through leachability testing); ▶ Soil is not in contact with groundwater; and/or ▶ The groundwater is not impacted by the potential hotspot; and/or ▶ Any groundwater impacted by site soil exceeding the contaminant criteria is assessed as not impacting on the receiving surface water body (e.g. by conducting a risk assessment). Remediation will include the following: ■ Excavation of materials in 0.5m to 1.0m increments. ■ Validation of excavations: ▶ Excavation of a significant portion of a domain – classification/validation based on a 20m grid; and ▶ Excavation of a hot spot - in situ classification/validation based on a 10m grid (for example, for a 30m x 30m excavation, 4 base samples and 8 wall samples would be included in the validation of the excavation).

Sub heading	Summary
	- Sampling of stockpiles & reclassification: - Soils of different classifications will be stockpiled separately; - Soil may also be stockpiled separately if the soil appears inconsistent with anticipated conditions; and - Stockpile sampling rate of one sample per 100m³ of material. - Re-use onsite or offsite disposal: - Onsite re-use where classification and depth allows; and - Offsite disposal of material unsuitable for onsite re-use. Additional remediation management procedures will be included in the Construction Environmental Management Plan (CEMP): The CEMP will cover day to day site management and include procedures for specific tasks (see Table 5.3 for summary of relevant procedures and sections of the Thiess Management Plan). Onsite material tracking: The classification and reuse of materials onsite requires a robust tracking system to be managed by the remediation contractor (Thiess). The system should be able to track the following: - Source and destination of materials including excavations, stockpiles, backfilling, site grading, truck movements; - Survey of any excavations showing extent (both lateral and vertical); - Survey of any excavation backfilled with Class 2 material to show 1m separation layer; and - Photographic record to substantiate the excavation information.
Quality control	Data quality objectives: - Accuracy: 75-125% recovery; - Precision: +/- 50% RPD; - Field splits and duplicates collected at a frequency of at least 1 in 20; - Overall completeness (percentage of total number of samples analysed that produce acceptable data) should be a minimum of 95%; - Limits of reporting: a maximum of 1/5, and preferably 1/10 of the acceptance criteria concentration; 1 laboratory duplicate, 1 spike, 1 method blank per analytical batch or per 20 samples; - Field duplicates collected at a rate of 10% of all samples – half analysed by the primary laboratory & half by the secondary laboratory; - Equipment blanks collected at a rate of 1 per day per field crew during sampling; - Field blanks to be collected whenever dusty or odorous conditions prevail; and - Samples to be placed in appropriate containers, stored on ice, and transported under a chain of custody procedure.
Statement of environmental audit	The end point for remediation of the site will be the statement of Audit
Liaison with auditor	The Auditor will overview the technical aspects of the remediation works

5.1.2 Site management plan (Thiess, 2005)

The Thiess CEMP for Highett Gasworks Remediation Project, (Thiess Services, Jul-05) provided management plans and procedures associated with specific activities relating to the handling of materials and remediation of the site. **Table 5.2** below provides a table of content for the CEMP document and **Table 5.3** provides detail on the various plans and procedures relevant to the environmental management of the site. The auditor reviewed the Management Plan on **13 July 2005** and considered the plan adequate with a few minor corrections. Once the CEMP was approved by the Auditor and EPA, a Pollution Abatement Notice (see **Appendix G**) was issued by EPA as a management tool for any potential detrimental effects associated with the construction and running of the ETC plant. Part of the PAN requirements included the reporting to EPA of Thiess's environmental performance against the CEMP. In total 16 Thiess reports were submitted to EPA. These reports were also reviewed by the Auditor (see **Appendix H** for record of Auditor review).

Table 5.2 Table of Content - Site Management Plan

Section	Sub Headings
1.0	Management Overview
2.0	Health & Safety Management
3.0	Environmental Management
4.0	Emergency Response Management

Table 5.3 Site Management Plan – Programs & Procedures

Environmental management programs	Relevant work procedures	Comments
Atmospheric emission	Air Quality Management Plan (TS-OPS-034015-WP02)	The objective was to minimise and control emissions to air including dust, exhaust, stack and vapour emissions.
	PM10 action levels	Air Quality Response Level 1(AQRL1) – 50% increase above the difference between the background concentration and 0.05mg/m3 AQRL2 – 90% increase above the difference between the background concentration and 0.05mg/m3 Max AQL – 0.05mg/m3 Instantaneous – 5mg/m3 1-hour average – 2mg/m3
	Deposited dust action levels	AQRL1 – 1g/m2/month increase above the background concentration with a maximum total of 3g/m2/month AQRL2 – 1.8g/m2/month increase above the background concentration with a maximum total of 3.8g/m2/month Max AQL – 2g/m2/month increase above the background concentration with a maximum total of 4g/m2/month
	Thermal Plant Stack emission action levels	Commissioning & monthly: CO – MaxAQL – 0.116g/s During commissioning only: NOx – 1.16g/s SOx – 0.116g/s TOCs – 0.058g/s

Environmental management programs	Relevant work procedures	Comments
		Benzene – 0.025g/s Particulates – 0.116g/s
Odour control	Air Quality Management Plan (TS-OPS-034015-WP02)	The objective was to minimise and manage objectionable odours beyond the site boundaries.
Groundwater and Surface water protection	Water Management Plan (TS-OPS-034015-WP03)	The objective of the surface water plan was to minimise the contaminant load in water prior to the re-use onsite or release offsite.
Noise emission	Noise Management Plan (TS-OPS-034015-WP01)	The objective was to minimise the impact of site generated noises and comply with relevant regulatory requirements. Night Period Noise Limit: 41 dBA Site Boundary compliance level: 53 dBA
Vibration	Noise Management Plan (TS-OPS-034015-WP01)	The objective was to control vibration generated from site operations.
Contaminated material	Contaminated Materials Management Plan (TS-OPS-034015-WP06) Enhanced Thermal Conduction Operations (TS-OPS-034015-WP07) Water Management Plan (TS-OPS-034015-WP03)	The objective was to minimise the impact of contaminated soils on clean soils. Contaminated Materials Management Plan Key objectives of this plan were: ■ To detail procedures and processes for the onsite management of excavated material; ■ To document the procedures for testing and classification of contaminated materials; ■ To describe the measures to minimise the loss of waste constituents to the environment (volatiles, dust, leachate generation); and ■ To track materials from 'cradle-to-grave'. Enhanced Thermal Conduction Operations The ETC plant was designed to heat the soil to a temperature of approximately 750C where organic contaminants were volatilised and pyrolysed. Volatilised gases were oxidised in the recuperative thermal oxidiser at temperatures of not less than 760C where they broke down into water and carbon dioxide. ETC treatment targets were set at Class 1 concentrations for organic contaminants of concern.
Traffic and public road maintenance	Community Relations Plan (TS-OPS-034015-WP04) Water Management Plan (TS-OPS-034015-WP03)	The objective was to minimise the effect of soil/mud on local public roads.
Waste disposal	Waste Tracking for Non-Liquid Wastes (TS-OPS-034015-WP05)	The objective was to minimise the amount of waste generated from site activities not associated with soil remediation.

Both the Specification (Golder, July 2001) and CEMP (Thiess, 2005) were reviewed and approved by the Auditor (see **Appendix G** for record of review).

5.2 Soil assessment

Numerous soil investigation reports have been reviewed for the site. The reports and scope of the investigations are provided in **Appendix D**.

During the various phases of site assessment, potential sources of site contamination were identified from the storage/disposal of gas works waste (tars, sludges, lampblack, light oils and spent oxide waste). Soil assessments were performed between 1994 and 2004 with further assessment of the gas main easement taking place in 2008.

Many of the site investigations prior to 2004 were based on a combination of gridded and targeted sampling for both soil and groundwater and resulted in a sampling density of approximately 18 locations per hectare and a sample grid size of approximately 23m (based on 132 soil sampling locations across the site). The Site Performance Specification (**Golder, Sep-01**), stipulated a final sample density of one sample per 30m grid size. In 2004 Golder conducted a review of existing soil assessment data in a report titled Further Soil Contamination Investigation to Support Environmental Audit (**Golder, Aug-04**), and conducted further investigation works to fill any data gaps identified in the review. This included an additional 234 soil sample locations and the laboratory testing of over 420 primary samples. The 2004 investigation resulted in a sample density of at least one sample location per 30m grid across the Stage 2 and 2A area.

It is noted that during additional works undertaken to remove underground services and structures and associated contamination, the sampling density noted above was exceeded via a combination of targeted and grid sample locations (and validation samples).

5.2.1 Summary of soil conditions pre-remediation

With the completion of site assessment investigations in 2004 (except for additional investigations conducted in 2008 related to the gas main easement), Golder (**Golder, 22-Jul-11**) produced a number of figures summarising the vertical and lateral distribution of inorganics (pH, metals, sulphate) and hydrocarbons (BTEX, TPHs, PAHs, phenols) prior to remediation works commenced. **Figures 20A & B** (Appendix A) provide a snapshot of soil conditions (inorganic and organic) respectively at this time.

Figure 20A shows that the distribution of inorganic contaminants were concentrated along the southwestern, southern and northern site boundaries. This distribution may have reflected the location of historic structures or processes such as the purifiers in the southern portion of the site (and locations where spent oxides may have been stockpiled (revivified) prior to re-use) and the tar treatment plant and oil tanks in the northern portion of the site. The purifiers removed sulphur from the gas and generated wastes such as sulphur and cyanide (Prussian Blue) impacted solid spent oxides.

The distribution of organic hydrocarbon based impacts in soil (**Figure 20B**) appeared to be more associated with the former tar dam (southeastern site boundary), the CWG plant, tar separators and effluent holding tanks located along the northwestern site boundary.

5.3 Soil remediation

The remediation process is set out in detail in the Specification for the remediation project (**Golder, Sep-01**). The process included an environmental assessment of the site, and then two stages of remediation:

- base works - remediation of known impacts (as of 2004) and validation sampling of these excavations; and
- additional works - remediation of additional impacts identified during the excavation of baseworks impacts, and further validation of additional works excavations.

The excavated contaminated material was either treated onsite using the Enhanced Thermal Conduction (ETC) unit run by the contractor or was disposed offsite if the material could not be treated by the unit. As a part of this remediation process historical underground services identified were further investigated and where found, removed and validated in line with the Specification. **Appendix D** provides a summary of reports relating to remediation works.

Redevelopment of the site in the 1970s - 1980s included the decommissioning of most above ground gasworks infrastructure, some below ground infrastructure, removal of approximately 28,000m³ impacted soil, and construction of the Research and Training facilities.

The remediation process can be divided into a number of components (**Figure 19, Appendix A** is a flow diagram of the remediation process):

- Excavation (a total of approximately 136,000 tonnes of soil was excavated from the site)
- Treatment (71,000 tonnes)
- Re-use (35,000 tonnes re-used directly, 71,000 tonnes re-used after treatment)
- Offsite disposal (30,000 tonnes)
- Importation of clean fill material (21,400 tonnes (14,260 m³))
- Gas main easement (not included in **Figure 19, Appendix A**)

During the excavation/stockpiling process, over 2,300 validation samples and over 3,000 stockpile samples were analysed.

5.3.1 Excavation and stockpiling

Approximately 136,000 tonnes of soil was excavated as part of the remediation of Stages 2 and 2A and 35,000 tonnes of this material was directly reused onsite at depth as Class 2 soil.

Excavation and stockpiling of soil was conducted in accordance with the Performance Specification (**Golder, Sept 2001**) and CEMP (**Thiess, July 2005**) and is detailed in the Environmental Assessment and Remediation report prepared by Golder (**Golder, 22 July 2011**).

The Auditor or auditor's representative conducted numerous site inspections to observe and confirm that the correct field practices and materials management were being implemented in accordance with the Specification and CEMP. A summary of site visits and photographs is included in **Appendix F**.

Stockpiles were sampled at a rate of 1 sample per 100m³ of material and tested for a general screen of contaminants including pH, metals, sulphate, ammonia, Total Recoverable Hydrocarbons (TRHs), Polycyclic Aromatic Hydrocarbons (PAHs), Monocyclic Aromatic Hydrocarbons (MAHs), phenols and cyanide.

A number of excavations posed specific issues related to depth of impact, unusual discolouration, and elevated sulphate concentrations, which required Auditor input and are discussed below.

5.3.1.1 Excavation 142

During early excavation works (conducted in 2005 and early 2006) chasing out soil impacts associated with underground services, a purple discolouration was observed in the walls of excavation 142 located in the southern portion of the site (**Appendix F and Figure 18, Appendix A**). Based upon historical site plans (**Figure 5, Appendix A**) excavation 142 was situated beneath the approximate location of the Number 1 gasholder and oxide shed. Therefore the purple discolouration may have been associated with contamination from spent oxides in the form of Prussian Blue (potassium ferrous ferricyanide).

A general contaminant screen of this material did not identify the cause of the discolouration or explain why the colour faded over time (**Golder, 16-May-2006, Appendix G**). Laboratory tests were conducted to assess if oxygen or light were the trigger for the colour fade, the test results were inconclusive.

The Auditor reviewed the Golder report on the excavation (**PB, 25-May-2006, Appendix G**) and concluded that the majority of stockpiled material from excavation 142 (three separate stockpiles) could be re-used onsite as Class 1 or 2 material. The Auditor noted that the elevated sulphate concentrations reported in one of the stockpiles would require the following actions: the completion of leachability testing; further discussion with EPA regarding the suitability of this material for onsite re-use; and conditions on the statement of audit relating to the long-term management of this soil.

A review of correspondence and reports provided by Golder indicate that no sulphate leachability testing was undertaken in response to the Auditor recommendations. However, extensive validation of the excavation was conducted in compliance with the Specification and Auditor advice.

Appendix G includes the Golder letter report (**Golder, 16-May-2006**) relating to excavation 142 including time lapse photographs showing the gradual fading of the purple discolouration.

5.3.1.2 Elevated sulphate in soils

The Specification for the site outlines sulphate screening criteria of 2000 mg/kg for both Class 1 and Class 2 material. This criterion has been established for the protection of buildings and structures, and groundwater. During remediation works it became evident that this criterion would result in large volumes of otherwise suitable material being removed from site to landfill.

By 2006 approximately 7,500m³ of sulphate impacted material had been removed from site and disposed of as either Contaminated Soil (Low Level) or Contaminated Soil (EPA Bulletin 448.1). In 2006 Golder, (17-Aug-2006) produced a report on reuse of sulphate impacted soil for auditor review. By this time over 3,300m³ of soil was stockpiled onsite with sulphate concentrations of over 2,000mg/kg. All other contaminants of concern were reported at or below Class 2 criteria.

In assessing the impact of sulphate of greater than 2000 mg/kg to groundwater consideration was made of existing sulphate concentrations, prior to remediation, together with the observed sulphate concentrations in groundwater beneath the site. This review indicated that high sulphate values have been found consistently in soil across the site and although groundwater at the site has been shown to be impacted with sulphate, the extent of this impact has been limited to within the site boundary. This suggested that the sulphate is of apparent low mobility.

Elevated sulphate concentrations in groundwater are generally located in the south west corner of the site (BH4, BHF31 and 9050001). Of the 7,500m³ of sulphate impacted material removed from the site, the majority originated from excavations 010, 107 and 114 located in the south west corner of the site. Therefore the Auditor considered that the bulk of elevated sulphate soil apparently associated with elevated groundwater concentrations had already been removed from the site, thus reducing the risk of ongoing leaching of sulphate to groundwater.

It was noted that given the widespread nature of soil sulphate impacts, any Statement of Environmental Audit prepared for the site would require the inclusion of a condition relating to the need for protection of buildings and structures.

In conclusion, the Auditor and EPA agreed that rather than remove and dispose offsite all material with individual sulphate concentrations of greater than 2000 mg/kg, that material with a mean or 95% UCL of around 2000 mg/kg would be considered suitable for reuse at the site as Class 2 material.

5.3.1.3 Excavation 002 – Tar Dam (deep excavation)

The former tar dam was located on the eastern boundary, immediately adjacent to Leigh Mardon commercial business (See Figure 23, Appendix A). Due to the historic storage/disposal of coal tar at this location, it was anticipated as early as 2004 (PB, 6-Sep-2004, Appendix G) that the vertical and lateral extent of contamination would extend to the site boundary with Leigh Mardon to the east, and may extend below the top of the water table beneath the dam. Therefore pile support was required to stabilise the excavation and protect the buildings and workers on both the Audit site and Leigh Mardon.

Test pitting of the tar dam was completed in June 2007 to estimate the nature of contamination and volumes of material to be excavated. The test pits indicated that hydrocarbons (PAHs, TPHs, BTEX) were the main contaminants of concern in this area.

Once piling of the boundary with Leigh Mardon was completed excavation of the tar dam commenced in November 2007. The Auditor and/or representative conducted field inspections of the tar dam excavation in October, November and December 2007. Golder, in Appendix K (Golder, 22-Jul-2011) provide photographic records of the residual soil impacts left in situ on the sides and base of the excavation.

The tar dam was excavated to a maximum depth of 6.5mBGL, just below the top of the water table (at approximately 6mBGL). Under Auditor direction/advice, the excavation was

terminated at this depth and considered remediated to the extent practicable. It was acknowledged by all parties that residual soil impacts would be left in situ beyond the limit of excavation. More information regarding the final condition of soil impacts associated with the tar dam is included in **Section 8.4**.

5.3.1.4 Excavation 189 - northwest corner (deep excavation)

Excavation 189 was located in the north west corner of the site in the vicinity of the former above ground tank farm (comprising water and liquor tanks and below ground pumps, in ground effluent pond and relief holder). Based on these historic uses, potential contaminants include: tar oils; ammoniacal liquor; blow down liquors containing arsenic, nickel, iron; and other tar distillates.

Excavation 189 was opened in October 2006 as excavation 019 and includes numerous excavations including Excavations 019, 018, 023, 024, 077, 213, 203, 210 and test pits TP7, TPBW024 and service trenches S469, S465, S468, S537, S506.

During remedial works it became apparent that contamination extended below the water table (~6.5mBGL). Due to stability and occupational health and safety issues, it was deemed appropriate that the excavation be kept open for as short amount of time as possible. Other safety measures were put in place such as fencing and benching.

The methodology for remediation of Excavation 189 was endorsed by the Auditor in the May 2007 workplan which allowed for excavation to the extent practicable (below water table) and collection of validation samples.

It is noted that test pits in the base of the excavation extended below the water table to a depth of 9.1mBGL and reported minimal impacts at this depth (below Class 2). However residual Class 2 and 3 impacts remain in situ at depths of between:

- 3 and 7.6mBGL due to the presence of the water table; and
- 1 and 3mBGL due mainly to the proximity to the gas main infrastructure located on the northern and southern boundaries of the excavation as shown on **Figures 17, 21 and 23**.

More information on the validation of excavation 189 is provided in **Section 8.5**.

In April 2008 a risk assessment was undertaken in order to confirm if residual material left beyond the limit of excavation in both the tar dam (002) and excavation 189 would pose an unacceptable risk to future onsite and current offsite users. A synopsis and discussion of the various risk assessments conducted for the site is included in **Section 9**.

5.3.2 Treatment - Enhanced Thermal Conduction (ETC) process

Approximately 71,000 tonnes (101 batches) of material was excavated and treated by the Enhanced Thermal Conduction (ETC) process by Thiess Services from commissioning on 28 March 2006 until the last batch was processed in June 2009. The material treated contained elevated organics (Class 2 or 3) which were stockpiled prior to treatment based on their Class and source location.

Various correspondence was entered into with the Auditor in May 2006 (**PB, 17-May-2006**) based on results of stockpile classification pre and post screening to remove the >50mm

fraction. Golder argued that in some circumstances (particularly with regard to material stockpiled from Stage 1) Class 3 stockpiled material could be re-classified as Class 2 or 1 after the >50mm fraction had been screened out without any thermal treatment. Therefore Golder suggested that this material did not need to be treated and could be immediately re-used onsite.

The Auditor reviewed the data Golder presented and concluded that:

"...the data shows that the screening process does not significantly impact upon average COC concentrations (BaP, PAHs, TPH>C9) in the stockpiles. In fact, average concentration of BaP and total PAHs already meets class 2 criteria in the in-situ and stockpiled data sets. Screening does reduce the variability (standard deviation) of the sample results, although it does not reduce the standard deviation to below 50% of the class 2 trigger values as recommended in schedule 7(BA) of the NEPM."

And

"...[the Auditor was] not satisfied that the screening process alone is sufficient to meet class 2 requirements for those stock piles. Given the variability of the soil in other (Stage 2) derived stockpiles awaiting screening and treatment, the decision to treat or not to treat should be taken on a batch by batch basis." **(email sent from Auditor to Golder 17-May-2006)**

The ETC unit consisted of several components including:

- Two process pads (concrete slabs) on which the batches (approximately 700 tonne) were constructed in layers interbedded with a series of manifolds and lateral pipes through which hot air could be pumped to heat up the pile. While one batch was being treated, another batch was being constructed on the second pad.
- A three-tier primary burner skid generated the hot air used to heat the batch to approximately 750 C.
- Quonset hut is the furnace structure that covers the batch, protecting it from outside climatic conditions, and capturing the volatilised and pyrolysed water and organic contaminants liberated from the pile by the heating process.
- The induced draft fan extracts the vapours from the Quonset hut and passes them through a recuperative thermal oxidiser at approximately 760 C where the vapour is converted to carbon dioxide and water which is eventually released to the atmosphere via the stack.

Once the batch has been treated it is cooled and then validated at a density of approximately 14 samples per batch and a Classification assigned. The target treatment criteria were based on Class 1 organic concentrations, however, Class 2 material was considered acceptable if appropriately re-used onsite (below 1m of final surface level).

It is noted that any material assigned Class 3 status due to inorganic impacts (with the exception of sulphate) required offsite disposal as the ETC process could not remediate inorganics.

Overall the Auditor was satisfied that all material treated via the ETC process reached Class 1 or 2 for organics. In addition, this material was appropriately tracked and re-used onsite in accordance with the Specification and agreed target soil profile.

5.3.2.1 Asbestos

All asbestos pipes, pits and other building materials on the site containing asbestos were removed and disposed of by an appropriately licensed subcontractor. Any asbestos fragments found in fill material were assessed and managed in accordance with Victorian EPA guidelines for Fill Material in the EPA Industrial Waste Strategy, WM10/88, Waste Management Guide, Transport and Disposal of Asbestos Waste”.

The Auditor notes that WorkSafe issued an Improvement Notice on 24 March 2009 regarding the handling of asbestos material onsite. As a consequence, the asbestos material (pipes) was bagged and removed as appropriate and site personnel were trained. WorkSafe confirmed compliance with the Notice on 27 March 2009. No other issues were noted relating to asbestos management onsite.

During numerous site inspections conducted by the Auditor, only minor non-fibrous fragments of asbestos cement sheeting were noted to be present in the soil profile.

5.3.2.2 Residual soil contamination - leachability

The Specification (**Golder, July 2001**) outlines the use of leachability testing of contaminants of concern that may be impacting on groundwater beneath the site.

“Some potential hotspots may remain in situ based on the following:

- *Potential hotspots will be assessed based on the risk posed to contaminant migration to groundwater and may remain in situ if the risk to groundwater is considered to be acceptably low. Demonstration of acceptable risks to groundwater will be shown when:*
 - ▶ *The soil contaminants are of acceptably low mobility (through leachability testing);*
 - ▶ *Soil is not in contact with groundwater; and/or*
 - ▶ *The groundwater is not impacted by the potential hotspot; and/or*
 - ▶ *Any groundwater impacted by site soil exceeding the contaminant criteria is assessed as not impacting on the receiving surfacewater body (e.g. by conducting a risk assessment).”*

Golder conducted leachability testing of metals and cyanide to further assess acceptable concentrations of these compounds to remain in-situ and to further assess concentrations suitable for reuse in stockpiled soils. No leachability analysis was conducted on organic compounds or sulphate either in residual soil or in treated material.

5.3.3 Backfilling and re-use

Backfilling was undertaken using treated materials from the site and other materials imported on to the site. The backfilling was undertaken under Level 1 supervision Level 1 Testing in accordance with AS 3798 - 2007 “Guidelines on Earthworks for Commercial and Residential Developments”. A Level 1 Geotechnical Inspections and Testing report was produced by Golder report on 17 December 2009. Golder established a temporary onsite NATA registered laboratory to monitor and conduct various geotechnical tests as required.

Fill used onsite included:

- Stockpiled material originating from site with an environmental classification of Class 1 or 2;
- Treated Class 3 material re-classified as Class 2 or better; and
- Imported fill.

All these materials had to be environmentally appropriate (imported “clean fill”, or Class 1 or 2 stockpiled material) as well as satisfying the geotechnical requirements as outlined in the Golder report (**Golder, 17-Dec-2009**).

Any Class 2 soil reused or remaining onsite was placed below 1 metre of the final surface level of the site. The placement of this material was verified through survey and materials tracking records collected by Thiess.

Where excavations extend below the water table (Excavations 189 and 002), Class 1 material was used to fill the excavation to the top of the water table to reduce the risk of groundwater contamination for direct leaching of Class 2 material. For example, the water table in excavation 189 was expected to be at approximately 6.9mBGL and Class 1 material was used to fill the excavation to a depth of 6mBGL to account for any fluctuation in groundwater elevation. Once excavations were brought up above the water table, Class 2 material could be used (in accordance with the Specification) until 1 metre below surface level.

5.3.3.1 Imported clean fill

Approximately 14,261 cubic metres of material was brought onto the site to make up for material considered to be unsuitable to remain at the site. This material was sourced from three locations:

- 15-19 Claremont Street, South Yarra (4,761 m³ of material);
- 2-4 Haneby Street Brighton (6,500 m³ of material); and
- Boral Lysterfield Quarry (3,000 m³ of material).

Prior to the material being brought onto the site a brief site history of the source site and analytical (contaminant) testing in line with relevant EPA Bulletins for the Classification of Fill, (**Publications 448.1 and 448.3**) was conducted.

Approximately 4,761 cubic metres of material sourced from 15-19 Claremont Street, South Yarra was imported to site in November 2005 and comprised of orange brown Silurian aged siltstone. Laboratory analysis of potential contaminants indicated the material was suitable for use as clean fill (more information regarding this material is contained in **Appendix I** of the Golder report (**Golder, 22 July 2011**)). The Auditor was satisfied with both the environmental quality of the imported material and that it was aesthetically compatible with the native soils at the site.

Approximately 6,500 cubic metres of clean fill from 2-4 Haneby Street Brighton was imported in January 2009. This comprised of natural sandy clay and clayey sand from the Brighton Group. The Auditor reviewed the laboratory certificates (contaminant) for this material and

visited the source site prior to importation on 12 November 2008, and was satisfied with the quality and aesthetics of the material.

In August 2009 approximately 3,000 cubic metre of Devonian aged siltstone (Humevale Formation) from Boral Quarry was imported onsite. The Auditor reviewed the laboratory certificates of this material prior to importation and was satisfied with the quality and aesthetics of the material.

5.3.3.2 Imported material from Stage 1

By December 2005 between 2,000 and 4,700 cubic metres of material from Stage 1 had been stockpiled on Stage 2. No validation of the stock pile had been undertaken, however assessment and validation results from the Stage 1 audit area, had effectively shown the material to be suitable for reuse as Class 1 material.

Golders sought advice from the Auditor in late 2005 and early 2006 regarding the reuse of this material.

The Auditor indicated that due to aesthetic impacts (in the form of pipes and rubble), the material could only be reused within Stage 2 as Class 2 material. However, once the material was screened of particles greater than 100mm, and inspected by the Auditor's assistant (on **23 Jan 2006 (Appendix G)**), the Auditor agreed that the material could be used as Class 1 material on Stage 2. The Auditor also noted that:

"...To confirm the suitability of the fill, ... a management plan should be implemented that allows for, and documents, regular inspections of the screened material. [Including Auditor] inspection of the screening operation to confirm it's effectiveness in removing the aesthetic impacts."

Subsequently all the material imported from the Stage 1 audit area was reused on Stage 2 after screening was conducted.

5.3.3.3 Imported material from Sir William Fry Reserve

Due to the likely presence of gasworks related impacts in soil on Sir William Fry Reserve (SWFR), in July 2008 DTF and the Auditor met with EPA regarding the generation of waste soil materials from the laying of the Alinta gas main in Sir William Fry Reserve and the potential treatment of this material on the Stage 2 site by Thiess as part of Highett Remediation Project. As discussed in more detail in **Section 5.3.5** below, the soil was found to be impacted with hydrocarbons (PAHs, TPHs and phenols) as well as cyanide and metals. In **November 2008 EPA (EPA, Nov 2008)** approved the importation of soil material from SWFR to the Stage 2 area for ETC treatment subject to the revision of the CEMP.

5.3.4 Offsite disposal

A number of stockpiles were disposed offsite following classification due to elevated levels (greater than Class 2 criteria) of inorganics which were unable to be treated using the ETC process. A number of stockpiles were also disposed of due to aesthetic impacts. A summary of the fate of each of the stockpiles is included in Tables E16 to E18 of the Golder report (**Golder, 22-Jul-2011**). In total approximately 30,000 tonnes of soil was disposed of offsite to an appropriately licensed landfill.

While the Auditor has not reviewed the EPA transport Certificates, he is satisfied that the material has been disposed of appropriately to a licensed landfill.

5.3.5 Gas easement

In 2008 an opportunity arose for assessment and partial remediation of the gas main easement that runs along the western boundary of the Audit site. This came about due to Alinta (now Jemena) approaching DTF regarding the possibility of laying the new gas main onsite prior to the removal of the old infrastructure. In response to this opportunity, the auditor received a work plan from Golder on **18 August 2008 (Appendix G)** outlining the assessment of the onsite portion of the gas main easement.

The purpose of the assessment was to:

- provide further information on the nature and extent of contamination along the old gas main alignment;
- potentially allow for remediation of impacts in the gas easement while Thiess were still onsite (thus reducing costs); and
- provide further certainty to the auditor regarding the status of soil impacts within the gas easement area so a statement of audit could be issued.

At the time of the assessment and remediation of the easement, the audit site had not yet been divided into Stages 2 and 2A.

The assessment of the gas main easement was a collaborative effort between Golder, Thiess, DTF, Alinta and the auditor.

The old gas main easement ran along the length of the western site boundary with a branch extending across the middle of the site towards the eastern site boundary (see **Figure 4** for the old and new gas main infrastructure). The new gas main easement runs parallel to the rail line from Bay Road in the south, along the western boundary of Sir William Fry Reserve, along the western boundary of the Audit site (Stage 2A), and continues along Station Street until it reaches Highett Road in the north.

The gas main is generally located at a depth of between 1 and 1.5mBGL and encased in packing sands. The gas main infrastructure includes; transmission lines; sensing lines; high and medium pressure mains and regulators.

Using existing soil investigation results and knowledge of the past site practices, Golder divided the easement into areas of high and low probability of contamination. Sampling was based on a 1 validation sample per 10 linear metres in high risk areas, and a 1 sample per 15 linear metres in low risk areas. A total of 60 test pit locations were excavated and sampled (see **Figure 21, Appendix A** for sample locations).

Soil samples were analysed for contaminants of concern including PAHs, cyanide and metals with approximately 20% of samples analysed for a wider screen including MAHs, TPHs, pH and sulphate.

5.3.5.1 Golder Associates investigation (onsite)

The investigation conducted by Golder in August 2008 (**Golder, 26-Sep-08b**), allowed for the development of a remediation strategy for the gas easement. This divided the works to be completed pre-infrastructure and post-infrastructure relocation.

During the period November 2008 to January 2009 partial remediation of the gas infrastructure easements were undertaken by Thiess. These works involved the removal to the extent practical of the contamination identified as part of the gas infrastructure easement investigation works. Table E10 of the Golder Environmental Assessment and Remediation Report (**22-Jul-2011**) is a summary of the gas easement remediation excavations and **Figure 21, Appendix A** show residual soil impacts associated with the gas main easement post remediation in 2011.

In consultation with the EPA and auditor it was agreed that any waste soil generated by the installation of pipework on Sir William Fry Reserve (SWFR) would be stockpiled, treated and re-used (where appropriate) on the Audit site. It is also noted that the imported packing material and bedding sands for the new gas main were tested in accordance with standard requirements and reviewed by the Auditor prior to use on the Audit site. **Table E12** of Golder report (**22-Jul-2011**) summarises residual soil impacts within the gas main easement.

5.3.5.2 Monarc Environmental investigation (offsite)

Prior to the Golder investigation Monarc Environmental Pty Ltd were engaged by Alinta to conduct a soil contamination investigation along the proposed gas main alignment in Sir William Fry Reserve. The results of this investigation were included in the Monarc report dated 18 June 2008 and were reviewed by both Golder and the Auditor prior to the Golder investigation on the Audit site.

The purpose of the Monarc (**18-Jun-2008**) investigation was to provide information to Alinta relating to the extent and nature of soil contamination from historic gasworks activities, and outline how to best manage the potential health, safety and environmental issues associated with this material during the installation of a gas main.

Monarc conducted a limited site history review and identified that three gasholders were located on SWFR until at least 1976 near the boundary with the Audit site.

As part of the investigation, Monarc conducted the following:

- A Ground-Penetrating Radar (GPR) survey of the gas main alignment to identify any underground pits, tanks or structures that may have been associated with the former gasworks and therefore a potential source of contamination;
- Excavation of nine soil bores along the gas main alignment using a mechanical push-tube sampler; and
- Analysis of soil samples for contaminants of concern and waste disposal classification.

Monarc concluded that gasworks waste in the form of ash, clinker and tar stained and/or saturated material was present along the proposed alignment particularly in the north near the Audit site. Some of this material was classified as Category A or B contaminated soil according to **EPA publication 448.3** due to the presence of elevated cyanide, arsenic, phenols, PAHs and TPHs. The GPR survey supported the findings of the site history, and

indicated the presence of historic gasworks structures (such as pipes and building rubble) along the northern portion of the alignment.

5.3.6 Material tracking system

A Materials Tracking System (MTS) was developed and implemented by Thiess to allow for the tracking of material from source (generally an excavation number) to stockpile, to ETC treatment batch, to post treatment stockpile and/or excavation for backfilling.

The materials were tracked via onsite signage and Truck Drivers log sheets. The onsite signage provided the stockpile number and current classification while the Truck logs tracked the movement of the material and included the excavation number, classification and destination of the material transported.

The nomenclature system was used to identify all source and destination areas for soil both on and off the site. This included remediation excavations, demolition features, underground services, stockpiles and offsite sources of material and is summarised below.

Table 5.4 Summary of MTS stockpile nomenclature

Suffix	Name	Description
Stockpile type		
AC	Awaiting classification	Stockpiles when first excavated
Stockpile Type - Once analytical results reviewed		
AD	Material for Offsite Disposal	Further assigned as Contaminated Soil or Low Level Contaminated Soil (based on EPA Publication 448.3 now superseded)
AT	Material with Treatment Potential	Further assigned 01 or 02 based on level of inorganic contamination
AR	Material for Reuse	Class 1 or Class 2 material
Excavation types		
S	Service excavations	Excavation of identified underground services
T	Trench	
TP	Test Pit	

Golder (**Section 6.2.3, Golder, 22-Jul-2011**) provide a more detailed summary of the MTS maintained by Thiess and audited by the Auditor's representative in **June 2007**.

The Auditor is of the opinion that the MTS was implemented and complied with correctly.

6. Groundwater assessment and CUTEP

Assessment of groundwater at the site had been undertaken through the 1990s by a number of consultants including: Land Remediation Department (LRD), Gas & Fuel Corporation of Victoria, Gas Services Business Land Remediation (GSB LR) and Golder Associates (GA). Monitoring wells were installed in the period 1997 – 2003 with a number of replacement wells installed in 2008.

In total, 40 wells were installed on the site (21 of which are still functional) and an additional twelve wells offsite (11 of which are still functional). **Table R1 of Golder CUTEP report (Golder, May 2010)** summarised the well locations, status and construction details for the onsite and offsite groundwater wells. The location of each monitoring well is shown in **Figure 11**. The June 2009 groundwater elevation and TDS contour plans are presented in **Figures 12 and 13, Appendix A**.

The majority of these wells were installed to monitor the upper three metres of the water table aquifer within the Brighton Group. Four onsite wells (9030003, 9150001, 9150002 and 9150003) were installed to monitor groundwater in the deeper portion of the Brighton Group Aquifer at around 19 metres below ground level.

Regional groundwater flow is expected to be towards the west (Port Phillip Bay) (at a velocity of 0.37-3.7m/year), however, groundwater at the site flows generally to the northwest at a velocity of 1.28-12.8 m/year. This deviation in flow direction from the regional flow is due to localised mounding of groundwater in the south west corner of the site. The exact cause of this mounding is unclear and has persisted since groundwater monitoring began in 1998-9 through to the most recent complete groundwater monitoring event in 2009.

The shallow groundwater quality in the Brighton Group aquifer at the site reported TDS concentrations less than 1 000 mg/L which falls into Segment A2 based on the SEPP (GoV).

Groundwater has been sampled at the site as part of a number of hydrogeological investigations, a summary of which is included in **Appendix D**.

6.1 Summary of groundwater conditions

An inferred groundwater contaminant distribution plan based upon numerous figures contained in the Golder CUTEP report (**Golder, May 2010**) is presented in **Figure 22** (Appendix A). Three main primary sources of contamination to groundwater have been identified and are indicated on **Figure 22**; the CWG Relief Holder and Effluent and Liquor Tanks (see Zone 1 on **Figure 5**) in the northwest corner of the site; the tar dam (Zone 7, **Figure 5**); and in the stockpiling area in the southern corner of the site (Zone 5, **Figure 5**).

As of 2009, elevated cyanide concentrations were present in wells located along the western site boundary (almost exclusively within the Stage 2A audit area) and extended northeastward beneath the former Oil tank farm and southeast beneath the stockpile area and tar dam. The generalised hydrocarbon plume (PAHs, TPHs, Phenols, BTEX) was inferred to extend along the full extent of the western site boundary as well as the majority of the southern boundary (beneath the former No. 1 Gasholder) and eastern boundary with Leigh Mardon (location of former Tar dam). The distribution of ammonia concentrations above ecosystem and extractive use criteria, while generally contained to the western portion of the site, are also identified offsite to the west.

Nitrate, nickel and zinc concentrations above beneficial use criteria have been reported in up-gradient background wells (both onsite and offsite), onsite wells, and down-gradient offsite wells and are likely to at least partly represent background conditions in the Brighton Group Aquifer.

6.2 Auditor review of data QA/QC and level of groundwater assessment

QA/QC information relating to the various groundwater investigations was contained in the individual reports (rather than separate QA/QC reports as generated for the soil remediation aspect of the project). As such, the Auditor review of these reports included a review of the QA/QC sections.

Prior to the CUTEF submission to EPA which included the Auditor's cover letter endorsing the submission, the Auditor had to ensure he was satisfied with the level of groundwater assessment. This included the design and vertical/lateral distribution of wells, analytical suite chosen, frequency of monitoring events and interpretation of results.

6.3 CUTEF

As part of the Environmental Audit process, the Auditor confirmed that:

- The groundwater at the site is polluted in specific areas (as documented in the **Golder CUTEF report, 27 May 2010**);
- The groundwater contamination was satisfactorily characterised;
- All primary and secondary source areas had been remediated to the extent practicable;
- There was evidence that natural attenuation was occurring within the aquifer;
- Offsite impacts were limited in extent and comprised mainly of inorganics such as ammonia, sulphate and some metals which may have multiple onsite and offsite sources and/or be ubiquitous to groundwater in the area; and
- Based upon the potential risks posed by the impacted groundwater, a groundwater quality restricted use zone (GQRUZ) was placed on the site along with a groundwater management plan (GMP) to monitor natural attenuation of the impacts.

The final status of groundwater and precluded beneficial uses is discussed in **Section 8.3.2**.

6.4 Surface water investigations

Golder (**Golder, 01-Aug-02**) collected one surface water sample from Sir William Fry Reserve (LAKE-0702) on 18 July 2002. Analytes above LOR are listed in Table 6.1 below.

Table 6.1 Summary of surface water analytical results above LOR

Analyte	LAKE-0702 Concentration (mg/L)	Background Monitoring Well 9120001*
pH	8.5	4.7
TDS	170	180
Arsenic	0.004	<0.001
Barium	0.02	-
Iron	0.12	<0.05
Calcium	23	0.37
Magnesium	5.5	6.8
Sodium	23	42
Potassium	4.1	0.12
Sulphate	8.3	4.7
Chloride	25	64
Bicarbonate	87	14

*Background well for comparison purposes only. Data transcribed from May 2002 GME.

A comparison of the chemistry of the lake water compared to background groundwater indicated that while the TDS concentrations were comparable, the sodium and chloride concentrations in the groundwater were higher while the bicarbonate concentration was higher in the lake water (suggesting a high proportion of rainwater recharge to the lake compared to the groundwater). The groundwater also reported a lower pH value typical of groundwater flowing through Brighton Group sediments where the breakdown of pyrites can lead to acidic conditions.

Based upon these limited results, it was unlikely that the lake was receiving baseflow from groundwater flowing from the gasworks site. Therefore no further investigations into surface water contamination were conducted.

7. Auditor review of data QA/QC, assessment and remediation

The quality of the available data relating to the site was assessed as follows:

- the site investigation and remediation reports have been reviewed by the auditor against documents referenced by the EPA and other relevant standards and guidelines in order to verify the quality and completeness of the assessment;
- the Auditor or his representative attended the site on numerous occasions, to gain an appreciation of the conditions and remedial works conducted at the site; and
- assurance/quality control (QA/QC) data acquired from the field samples collected and analysed were also audited.

7.1 Data QA/QC reports

Golder provided data QA/QC reports for soil excavation/remediation works on a periodic basis in all ten data QA/QC reports were provided by Golder and reviewed by the Auditor.

The results of these quality assessments are discussed below and summary tables of correspondence and review are contained in **Appendices G and H** respectively.

The following aspects were outside of the scope of the QA/QC reports:

- at the time of reporting, the site was not divided into Stages 2 and 2A;
- the reports did not assess the level of assessment (density, depth, and characterisation) for each phase of works. This has been undertaken by the auditor while reviewing each individual assessment or remediation report provided by Golder;
- the reports focused on performance relating to the Specification (**Golder, 2001**) and therefore do not directly assess the performance of the ETC treatment process. Thiess provided periodic reports to EPA which assessed Thiess's performance against the CEMP and the requirements of the PAN and included the ETC outcomes. These reports were reviewed by the Auditor and are discussed in more detail in **section 7.3**; and
- the reports do not discuss groundwater data QA/QC. This information was contained within the individual groundwater monitoring reports;
- the Auditor review of all the QA/QC data reports noted that no rinsate, trip or field blanks were collected during these phases of work. These particular omissions have been reviewed by the Auditor in light of the requirements set out in the Specification as well as Golder's response to the Auditor's comments. This information is presented in **Table 7.1** below.

Table 7.1 Summary of Auditor comments

Objective	Site specification	Comment
Rinsate blank	While the use of appropriate sampling and decontamination techniques should minimise the possibility of cross contamination, equipment blanks are to be collected at the rate of 1 per day per field crew during sampling	Golder response: There have been no rinsate samples collected or reported as the sampling procedure adopted does not use any equipment that comes in contact with the sample between sample locations. Soil sample collect has been via grab sampling from an excavator bucket using new latex gloves for each sample collected. This was verified by the Auditor and Auditor assistant during site inspections and the Auditor is satisfied that the potential for cross contamination during soil sampling was low.
Trip blank	Not included in Specification	Golder response in relation to Report #5: Requirements for trip blank do not form part of this Specification and where not considered necessary during the sampling program. While the absence of trip blanks does not comply with AS4482.1 and 2, the Auditor does not believe this compromises the quality of the data.
Field blank	Field blanks will be collected whenever dusty or odorous conditions prevail.	Golder response in relation to Report #5: In line with the Performance Specification field blanks were not considered necessary as dusty or odorous conditions did not prevail. Auditor requested comment from Golder in relation to the presence of highly odorous conditions which prevailed intermittently during excavation of 189 and the tar dam. No comment was provided by Golder. While the absence of field blanks does not comply with AS4482.1 and 2, the Auditor does not believe this compromises the quality of the data.

Below is a record of auditor review of the Data QA/QC reports provided by Golder.

Table 7.2 Review of Data Quality Assurance reports

Report	Auditor review date	Report finalisation	Auditor acceptance		
			yes	no	comment
Golder Associates, 01-Dec-05. Report No 1 - Data Quality Assurance. Period 20 Sept to 02 Dec 2005. Vol 1	NA	NA	☒	☐	Reviewed as part of Audit of Stage 1

Auditor acceptance					
Report	Auditor review date	Report finalisation	yes	no	comment
Golder Associates, 01-Mar-06. Report No 2 - Data Quality Assurance. Period 03 Dec 2005 to 28 Feb 2006	NA	NA	☒	☐	Reviewed as part of Audit of Stage 1
Golder Associates, 01-Jun-06. Report No 3 - Data Quality Assurance. Period 01 Mar to 31 May 2006	NA	NA	☒	☐	Reviewed as part of Audit of Stage 1
Golder Associates, 01-Oct-06. Report No 4 - Data Quality Assurance. Period 01 Jun to 31 Aug 2006. Vols 1 & 2	NA	NA	☒	☐	Reviewed as part of Audit of Stage 1
Golder Associates, 01-Jan-07. Report No 5 - Data Quality Assurance. Period 01 Sep to 30 Nov 2006	Auditor review in March 2007, Golder response in April 2007	14-Jan-08	☒	☐	See comments in Table 7.1 above
Golder Associates, 01-May-07. Report No 6 - Data Quality Assurance. Period 01 Dec 2006 to 28 Feb 2007	Auditor review 14 Jan 2008, Golder response 14 Jan 2008	14-Jan-08	☒	☐	See comments in Table 7.1 above
Golder Associates, 01-Jul-07. Report No 7 - Data Quality Assurance. Period 01 Mar to 31 May 2007	Auditor review 14 Jan 2008, Golder response 14 Jan 2008	14-Jan-08	☒	☐	See comments in Table 7.1 above
Golder Associates, 01-Oct-07. Report No 8 - Data Quality Assurance. Period 01 Jun to 31 Aug 2007	Auditor review 14 Jan 2008, Golder response 14 Jan 2008	14-Jan-08	☒	☐	See comments in Table 7.1 above
Golder Associates, 01-Jan-08a. Report No 9 - Data Quality Assurance. Period 01 Sep to 31 Dec 2007	Auditor review 20 February 2008, no action required	01-Jan-08	☒	☐	NA
Golder Associates, 26-Aug-09. Report No 10 - Data Quality Assurance. Period 01 Jan to 31 Aug 2009	Auditor review 11 September 2009, no action required	26-Aug-09	☒	☐	NA

Based on the above, the Auditor considered that overall; the available soil data were of a suitable quality and completeness to support the enclosed Statement of Environmental Audit.

7.2 Adequacy of level of site assessments and remediation

Based upon the progressive review of over sixty reports spanning over ten years of site assessment and remediation, the Auditor is satisfied that the level of assessment has provided a good understanding of the nature and extent of contamination and remediation.

Table 7.3 below provides a summary of the level of investigation, the key documents where this information is available, and if the Auditor is satisfied with the level of assessment.

Appendices G and H provide a more detailed outline of the level of auditor correspondence and auditor review respectively.

Table 7.3 Summary of level of investigation

Objective	Soil	Groundwater	Auditor approval
Site assessment			
Potential and actual sources of contamination	Various site history, and investigation reports	CUTEP	yes
Nature of contamination (contaminants of concern)	Various site history, and investigation reports	CUTEP	yes
Potential migration pathways	HHRAs	CUTEP	yes
Extent of contamination (vertical and lateral)	Soil investigations have extended to over 10mBGL The soil sample location density is better than 1 sample location per 30m grid	Groundwater investigations have extended to over 19mBGL Over 40 groundwater wells were installed throughout the life of the project	yes
Remediation			
Management of materials	Implementation of the MTS was audited by the Auditor & found to be generally compliant Auditor site visits confirmed stockpiling and validation sampling was being conducted in accordance with the Specification	No releases of impacted groundwater were reported to the Auditor or EPA during the life of the project	yes
Understanding and implementation of potential remedial technologies	Feasibility Study conducted by Golder and ETC process chosen A site EMP will be implemented as part of the Audit conditions	CUTEP and monitored natural attenuation covered by a GQRUZ and GMP	yes
ETC process	Thiess operated the plant and associated tasks in general accordance with the requirements of the PAN. Issues related to noise, odour, dust and asbestos were dealt with quickly and appropriately and with the knowledge of both the EPA and the Auditor.	NA	yes

Objective	Soil	Groundwater	Auditor approval
Site reinstatement	The final site surface meets the requirements of the Specification and has been surveyed by a licensed surveyor. A one metre thick Class 1 soil layer covers the majority of the site as required by the Specification.	Groundwater wells not considered necessary for ongoing monitoring have been or will be decommissioned in accordance with appropriate standards and guidelines.	yes

7.3 ETC performance

Appendix D contains a summary of all ETC batch reports provided by Thiess. **Table 7.4** below provides further information on those batches that exceeded Class 2 based upon individual results. The table below summarises the available information relating to Batches 3, 5, 13 and 38 and categorises them based upon individual peak concentrations; the statistical mean of the population; and the 95% UCL on the mean as stipulated in the Specification.

Table 7.4 Summary of ETC batches exceeding Class 2

Batch exceeded	Report*	Batches	Individual results	Class (individual)	Statistical results	Class (stats)
Batch 3	Thiess Services Pty Ltd, Aug 2006. June 2006 – August 2006	1 – 9	One sample exceeded. Batch 3 sample 945874 Total PAHs & BaP concentrations of 130 & 7.2mg/kg respectively.	Class 3	Statistics on Golder samples: Population: 14 samples Mean: 1.08mg/kg (BAP) & 20.28mg/kg (PAHs)	Class 2
Batch 5	Golder Associates, 11 July 2006, Further Information on treated material, Former Highett Gasworks, 1136-1138 Nepean Highway, Highett. Report No. 05613598/044. June 2006 – August 2006	1 - 6	One sample exceeded. Batch 5 sample T1/005/003 with PAHs, BaP & TPH C9-C36 concentrations of 98, 8.3 & 1420mg/kg respectively. Golder and Thiess conducted validation sampling separately, therefore the disparity between Thiess and Golder Batch 5 validation results is likely to be due to the heterogeneity of the material.	Class 3	Statistics on Golder samples: Population: 16 samples Mean: 0.71mg/kg (BAP) & 8.58mg/kg (PAHs) Statistics on Thiess samples: Population: 8 samples Mean: 0.55mg/kg (BAP) & 10.43mg/kg (PAHs)	Class 1
Batch 13	Thiess Services Pty Ltd, Nov 2006. September 2006 – November 2006	10 - 20	Thirteen samples exceeded. Batch 13 , 13 out of 15 samples failed Total PAHs concentrations of 20mg/kg or less. Total PAHs concentrations ranged from 11.8 to 402.7mg/kg after treatment and BaP concentrations ranged from 0.5 to 7.0mg/kg after treatment. Noted that email from Golder 8-Dec-2006 indicates that Batch 13 was treated again with Batches 16 to 20 and achieved Class 1 or 2 status.	Class 3	Statistics on Thiess samples: Population: 15 samples Mean: 5.03mg/kg (BAP) & 84.55mg/kg (PAHs), 807.67mg/kg TRH C9+ Statistics on Golder samples: Population: 14 samples Mean: 11.19mg/kg (BAP) & 136.36mg/kg (PAHs), 1029.71mg/kg (TRH C9+) 95% UCL (student-t): 12.52mg/kg (BAP) & 155.3mg/kg (PAHs), 1148mg/kg (TRH C9+)	Class 3
Batch 38	Thiess Services Pty Ltd, Jul 2007. May 2007 – July 2007	35 - 43	One sample exceeded. Batch 38 sample 1177321 Total PAHs & BaP concentration 110 & 2.9mg/kg respectively.	Class 3	Statistics on Thiess samples: Population: 15 samples Mean: 0.3mg/kg (BAP) & not enough data for statistical analysis for PAHs or TRHs	Class 1

Overall the Auditor was satisfied that all material treated via the ETC process reached Class 1 or 2 for organics. In addition, this material was appropriately tracked and re-used onsite in accordance with the Specification and agreed target soil profile.

7.4 Auditor verification and observations of field protocols

From the auditor and his representative's observations of the field works, the soil and groundwater sampling procedures employed were noted to be consistent with the methodologies outlined in the Specification and generally adequate and consistent with practises recommended in the EPA guidelines and relevant Australian Standards (**AS 4482.1 and 2, and AS5667.1**). Minor discrepancies observed were considered unlikely to affect the outcomes of the audit.

The Auditor and or a nominated representative periodically visited the site in order to collect and verify evidence to support findings relating to the audit criteria including:

- Confirmation that site activities were being undertaken in compliance with the Specification and CEMP;
- Review of validation sampling results provided by Golder to confirm waste material was being appropriately handled;
- Review of materials tracking records to confirm the quantity and destination of materials moved around the site as well as material disposed of offsite;
- Collection of verification samples as required;
- Inspection of monitoring and operational records including but not limited to: requirements of the PAN site CEMP (including management of the ETC Plant, and environmental management such as noise, odour, air quality, wastewater, contaminated materials handling and storage procedures);
- Inspection of excavation works, validation sampling and backfilling of excavations as well as pre and post treatment stockpiles; and
- Progressive review of data to assess that material was appropriately characterised and managed, and that the surrounding natural soil was also characterised.

Appendix F includes annotated photographs (and laboratory certificates) of the site visits listed below.

Table 7.5 Summary of auditor site inspections

Date & person	Purpose	Samples/ photographs	Results/observations/comments
November - December 2005, DA & JT	Inspection of process in Stage 1 and purple discoloration in excavation 142	9 photographs	■ Purple discoloration first noted in late 2005 in excavation 142. ■ Further investigation and testing of material by Golder in consultation with Auditor did not reveal the source of the discoloration. ■ Formal investigation and report on purple colouring conducted by Golder in May 2006.

Date & person	Purpose	Samples/ photographs	Results/observations/comments
12 December 2005, DA	Inspection of Stage 1 area & material from Stage 1 stockpiled on Stage 2	9 photographs	Aesthetic attributes of the soil preclude use as Class 1 at surface without further remediation (removal of conduits etc.).
11 May 2006, DA & JT	Inspection of stockpiles prior to ETC treatment. Collection of stockpile samples	none	Visual assessment of samples of stockpiled soil that are representative of pre- and post-treatment
21 June 2006, JT	Site meeting and walkover to inspect ETC plant, stockpiles and preparations for excavation of tar dam.	none	- Batch 5 treated to 200 degrees higher than previous batches, apparently due to presence of mulch mixed into the pile (based on SA experience). - Validation sampling looks ok (verbal). - Validation sampling for this and previous batches will be forwarded for review. - Targeted sampling of tar/coke rubble to also be undertaken on treated batch 5 stock pile to further assess the effects of the higher temperatures. - Protective piling and odour control misting systems in place for tar dam excavation works which are expected to commence next week and continue for 2-3 months. - Contaminated soil will be removed on a batch by batch basis and as such excavation will be open for some time
23 January 2006, JT	Inspection of north eastern corner of site (near entrance) & surplus stockpiled material from Stage 1	9 photographs	- Residual aesthetic issues currently associated with the fill should be addressed if the entire stockpiled fill is passed through a 100mm screen. - Inspection of residual soil impacts (aesthetic) in Stage 1 'buffer zone'
23 October 2007, CLS	Inspection of Sir William Fry Reserve and onsite works	36 photographs	- Identification of approximate location of former gas holders on Sir William Fry Reserve. - Assessment of depth of main pond on SWFR and likely surface water runoff directions. - Onsite inspection of trench near tar dam with residual coke impacts. - Evidence of historic gasworks pipes (metal) containing tar material. - Observed nature of fill material around various underground services.
5 December 2007, CLS	Excavation of tar dam	6 photographs	Noted black staining impacts on soil in shallow profile (1-2mBGL)
11 November 2008, CLS & JT	Observe condition of western boundary	21 photographs	- Noted new stormwater drain installation on southwestern boundary. - Noted existing gas main infrastructure to be removed with old gas mains. - Noted residual soil impacts along western boundary - mainly coke and slag.

Date & person	Purpose	Samples/ photographs	Results/observations/comments
November/December 2008, no auditor or representative onsite	Observe flooding of site	2 photographs	- Photographs taken by site personnel after large rainfall event. - Flooding may have been caused by blocked stormwater drain in southern portion of the site.
10 December 2008, CLS	Observe excavation S4 along western boundary fenceline	Validation sample S4-5 BASE collected 10/12/08 Numerous site photographs showing residual contaminated soil that cannot be removed due to existing fence.	- Auditor validation sample compared well with Golder sample S4-5BASE/002. - Auditor inspection of sample collection and field practices deemed appropriate. - Residual soil impacts along western fenceline noted.
20 August 2009, CLS & JT	Observation of final site condition	Numerous site photographs	- Noted minor black staining (residual soil impacts) located near former tar dam (boundary with Leigh Mardon). - ETC plant decommissioned, some pipework still onsite. - Batter slope on western boundary and along Leigh Mardon boundary noted. - Noted gravel stockpile near site office.

Based on the numerous site inspections conducted as summarised above, and the over 40 meetings conducted on site (see **Appendix G, Table G1**), the Auditor considered that overall; field activities were conducted in accordance with the Specification and appropriate State, Federal and industry regulations and guidelines to achieve the level of quality and completeness to support the enclosed Statement of Environmental Audit.

7.5 Record of Auditor review of documentation

Auditor conducted a review of the material tracking system (MTS) in June 2007 and found that compliance was being achieved.

The review consisted of the following:

- Meeting with A representative of Golder at the site office
- Golder provided a demonstration of the MTS:
 - ▶ Demonstrated how soil samples are linked to particular excavations or ETC batch;
 - ▶ Tracking of the analytical results;
 - ▶ Linkage between soil samples and associated stockpiles/excavations;
 - ▶ Logging of truck movements;
 - ▶ Management of stockpiles (classification) on the basis of analytical results;

- ▶ Location of excavations where treated soil was reused;
- ▶ Surveyed location of all excavations
- A site tour was then undertaken demonstrating how samples were collected and the labelling of stockpiles.

Appendix H, Tables H1 and H2 provide a summary of the auditor review records for all reports related to the audit site.

8. Final site conditions

This section provides a summary of current conditions on the two audit areas – Stage 2 and Stage 2A. Due to the shared historic gasworks use of the site, there are aspects of the final site conditions which are common to both Stages. These include:

- the existing infrastructure on the site;
- the final condition of groundwater beneath the site; and
- the presence of residual soil impacts in the audit areas.

These aspects are discussed in more detail below prior to discussion of the individual Stages in the following sections.

Residual soil impacts on both Stages include those that could not be removed due to the proximity to the: site boundary; water table; and gas infrastructure. It is noted that impacts related to the presence of the gas infrastructure are largely associated with the Stage 2A audit area.

8.1 Infrastructure remaining onsite

All known and discovered structures and underground services at the site have been removed during the remediation works with the exception of:

- The historic retort house chimney.
- Old gas main easement - Infrastructure within the existing gas easements on the site. A series of high pressure gas mains and transmission mains (with associated sensing lines and regulators) run east to west through the centre of the site (Stage 2 audit area) and north to south along the western site boundary (Stage 2A audit area) (**Figure 4, Appendix A**). The easements have an approximate area of 0.57 ha. It is likely that the old gas main will be removed from the site in 2012-2013.
- New gas main easement - A new main was installed in 2009 along the full length of the western boundary (Stage 2A area) from Sir William Fry Reserve to View Street. It is understood that a six metre gas main easement will remain along this alignment (**Figure 4, Appendix A**).
- A stormwater drain traverses the southern boundary of the site from the court house to the railway line and drains the Moorabbin Courthouse development.

It is the Auditor's understanding that the old gas main infrastructure will be removed and validated in 2012 and 2013. Current residual soil impacts are described in more detail below.

8.2 Groundwater

Exceedences of the adopted criteria groundwater at the site are present for metals, PAHs, MAHs, cyanide, ammonia sulphate and phenol. Whilst offsite wells are impacted with metals, cyanide, ammonia and sulphate. In general the data suggests that there were three main primary sources of contamination: the CWG Relief Holder and Effluent and Liquor Tanks (see Zone 1 on **Figure 5**) in the northwest corner of the site; the tar dam (Zone 7, **Figure 5**); and in the stockpiling area in the southern corner of the site (Zone 5, **Figure 5**). All these primary sources of ongoing groundwater impact have been removed as part of the remedial works conducted on the site.

Figure 22 provides a summary of the inferred contaminant plumes based upon 2009 GME data, including the inferred source areas, and **Table 8.1** below summarises the beneficial groundwater uses (onsite and offsite) that are currently precluded.

In order to fully assess the impact of pollution on the protected beneficial uses of groundwater, the auditor has considered the likelihood of groundwater in the vicinity of the site being utilised for each of the protected beneficial uses. The analysis is presented in **Table 8.2** below and takes into account a number of factors including:

- Are there any registered wells in the area that are currently being used or could be used for the beneficial use that is protected?
- Is the aquifer yield sufficient to support the beneficial use that is protected?
- Given the current or likely future landuse of the site, is it likely that the groundwater will be used for the beneficial use that is protected?
- Given the current and future surrounding landuses, is it likely that the groundwater will be used for the beneficial use that is protected?

In summary, groundwater is being utilised, or could reasonably be assumed to be utilised, for the following protected beneficial uses: primary contact recreation (on site and off site); industrial uses (offsite only); buildings and structures (on site and off site); and irrigation (onsite and offsite).

Table 8.1 Protected beneficial uses potentially precluded by residual groundwater contamination

Contaminant	Maintenance of ecosystems		Potable water supply		Primary contact recreation		Stock watering		Irrigation		Buildings & structures		Industrial water	
	onsite	Offsite	onsite	offsite	onsite	offsite	onsite	offsite	onsite	offsite	onsite	offsite	onsite	offsite
Metals														
PAHs			#		#									
MAHs														
Cyanide														
Ammonia														
Sulphate														
Phenol														

Notes:

No criteria have been derived for PAHs, Risk on site driven by vapour as assessed through the human health risk assessment (Golder, Feb 2010).

Table 8.2 Likelihood of protected beneficial use of groundwater being realised

Protected Beneficial Use	Onsite	Offsite
Maintenance of ecosystems	Unlikely No onsite aquatic ecosystems that rely on groundwater discharge or are in connection with groundwater.	Unlikely Port Phillip Bay is located over 3km west of the site and given the local groundwater and surface water flow regime, impacts to Port Phillip Bay are considered unlikely.
Potable drinking water	Unlikely Reticulated potable water supply is available for this area of Melbourne. Aquifer yields are unlikely to sustain a potable drinking water supply.	Unlikely Reticulated potable water supply is available for this area of Melbourne. Aquifer yields are unlikely to sustain a potable drinking water supply.
Irrigation	Possible Groundwater from the Brighton Group Aquifer is used in the area for irrigation purposes, and it is possible that future site development could utilise groundwater to irrigate common gardens and open spaces.	Existing Known groundwater use for the purpose of watering golf courses and private gardens in the area..
Stock watering	Unlikely Medium/high-density residential development with minimal access to garden bed areas is proposed for the site. Rearing of stock is not compatible with local land use zoning	Unlikely The local surrounding area is largely occupied by residential, commercial and industrial properties. The abstraction of groundwater for stock watering purposes is considered unlikely.
Industrial use	Unlikely The site is being redeveloped for medium/high-density residential development purposes.	Existing Industrial use wells are located in the area. However, it is considered that a reticulated supply in commercial quantities would be available for this area of Melbourne.
Primary contact recreation	Possible The proposed development is for a medium/high-density residential development. There are no known plans to incorporate swimming pools or spa into the development,, however it would be feasible to do so. Pools are more likely to be filled with scheme water or by tanker. Topping up with bore water is plausible. .	Possible Potential for the use of groundwater to fill swimming pools within the surrounding area. Impacts to Port Phillip Bay and associated recreational uses are considered unlikely.
Buildings & structures	Possible The proposed development is slab on ground with semi buried carpark basements. Groundwater beneath the site is located between 6 - 10mBGL and is unlikely but possible that it could impact on underground services or building structures.	Possible Based on the known depth to the local groundwater table ranging between 6-10 mBGL, there is potential for deep services such as trunk sewers and/or multilevel below ground carparks to intersect the water table.

8.2.1 Groundwater quality restricted use zone

A groundwater quality restricted use zone (GQRUZ) is used by EPA and planning authorities as a tracking and information tool to be applied when groundwater is not suitable for use due to contamination. A groundwater quality restricted use zone is defined in the SEPP as follows:

An area the Authority identifies in accordance with Clause 19 as having an existing level of contamination of groundwater that precludes one or more beneficial uses that would otherwise apply to that groundwater.

While groundwater impacts that preclude some beneficial uses have been identified beyond the western boundary of the site, as shown in **Figure 22**, the nature and extent of offsite groundwater pollution is minimal and mainly related to elevated ammonia concentrations.

Golder's assessment of the likely beneficial uses of groundwater and the preclusion of these due to groundwater pollution has been reviewed by the Auditor and is considered appropriate. In addition, a request for a CUTEP determination was submitted to EPA with the Auditor's endorsement in June 2010 and EPA ruled thusly in November 2010 with the requirement that a groundwater quality restricted use zone (GQRUZ) be placed over the area of polluted groundwater.

Figure 25 shows the extent of the GQRUZ for the site (i.e. the boundary of the Stage 2 and 2A audit area). The extent of the GQRUZ was based on the following factors:

- The limited extent of offsite impacts based on ten years of groundwater monitoring on and offsite;
- Evidence of natural attenuation of contaminants in the groundwater as groundwater moves away from the historic source of contamination;
- The slow groundwater flow velocity and associated contaminant movement as observed over ten years of groundwater monitoring and in consideration of over 30 years of operational history and over 40 years since the site stopped producing gas;
- Consideration of the government (local and state) ownership of property down gradient of the site, including the railway easement; and
- The ease of tracking and management of the GQRUZ under one site owner (currently the Department of Treasury and Finance).

8.3 Residual soil impacts

8.3.1 Contaminants

Residual soil impacts (contaminants remaining on site above Class 1 criteria at <1mBGL, and above Class 2 criteria at >1mBGL) have been classified into four main groups by Golder and have been used by the auditor herein:

- **“Groundwater”** – Residual soil impacts below the water table. These residual soils were confined to excavations 189 and 002 located near the former water, effluent and

liquor tanks in the northwest corner of the site and the former tar dam located on the south eastern boundary of the site respectively;

- **“Boundary”** - Soil impacts at and beyond the site boundary that could not be removed. The residual soil located at the boundaries of the site are confined to the western boundary (between the remaining gas infrastructure and the railway line easement), and small portions of the southwestern corner of the site, the eastern site boundary with Leigh Mardon, and the northern boundary;
- **“Gas infrastructure”** - Soil impacts located in the immediate vicinity of the existing gas infrastructure and generally limited to the western portion of the site (Stage 2A audit area) ; and
- **“Remaining”** - A number of samples not related to either the gas infrastructure, material at depth or along the site boundary which exceeded the adopted criteria. These samples include:
 - ▶ shallow (< 1 metre deep) samples that exceed Class 1 criteria considered to be protective of the environment and therefore conservative (mainly metals);
 - ▶ samples with concentrations of less than 2.5 times the adopted criteria (these were calculated in accordance with the NEPM methodology outlined in Schedule B (7A)); and
 - ▶ samples where the adopted sulphate criterion of 2000 mg/kg is exceeded at the individual sample location but where the mean sulphate concentration in the general area is less than 2000 mg/kg.

Figure 23, is a composite diagram modified from of the Golder (**22 July 2011**) report showing residual soil impacts in shallow soil and at depth (>1mBGL). Further details can be found in **Tables E21 and E22** of the final Golder Environmental Assessment and Remediation Report, Stage 2 Audit Area (**Golder, 22 July 2011**), which provide a summary of the residual soil remaining on the Stage 2 and 2A areas respectively.

8.3.2 Aesthetics

There are numerous sample locations with aesthetic impacts that exist within the top 1m of soil. These mostly comprise ashy and coke fragments, cyanide staining, ammonia odour, naphthalene odour, black staining, slag and solidified tar fragments (Golder Figure 24 and Tables E23 and E24 (Golder, 22 July 2011). A visual inspection of the final conditions of the site was undertaken by the Auditor in August 2009 (see **Appendix F** for site photographs) where minor aesthetic impacts were noted along the eastern site boundary. At the request of the Auditor, Golder conducted a comparison of recorded aesthetically impacted samples against chemical analysis and concluded that the majority of samples did not exceed the contaminant criteria protective of the beneficial uses. Based on this chemical information; the visual inspection of the site; and the scattered nature of the aesthetic impacts, the auditor is satisfied that while aesthetic impacts exist across the site, they can be appropriately managed within the development framework for the site by with the implementation of a site management plan.

8.4 Stage 2 audit area - final soil conditions

In accordance with the Land SEPP, the development is classified as medium / high density residential and/or commercial/industrial and falls under the land use *Sensitive Use: Other*. In order for a *Certificate of Environmental Audit* to be issued, it must be demonstrated that the site is neither detrimental nor potentially detrimental to any one or more of the relevant beneficial uses of the site.

Although 'Maintenance of Natural Ecosystems' is not required to be protected for the proposed medium / high density residential development, consideration is given to this beneficial use in order to consider unrestricted use of the site.

The distribution of residual soil impacts in Stage 2 are shown on **Figure 23**, and these are described in more detail below.

8.4.1 "Boundary" residual soil impacts

Shallow soil impacts are located along part of the northern, southern and eastern site boundaries where further soil removal was not possible due to the proximity of adjoining properties including buildings and structures at the site boundary.

- Shallow layers of ashy fill material were visible in the excavation face at the common boundary with the Buckingham Motel on the northern boundary of the site (excavation 028, see **Figure 18** for location). The fill appeared to extend below the adjacent motel car park and overlaid natural soils. Residual impacts in the fill are characterised by ashy fill containing PAHs, TPHs and inorganic contaminants such as cyanide, sulphate and arsenic. **Table 8.3** below provides a summary of residual soil impacts associated with excavation 028 and Golder (22-July-2011, Appendix K) include site photographs of the northern boundary impacts. Excavation 028 only penetrated to a maximum depth of 1.1mBGL and therefore the nature of deeper residual soil impacts at the boundary are similar to those between 0 and 1mBGL and comprise of PAHs, TPHs, cyanide and sulphate.
- Shallow fill impacts comprising PAHs, TPHs, mercury and cyanide in ashy fill and blue/black stained material were also left in situ at excavation limits (excavations 055 and 145) beneath the fence line at the south western corner of the site as summarised in **Table 8.4** below (see **Figure 16**). Excavations 055 and 145 reached depths of approximately 2.0mBGL. therefore the majority of residual soil impacts between 1 and 2mBGL were contained in fill material and had a similar chemical make up to the shallow impacts with addition of elevated arsenic and sulphate concentrations as show in **Table 8.4** below.
- Fill material was also present below the fence line on the eastern (Leigh Mardon) boundary of the site (see **Figure 23** for location of excavation and Golder (22-July-2011, Appendix K for site photographs of the residual boundary impacts), above the former tar dam location. The Leigh Mardon site is slightly elevated above the Stage 2 area and contiguous piles were installed adjacent to the tar dam to facilitate excavation and to protect buildings and roadways on the Leigh Mardon site. Residual impacts comprise PAHs including BaP and are summarised in **Table 8.5** below. The auditor notes that the majority of residual soil impacts between 0 and 1mBGL at the tar dam remain in situ due to their proximity to the site boundary with Leigh Mardon.

- Deeper soil impacts are present at the Leigh Mardon site boundary and are discussed further in **Section 8.4.2** below.

Table 8.3 Residual soil impacts at the northern boundary near Buckingham Motel (excavation 028)

Residual Contaminants	Min concentration (mg/kg)	Max concentration (mg/kg)	"boundary"	"remaining"
Surface to 1mBGL				
PAHs				
BaP	<0.1	1.4	x	
NAP	<0.1	0.3	x	
Total PAHs	<1.6	18	x	
TPHs				
TPH <C9	<20	47	x	
TPH >C9	<120	590	x	
Inorganics				
Arsenic	<5	27	x	x
Cyanide	<5	9500	x	x
Sulphate	<2.5	180	x	x
At depth >1mBGL				
PAHs				
BaP	<0.1	0.4	x	
NAP	<0.1	0.1	x	
Total PAHs	<1.6	11	x	
TPHs				
TPH <C9	<20	<20	x	
TPH >C9	-	313	x	
Inorganics				
Cyanide	<5	460	x	x
Sulphate	300	2500	x	x

Note: maximum depth of excavation 1.1mBGL

Table 8.4 Residual soil impacts at the southern site boundary (excavation 055 and 145)

Residual Contaminants	Min concentration (mg/kg)	Max concentration (mg/kg)	"boundary"	"remaining"
Surface to 1mBGL				
PAHs				
BaP	<0.1	3.3	x	
NAP	0.1	2.4	x	
Total PAHs	0.7	68	x	
TPHs				
TPH <C9	<20	66	x	
TPH >C9	<138	1370	x	
Inorganics				
Mercury	<0.05	3.9	x	x
Cyanide	29	750	x	x
At depth >1mBGL				
PAHs				
BaP	0.3	4.4	x	
NAP	<0.1	2.1	x	
Total PAHs	7.3	58	x	
TPHs				
TPH <C9	<20	75	x	
TPH >C9	<120	1120	x	
Inorganics				
Arsenic	<5	36	x	x
Mercury	<0.05	0.44	x	
Cyanide	5	75	x	x
Sulphate	150	3400	x	x

Note: maximum depth of excavation 2.0mBGL

8.4.2 "Groundwater" residual soil impacts

The tar dam (excavation 002) located adjacent to the boundary with Leigh Mardon is the only known location on Stage 2 where hydrocarbon impacts extended into the water table and could not be entirely removed. Residual impacts are summarised in **Table 8.5** below.

Table 8.5 Residual soil impacts following excavation of tar dam (002*)

Residual Contaminants	Min concentration (mg/kg)	Max concentration (mg/kg)	"boundary"	"groundwater"
Surface to 1mBGL				
PAHs				
BaP	3.4	8.8	x	

Residual Contaminants	Min concentration (mg/kg)	Max concentration (mg/kg)	"boundary"	"groundwater"
NAP	<0.1	1.5	x	
Total PAHs	50	50	x	
MAHs				
Benzene	<0.5	<0.5	x	
Toluene	<0.5	<0.5	x	
Ethyl benzene	<0.5	<0.5	x	
Xylenes	<0.5	<0.5	x	
TMB (124)	<0.5	<0.5		
TPHs				
TPH <C9	<20	<20	x	
TPH >C9	<120	1370	x	
Total Phenols	<0.1	1.6	x	
At depth >1mBGL**				
PAHs				
BaP	3.8	73		x
NAP	<0.1	2000		x
Total PAHs	22	4000		x
MAHs				
Benzene	<0.5	76		x
Toluene	<0.5	100		x
Ethyl benzene	<0.5	22		x
Xylenes	<0.5	160		x
TMB (124)	<0.5	69		x
TPHs				
TPH <C9	<20	480		x
TPH >C9	<120	31400		x
Total Phenols	<0.1	620		x

Notes:

* includes excavations 216, 217, 218, 219, 220

** maximum depth of excavation 6.5mBGL

8.4.3 “Remaining” residual soil impacts

The majority of impacts in the shallow soil profile (top metre) are scattered throughout the site and are related to either exceedences of criteria considered conservative (i.e. protective of the environment (NEPM EILs)) or inorganic contaminants such as metals, sulphate and pH, often found naturally in elevated concentrations in Brighton Group sediments and unlikely to pose an unacceptable risk to site users;

- impacts >1m depth are present in the south western corner of the site (excavations 010, 107 and 114, see **Figure 18** for excavation location and **Figure 23** for location of residual impacts) where high sulphate concentrations were reported due to historic stockpiling of spent oxide and sulphate rich soil; and

- shallow impacts (<1m depth) are scattered randomly across the stage 2 area as shown in **Figure 23**.

8.4.4 Stage 2 target soil profile

Golder (**Golder, 22 July 2011**) have provided detailed results and discussion regarding the nature and extent of residual soil impacts remaining within the Stage 2 audit area. **Figure 23** and **Table 8.6** below provides a summary of the depth and nature of these residual soil impacts and also shows how the residual soil impacts are classified under the target soil profile outlined in the Specification.

It is noted that the depth of impact does not reflect upon the preclusion of a beneficial use (i.e. if a contaminant concentration is above the criteria protective of that beneficial use, it does not matter if the contaminant is at surface or 5mBGL – the beneficial use is still precluded). However, the depth of the impact may help determine the level of risk posed by that impact on the potential receptor.

The majority of shallow residual impacts (0-1mBGL) are inorganic (metals, sulphate, pH and cyanide), while the chemistry of the deeper impacts are more varied but generally include a higher proportion of hydrocarbon impacts including PAHs, MAHs, BTEX.

Based upon the results summarised above, soil in the Stage 2 audit area generally complies with the target soil profile (Class 1 in top metre, Class 2 below 1 metre) with the exception of:

- material that had to remain in situ due to boundary conditions or water table considerations; and
- “remaining” material considered not to be a risk to human health and/or leaching to groundwater (for example, elevated sulphate and metals such as arsenic and zinc).

Soil contamination in Stage 2 is therefore considered to have been cleaned up to the extent practicable. With the exception of the shallow residual impacts outlined above, **Figure 24** is a contour plan of the top of Class 2 material across the Stage 2 audit area.

A human health risk assessment was completed (**Golder, Feb 2010**) to assess the vapour risk from residual soil and groundwater associated with excavation 002 beneath the former tar dam. The assessment included the following residual soil contaminants: benzo(b)fluoranthene, chrysene, naphthalene, TPH C6-C9, and TPH C10-C14. The outcomes of this assessment are discussed in more detail in **Section 9**.

Table 8.6 Summary of residual soil impacts and all protected beneficial uses – Stage 2

Residual Contaminants	Min concentration (mg/kg)	Max concentration (mg/kg)	Class	Modified ecosystems	Human health Residential sensitive use	Human health Commercial / industrial use	Buildings & structures	Aesthetics	Production of food, flora & fibre
Surface to 1mBGL (Class 1)									
Metals									
Arsenic	27	97	Class 2						
Total Chromium	<5	110	Class 2						
Copper	<5	105	Class 2						
Mercury	<0.05	3.9	Class 2						
Nickel	61	110	Class 2						
Zinc	240	460	Class 2						
PAHs									
BaP	1.1	8.8	Class 3						
NAP	0.1	2.4	no criteria						
Total PAHs	22	68	Class 2						
MAHs									
Benzene	-	-	-						
Toluene	-	-	-						
Ethyl benzene	-	-	-						
Xylenes	-	-	-						
1,2,4 TMB	<0.5	0.94	no criteria						
TPH <C9	-	-	-						
TPH >C9	<120	1370	Class 3						
Cyanide	270	9500	Class 3						
Sulphate	2300	3100	Class 3*						
pH (>4 pH units)	3.5	3.9	Class 2						
At depth >1mBGL (Class 2)									
Metals									
Arsenic	21	82	Class 2						
Copper	-	-	-						
Total Chromium	120	180	Class 2						
Lead	<5	420	Class 2						
Mercury	1.1	3.4	Class 2						
Nickel	65	130	Class 2						
Zinc	310	770	Class 2						
PAHs									
BaP	1.1	73	Class 3						
NAP	0.1	2000	no criteria						
Total PAHs	24	4000	Class 3						
MAHs									
Benzene	1.3	76	Class 3						
Toluene	8.1	100	Class 3						
Ethyl benzene	3.7	22	Class 3						
Xylenes	28	160	Class 3						
1,2,4 TMB	<0.5	69	no criteria						
TPH <C9	170	22900	Class 3						
TPH >C9	190	34000	Class 3						
Cyanide	330	480	Class 2						
Sulphate	2200	3800	Class 3*						
pH (>3 pH units)	3.2	3.9	Class 1						

Notes:
Dark grey shading – beneficial use precluded
Light grey shading – target soil profile Class exceeded
No criteria – no Class criteria specified
see discussion on aesthetic impacts
* see discussion on elevated sulphate concentrations in soil

8.5 Stage 2A audit area - final soil conditions

In accordance with the Land SEPP, the development is classified as medium / high density residential and/or commercial/industrial and falls under the land use *Sensitive Use: Other*. In order for a *Certificate of Environmental Audit* to be issued, it must be demonstrated that the site is neither detrimental nor potentially detrimental to any one or more of the relevant beneficial uses of the site.

Although 'Maintenance of Natural Ecosystems' is not required to be protected for the proposed medium / high density residential development, consideration is given to this beneficial use in order to consider unrestricted use of the site.

The distribution of residual soil impacts in Stage 2A are shown on **Figures 17, 21 and 23**, and these are described in more detail below.

8.5.1 "Boundary" residual soil impacts

Figures 21 and 23 show the distribution of shallow and deep residual soil impacts present along the western site boundary. These impacts were unable to be removed due to the proximity of the railway fence line and rail infrastructure adjacent to the western boundary.

- Excavation along the western site boundary (see site photographs from 10 December 2008 in **Appendix F**) show the presence of ashy fill and some discoloured (blue/green and black staining) material in addition to fill containing bricks and other miscellaneous building rubble. Much of the shallow impacts comprise of less volatile hydrocarbons such as B(a)P, PAHs, TPH C₉-C₃₆ and inorganics such as cyanide, arsenic and nickel (see **Table 8.7** for summary of residual impacts associated with the gas easement and site boundary).
- The majority of excavations along the western boundary terminated at less than 4mBGL and therefore deeper residual impacts along the boundary are similar in nature to those noted between 0 to 1mBGL.

8.5.2 "Gas main" residual soil impacts

The distribution of residual impacts is effected by the presence of the gas infrastructure and the site boundary with the rail line. Both these structures required a safety buffer around them where no excavation work could be conducted.

- Gas main impacts generally comprise hydrocarbons such as B(a)P, PAHs, TPHs and cyanide. The concentrations of residual impacts associated with the gas main appear to increase with depth (see **Table 8.7**).

8.5.3 "Remaining" residual soil impacts

As with Stage 2, scattered shallow and deeper (below 1mBGL) residual soil impacts are present in the Stage 2A audit area. In general, these impacts are considered not to pose an unacceptable risk to site users if appropriate precautions are taken.

As indicated in **Table 8.7** below and **Figure 23**, inorganic impacts (including arsenic, mercury, nickel and cyanide) classified as “remaining” are present at depths ranging from surface to approximately 4mBGL, with the majority located in the northern portion of the Stage 2A audit area.

Table 8.7 Residual soil impacts following excavation of gas easement*

Residual Contaminants	Min concentration (mg/kg)	Max concentration (mg/kg)	"boundary"	"gas main"	"remaining"
Surface to 1mBGL					
PAHs					
BaP	<0.1	19	x	x	
NAP	<0.1	6.5	x	x	
Total PAHs	<0.1	360	x	x	
TPHs					
TPH <C9	<20	210		x	
TPH >C9	<120	10240	x	x	
Inorganics					
Arsenic	<5	65	x		x
Mercury	-	-			x
Zinc	<	460			x
Nickel	<5	140		x	x
Cyanide	<5	12000	x	x	x
At depth >1mBGL**					
PAHs					
BaP	<0.1	140		x	
NAP	<0.1	2600		x	
Total PAHs	<0.1	6500		x	
MAHs					
Xylenes	<0.5	2.1		x	
TMB (124)	<0.5	18		x	
TPHs					
TPH <C9	<20	1300		x	
TPH >C9	<120	69000	x	x	
Inorganics					
Arsenic	<5	130	x		x
Mercury	<0.05	1.9	x		x
Zinc	<5	440	x		x
Nickel	<5	130	x		x
Chromium	<5	350	x		x
Copper	<5	190			x
Lead	<5	930			x
Cyanide	<5	26000		x	x

Notes:

* includes service excavations, probes, and trenches: excavations 189, 213, 228, 229, GP27, GP30, S1-1 to S1-9, S2-1 to S2-4, S2-7, S3-1 to S3-3, S4-1 to S4-5, S4-8 to S4-16, S4-19, S4-23 to S4-26, S621, T1 – T2, T5, T8, and

Railway Boundary

** maximum depth of excavation 4.1mBGL for services & trenches, 6.4mBGL for excavations.

8.5.4 “Groundwater” residual soil impacts

The excavation 189 located in the northern portion of Stage 2A is the only known location on Stage 2a where hydrocarbon impacts extended into the water table and could not be entirely removed. Residual impacts are summarised in **Table 8.8** below.

Table 8.8 Residual soil impacts at the water table (excavation 189*)

Residual Contaminants	Min concentration (mg/kg)	Max concentration (mg/kg)	"groundwater"
At depth >1mBGL**			
PAHs			
BaP	<0.1	270	x
NAP	<0.1	4600	x
Total PAHs	<0.1	10000	x
MAHs			
Benzene	<0.5	340	x
Toluene	<0.5	500	x
Ethyl benzene	<0.5	20	x
Xylenes	<0.5	370	x
TMB (123)	<0.5	39	x
TPHs			
TPH <C9	<20	1600	x
TPH >C9	<120	32100	x

Notes:

* includes excavations 019, 021, 022, 023, 024, 075, 188, 189, 189TP7, 210, 213, 235

** maximum depth of excavation 9.1mBGL

8.5.5 Stage 2A target soil profile

Golder (**Golder, 22 July 2011**) have provided detailed results and discussion regarding the nature and extent of residual soil impacts beneath the Stage 2A audit area. As for the Stage 2 audit area, **Table 8.9** below provides information on both the exceedences of the target soil profile and beneficial uses. The data shows that:

- remediation to the extent practicable has not been able to achieve the desired target soil profile in all areas; and
- limitations relating to excavation work along the rail line boundary and in the vicinity of the gas mains, as well as depth limitations encountered in excavation 189 (north west corner of the site) have resulted in all beneficial uses of land being potentially precluded.

As a result of residual soil impacts in both the shallow and deep soil profile, the Auditor notes that further remediation will have to be conducted to restore any beneficial use of land for the Stage 2A audit area.

In order to further assess the consequences of the residual impacts of risk to human health, a human health risk assessment was conducted (**Golder, Feb 2010**) to assess the potential vapour risk from residual soil and groundwater impacts (particularly naphthalene and TPHs) associated with excavation 189 located in the northwest corner of the audit area. The outcomes of this assessment are discussed in more detail in **Section 9**.

Table 8.9 Summary of residual soil impacts and all protected beneficial uses – Stage 2A

Residual Contaminants	Min concentration (mg/kg)	Max concentration (mg/kg)	Class	Modified ecosystems	Human health Residential sensitive use	Human health Commercial / industrial use	Buildings & structures	Aesthetics	Production of food and flora
Surface to 1mBGL (Class 1)									
Metals									
Arsenic	23	65	Class 2						
Total Chromium	-	-	-						
Copper	-	-	-						
Mercury	-	-	-						
Nickel	66	140	Class 2						
Zinc	400	440	Class 2						
PAHs									
BaP	1.7	19	Class 3						
NAP	0.1	7.3	no criteria						
Total PAHs	21	360	Class 3						
MAHs									
Benzene	-	-	-						
Toluene	-	-	-						
Ethyl benzene	-	-	-						
Xylenes	-	-	-						
1,2,4 TMB	<0.5	2.6	no criteria						
TPH <C9	<120	210	Class 3						
TPH >C9	1100	10240	Class 3						
Cyanide	290	12000	Class 3						
Sulphate	-	-	-						
pH (>4 pH units)	-	-	-						
At depth >1mBGL (Class 2)									

Residual Contaminants	Min concentration (mg/kg)	Max concentration (mg/kg)	Class	Modified ecosystems	Human health Residential sensitive use	Human health Commercial / industrial use	Buildings & structures	Aesthetics	Production of food and flora
Metals									
Arsenic	23	130	Class 2						
Copper	<5	190	Class 2						
Total Chromium	110	350	Class 2						
Lead	<5	930	Class 2						
Mercury	1.4	1.9	Class 2						
Nickel	61	130	Class 2						
Zinc	230	280	Class 2						
PAHs									
BaP	0.7	270	Class 3						
NAP	0.1	4600	no criteria						
Total PAHs	21	10000	Class 3						
MAHs									
Benzene	130	340	Class 3						
Toluene	250	500	Class 3						
Ethyl benzene	9.5	20	Class 3						
Xylenes	120	370	Class 3						
1,2,4 TMB	<0.5	18	no criteria						
TPH <C9	120	1600	Class 3						
TPH >C9	370	69000	Class 3						
Cyanide	290	26000	Class 3						
Sulphate	2400	3700	Class 3*						
pH (>3 pH units)	-	-	-						

Notes:

Dark grey shading – beneficial use precluded

Light grey shading – target soil profile Class exceeded

No criteria – no Class criteria specified

see discussion on aesthetic impacts

* see discussion on elevated sulphate concentrations in soil

9. Risk assessment

After the completion of remedial works, residual soil contamination that precluded relevant beneficial uses remained in situ at the site. This was due to excavation being limited by the proximity of; site boundaries; the water table; and gas infrastructure. The use of generic investigation levels provides a conservative approach to the assessment of site suitability for intended uses. As these investigation levels are exceeded at specific locations at the site, quantitative human health risk assessments (HHRAs) were conducted to further understand the implications of the exceedences of the nominated criteria.

Golder conducted risk assessments to address two specific issues relating to the future redevelopment of the site:

1. Risk posed to onsite and offsite sensitive receptors (residential) from residual soil impacts located:
 - a) at the site boundaries which cannot be removed; and
 - b) at depth (i.e. below the water table) which cannot be removed.
2. Risk posed by Class 2 material located directly beneath a building, basement carpark or road slab, and Class 2 or 3 material at a depth of up to 4mBGL. Impacts below 4mBGL were not included in the modelling as they were assumed to present a further reduced risk.

9.1 HHRA – deep excavations and groundwater

Golder Associates, 02-Feb-10. Revised Human Health risk Assessment, Highett Gasworks Site, 1136-1138 Nepean Highway Highett, Victoria. Report No 05613598 131 rev 2.

9.1.1 Objectives and scope

This risk assessment set out to Establish whether residual soil and groundwater contamination posed an unacceptable risk to future onsite residential receptors, and to also calculate risk-based site-specific soil and groundwater criteria for the chemicals of interest.

The investigation was conducted in three phases:

- Phase 1 – initial HHRA. To model whether residual soil and groundwater contamination poses an unacceptable risk to future onsite residential receptors;
- Phase 2 – Soil vapour monitoring (Round one vapour sampling conducted Feb 2009, round two conducted April 2009). Installation, sampling and analysis of eight soil vapour bores in the vicinity of excavation 189 (northwest corner of Stage 2A); and
- Phase 3 – Revised HHRA including soil vapour results and residual impacts in close proximity to the gas main. The Phase 3 assessment reflected the final soil and groundwater conditions for the site following remediation. The assessment also included shallow residual soil impacts located on the northern, eastern and southern boundaries.

It is noted that potential pathways of exposure and receptors considered in the Phase 3 assessment were:

- Receptor:
 - Future onsite residents
- Potential pathways:
 - Vapour migration from residual soil impacts to onsite residential indoor air;
 - Vapour migration from residual groundwater impacts to onsite residential indoor air; and
 - Vapour migration from residual soil impacts to offsite residential indoor air.

The following scenarios were also considered in a qualitative sense but did not warrant further quantitative analysis:

- Potential commercial/industrial sensitive receptors;
- Risks to onsite residential receptors from vapour migration to outdoor air;
- Risks to onsite residential receptors from direct contact with soil and/or groundwater; and
- Risks to construction and maintenance workers from direct contact with soil and/or groundwater.

9.1.2 Results

Phase 1

Site-specific risk-based groundwater criteria for indoor air vapour inhalation were developed for TRH C₁₀-C₁₄ (3.5mg/L) and benzene (0.9mg/L). Two monitoring wells (BH9140004 and BH6) located in the northwest corner of the site in the vicinity of excavation 189 exceeded these values.

A potential vapour risk (indoor air) associated with naphthalene and benzene in soils at depth (>5mBGL) in excavations 002, 217, 189 and 210 (located in the northwest corner of the site and in the vicinity of the tar dam).

Phase 2

Analysis of soil vapour samples from the vicinity of excavation 189 in the north west corner of the site indicated that the following 5m deep vapour bores reported chemical concentrations above the laboratory limit of reporting: GP001A (toluene, ethylbenzene, xylenes, 1,2,4 TMB, TCM); GP002A (naphthalene); GP004A (numerous). Only one shallow bore, GP004B installed at 2.5mBGL, reported concentrations of benzene and naphthalene. See **Table D5 in Appendix D** for soil vapour results.

It is noted that the soil vapour RISC modelling results were based on residual soil and groundwater impacts (from Phase 1) and were found to be conservative (at least 3 orders of magnitude higher than the measured soil vapour concentrations reported in Phase 2).

Phase 3

The residual contamination in the vicinity of the gas main on Stage 2A represented by the concentrations in excavations 228, 229, S2-7, S4-16, and T8 pose an unacceptable vapour risk to residential receptors should be removed prior to residential redevelopment (**Figure 26, Appendix A**).

The risks to future onsite and current offsite residents (indoor air) from residual soil and groundwater impacts at the site, beyond the areas noted above, were considered to be acceptable.

9.1.3 Auditor comments

The Auditor noted the following key assumptions that with regard to the risk posed and future management of residual soils at site boundaries and at depth:

- The maximum residual soil concentrations of benzene and naphthalene remaining in situ along the gas easement were not utilised by Golder in modelling vapour risks (in Phase 3) on the basis that they will be removed along with the old gas main. However, maximum benzene and naphthalene concentrations below 1mBGL were modelled as part of the Phase 1 assessment and indicated a potentially unacceptable risk to human health. Golder state the contamination represented by the concentrations in excavations 228, 229, S2-7, S4-16 and T8 will ultimately be remediated during the removal of the old gas infrastructure.
- That the residual material along the western boundary(Stage 2A) is likely to be located beneath an easement for gas utilities and would therefore not contain more sensitive receptors;
- That the residual material would be noted in the Audit report;
- That direct contact with residual contamination in soil at the site would be managed through the placement of a 1m layer of fill material (Class 1 material) – this is not currently the case for the gas main easement in the Stage 2A audit area;
- The residual soil contamination (Class 3 and Class 2 exceedances) associated with identified areas of the gas infrastructure within Stage 2A will be excavated, remediated and validated as part of the planned gas infrastructure decommissioning to be undertaken in 2012 and 2013; and as a consequence of this
- The Stage 2A area will be subject to another Environmental Audit to assess its suitability for medium/high density residential use.

As the Auditor cannot place future clean up conditions in a Statement of Audit, the Statement of Audit for Stage 2A will consider the site in its current condition.

9.1.4 Auditor review

The Auditor reviewed and commented upon four revisions of the HHRA from 2008 to 2010 (**Table H1, Appendix H**). A summary is provided below.

- Golder Associates, 11-Sep-08. Draft Human Health Risk Assessment, Former Gasworks Site, 1136 Nepean Highway, Highett, Victoria. Report No. 05613598 131 R Rev0.
- Golder Associates, 20-Mar-09. Summary of Round one of Soil Vapour Assessment, Former Gasworks Site, 1136 Nepean Highway, Highett. Report no 05613598 150 L Rev0.
- Golder Associates, 20-Oct-09. Revised Human Health Risk Assessment Highett Gasworks Site, 1136-1138 Nepean Highway Highett, Victoria October 2009 Report No. 05613598/131 Rev1.
- Golder Associates, 02-Feb-10. Revised Human Health risk Assessment, Highett Gasworks Site, 1136-1138 Nepean Highway Highett, Victoria. Report No 05613598 131 rev 2.
- Golder Associates, 6 September 2011. Letter report: Response to auditor's comments on human health risk assessment of Class 2 material below buildings. Former Gasworks Site, 1136 Nepean Highway, Highett. Report Number: 05613598-197-L-Rev0 (contains further information relating to the site wide HHRA as well as Class 3 material).
- Golder Associates, 6 September 2011. Letter report: Response to auditor's comments on environmental assessment and remediation, Highett Gasworks Site, Stage 2. Report Number: 05613598-198-L-Rev0.

In reviewing these documents, the auditor was cognisant of the following:

- That all potential receptors (both onsite and offsite as well as residential and commercial) and pathways (vapour migration was identified as the driver due to the likely audit conditions on the site to manage residual soil impacts near surface) were assessed;
- That appropriate chemicals of interest (COIs) were selected and assessed and where appropriate, these COIs were modelled both individually and cumulatively; and
- That the sources of the potential risks were identified (e.g. residual soil at site boundaries; residual soil at depth; and residual groundwater impacts) and appropriately characterised.

While the Auditor noted that cumulative hazard quotients were not calculated for all COIs as recommended by the Auditor, the level of conservatism inherent within the risk assessment meant that the Auditor was satisfied that the risk had been appropriately quantified.

Similarly, while the HHRA assessed risk to onsite residential receptors and did not assess onsite commercial users, the extra level of conservatism associated with residential receptors was deemed to adequately protect potential commercial/industrial site users.

9.2 HHRA – Class 2 soil under buildings

Golder Associates, 18-Jan-11. Human Health Risk Assessment of Class 2 Material Below Buildings. Former Gasworks Site, 1136 Nepean Highway, Highett. Report Number: 05613598-090-R-Rev0.

9.2.1 Objectives and scope

This HHRA was instigated to confirm that the adopted target soil profiles did not pose an unacceptable risk to site users. Specifically, whether Class 2 material beneath areas of hardstand, road and basement concrete slabs, posed an unacceptable risk to human health and the environment – particularly vapour migration to basements or car parks.

This report discussed risks of:

- Vapour migration into slab-on-ground residential buildings.
- Vapour migration into basement residential car parks.

The identified chemical of concern was considered to be naphthalene.

Residual impacts at the boundary of the site were not included in the assessment as they had been covered in the broader HHRA conducted in Feb 2010 (discussed above).

9.2.2 Results

The results of the Class 2 risk assessment indicated that:

- Risks due to the presence of volatile PAHs in residual Class 2 soil were acceptable as concentrations of vapour anticipated to enter overlying structures were below levels likely to present a health concern;
- Risk due to the presence of other chemicals within residual Class 2 soils were considered to be acceptable on the basis that analytes had previously been assessed under conservative (sensitive use) guidelines;
- Risk due to the presence of other chemicals within residual Class 2 soils were considered to be acceptable due to the low volatility of the contaminants; and
- The presence of Class 2 material located immediately beneath residential buildings or residential basement carparks were considered to be acceptable.

9.2.3 Auditor comments and review

The Auditor reviewed and commented upon one revision of the Class 2 HHRA plus a number of additional correspondences. See **Table H1, Appendix H** for summary of reviews. Below is a list of the reports and correspondence the Auditor has reviewed and commented on:

- Golder Associates, 18-Jan-11. Human Health Risk Assessment of Class 2 Material Below Buildings. Former Gasworks Site, 1136 Nepean Highway, Highett. Report Number: 05613598-090-R-Rev0.
- Golder Associates, 6 September 2011. Letter report: Response to auditor's comments on human health risk assessment of Class 2 material below buildings. Former Gasworks Site, 1136 Nepean Highway, Highett. Report Number: 05613598-197-L-Rev0.

- Golder Associates, 6 September 2011. Letter report: Response to auditor's comments on environmental assessment and remediation, Highett Gasworks Site, Stage 2. Report Number: 05613598-198-L-Rev0.

The Auditor was satisfied with the scope and quality of the HHRA and concurs with the outcomes of the assessment.

9.3 Assessment of beneficial uses - Stage 2

The HHRA findings indicated that residual soil impacts containing volatile compounds that may represent a vapour intrusion risk, are not considered to present an unacceptable risk to human health or the environment. **Table 9.1** below shows the beneficial uses of the land that were initially considered as potentially precluded by residual contamination, and the modification of this determination on the basis of the HHRAs. Specifically:

- Volatile impacts precluding various beneficial uses below 1mBGL will be managed as part of the environmental management plan (EMP) and are not considered to pose an unacceptable risk to human health;
- Volatile impacts precluding various beneficial uses located at the site boundaries at less than 1mBGL are not considered to present an unacceptable risk to human health;
- The HHRA identified that non-volatile impacts in the top metre of soil (cyanide, metals, sulphate) would not pose an unacceptable risk to site users as long as access to these impacts was restricted as identified in the conditions of the Statement of Audit and site environmental management plan (EMP);
- Potentially volatile impacts precluding various beneficial uses located in the top one metre of soil (not related to boundary impacts) have a scattered distribution and as such are unlikely to pose an unacceptable vapour risk to future site users;
- As noted in **Section 8.3.2**, residual aesthetic impacts are considered to be scattered in nature and manageable under the conditions of the Statement of Audit and site environmental management plan (EMP);
- Non-volatile compounds below 1 metre are not considered an unacceptable risk due to restricted access and will be managed in accordance with the conditions of the Statement of Audit and site environmental management plan (EMP).

Based upon this assessment, the Auditor is satisfied that the Stage 2 audit area is suitable for medium to high density residential and recreational open space land uses. It is noted that the beneficial use – production of food, flora and fibre, while of marginal relevance to the site, will be protected in the Stage 2 audit area under the conditions outlined in the EMP (in particular the maintenance of a 1m thick separation layer of Class 1 material).

Table 9.1 Final assessment of beneficial uses of the land – Stage 2

Residual Contaminants	Maintenance of modified ecosystems	Human health Residential sensitive use	Human health Commercial / industrial use	Buildings & structures	Production of food, flora & fibre
Surface to 1mBGL					
Metals	EMP	EMP			EMP
PAHs	EMP	No unacceptable risk	No unacceptable risk		EMP
MAHs	EMP				EMP
TPHs	EMP	No unacceptable risk	No unacceptable risk		EMP
Cyanide	EMP	EMP	EMP		EMP
Sulphate				EMP	
pH (>4 pH units)				EMP	
At depth >1mBGL					
Metals	EMP	EMP			EMP
PAHs	EMP	No unacceptable risk	No unacceptable risk		EMP
MAHs	EMP	No unacceptable risk	No unacceptable risk		EMP
TPHs	EMP	No unacceptable risk	No unacceptable risk		EMP
Cyanide	EMP	EMP			
Sulphate				EMP	
pH (>3 pH units)					

Notes:

EMP – risk will be managed by audit conditions and EMP

No unacceptable risk – risk assessment indicates that impact pose no unacceptable risk

9.4 Assessment of beneficial uses - Stage 2A

The residual contamination in the vicinity of the gas main on Stage 2A represented by the concentrations in excavations 228, 229, S2-7, S4-16, and T8 pose an unacceptable vapour risk to residential receptors must be removed prior to residential redevelopment (**Figure 26, Appendix A**).

Table 9.2 below reflects the conclusions of the HHRAs specifically:

- Residual volatile contaminants (hydrocarbons) precluding various beneficial uses below 1mBGL still constitute an unacceptable risk;
- Residual volatile contaminants (hydrocarbons) impacts precluding various beneficial uses located at less than 1mBGL still constitute an unacceptable risk;
- The HHRA identified that non-volatile impacts in the top metre of soil (cyanide, metals, sulphate) would not pose an unacceptable risk to site users as long as access to these impacts was restricted as identified in the conditions of the Statement of Audit and site environmental management plan (EMP);
- As noted in **Section 8.3.2**, residual aesthetic impacts are considered to be scattered in nature and manageable under the conditions of the Statement of Audit and site environmental management plan (EMP);
- Non-volatile compounds below 1 metre are not considered an unacceptable risk due to restricted access and would be managed in accordance with the conditions of the Statement of Audit and site environmental management plan (EMP).

Based upon this assessment, the Auditor has determined that the Stage 2A audit area is currently not suitable for medium to high density residential or commercial / industrial land uses and all beneficial uses of land are currently precluded (see **Figure 27, Appendix A**).

Table 9.2 Final assessment of beneficial uses of the land – Stage 2A

Residual Contaminants	Maintenance of modified ecosystems	Human health Residential sensitive use	Human health Commercial / industrial use	Buildings & structures	Production of food, flora & fibre
Surface to 1mBGL					
Metals	EMP				EMP
PAHs					EMP
MAHs					EMP
TPHs					EMP
Cyanide	EMP	EMP	EMP		EMP
Sulphate					
pH (>4 pH units)					
At depth >1mBGL					
Metals	EMP	EMP			EMP
PAHs					EMP
MAHs					EMP
TPHs					EMP
Cyanide	EMP	EMP	EMP		EMP
Sulphate				EMP	
pH (>3 pH units)					

Notes:

EMP – risk could be managed by audit conditions and EMP

Dark grey shading – beneficial use precluded

10. Conclusions

10.1 Stage 2 Audit Area

A Statement of Environmental Audit has been issued for the site and is attached to the front of this Audit report. It takes into account all relevant findings and conclusions, and specifies the range of uses for which the site, in its current form is suitable. The Statement of Environmental Audit also includes the EPA determination of Clean Up to the Extent Practicable (CUTEP) and the resulting Groundwater Quality Restricted Use Zone (GQRUZ) for the Stage 2 audit area.

The site (Stage 2) in its current condition is considered suitable for the intended medium-density residential development, subject to the following conditions, as outlined in the Statement of Environmental Audit:

- Groundwater at the site is polluted. Groundwater must not be used for any beneficial use without prior testing and review of results by an environmental auditor (appointed under part IXD of the *Environmental Protection Act 1970*) to confirm its suitability for that use. It may be extracted for the purpose of environmental monitoring or remediation.
- Prior to 31 January 2012, the Groundwater Quality Management Plan (GQMP) formulated for the site and accepted by the environmental auditor must be implemented and maintained by the Department of Treasury and Finance and future owners of the site. The GQMP provides details on the groundwater monitoring program including, the monitoring wells to be sampled, laboratory analysis program, methodology, monitoring frequency, program duration, review procedure, reporting requirements and, roles and responsibilities.
- The GQMP forms part of this Statement of Environmental Audit and must be provided to all future owners/occupiers of the site.
- The GQMP must remain in force until such time as an environmental auditor (appointed under part IXD of the *Environmental Protection Act 1970*) confirms in writing that the monitoring and management requirements are no longer required, and this confirmation is advised in writing to the EPA and the planning authority. The GQMP has identified a Section 53V audit as the appropriate mechanism for cessation of the groundwater management and monitoring requirements.
- Prior to 29 February 2012, an Environmental Management Plan (EMP) must be developed for the site by a suitably qualified professional and accepted by an environmental auditor appointed under Part IXD of the *Environment Protection Act 1970*, and this acceptance advised in writing to EPA and the planning authority.
- Prior to 15 March 2012, the Department of Treasury and Finance and future owners of the site must implement and maintain the EMP.
- The site must be covered with a physical barrier, such as “fill” (consistent with IWRF 621) to a minimum depth of 1m, unless beneath building slabs, roads, or other concrete structures and must be specified in the EMP. The site in its current condition meets this requirement.

- Any landscaped area or garden beds must have at least 1m thickness of soil below the finished surface, which is demonstrated to be suitable for the site and consistent with IWRF 621 as “fill” and must be specified in the EMP.
- Access to residual soil impacts in shallow soil (<1mBGL) that could not be remediated due to proximity with the site boundary (as indicated in **Figures 23 and 27** of this report) should be minimised with the placement of either permanent paving, buildings or a barrier of at least 1m of clean fill. Where works require the excavation of soil along the northern, southeastern or southern boundaries, relevant workers should be made aware of the presence of contaminated soil in this area and appropriate protective measures taken during any excavation and maintenance works. Any soil/fill excavated from these areas is to be characterised and disposed to a licensed landfill as appropriate. The management of these soils should be managed in accordance with the EMP to avoid exposure and/or transport of impact material.
- All physical barriers (as stated above), if subsequently damaged or removed during development or occupation of the site, must be reinstated as soon as possible and to the same condition or better as they were prior to disturbance.

The condition of the site is detrimental or potentially detrimental to sensitive, commercial and industrial, and open space beneficial uses of the site. Accordingly, I have not issued a Certificate of Environmental Audit for the site in its current condition. The terms and conditions that need to be complied with before a Certificate of Environmental Audit may be issued are as set out as follows:

- Remediation of residual groundwater impacts associated with the site, to the extent that relevant beneficial uses of groundwater are restored.
- Removal of all residual soil impacts below the site.

Other related information

- The site (1136-1138 Nepean Highway Highett Stage 2) is defined by the coordinates presented in **Figure 1** of this report.
- A separate Statement of Environmental Audit has been issued for the adjoining Stage 2A area.
- The Authority has determined that groundwater has been cleaned up to the extent practicable and the site is a groundwater quality restricted use zone (GQRUZ) as illustrated in **Figure 25** of this report.
- Groundwater below the site is polluted and is not suitable for any beneficial use and should only be extracted for the purpose of environmental monitoring or remediation purposes.
- In accordance with clause 19(3) of the SEPP (Groundwaters of Victoria), the Authority may require periodic reassessment of the practicability of groundwater clean up.
- Soil and groundwater beneath the site may impact on future building footings and other subsurface structures due to its elevated sulphate content and reduced pH.

- Scattered pieces of coke, coal, black stained soil, have been reported at some locations on the site. This material has been removed as far as practicable but minor occurrences may remain within the soil and be uncovered during excavation works.
- Any material excavated from the site and disposed off site must be classified and managed in accordance with relevant statutory regulations and EPA guidelines.
- Any fill or soil imported to the site must be chemically tested soil or fill that classifies as “fill material” in accordance with relevant EPA guidelines.
- In accordance with section 53Z of the Environment Protection Act 1970 the owner/occupier of the site must provide a copy of this Statement to any person who becomes or proposes to become an occupier of the site.
- Not all land uses for which the land is considered suitable by this audit may be allowed under the existing zoning of the Kingston Council Planning Scheme.

10.2 Stage 2A Audit Area

A Statement of Environmental Audit has been issued for the site and is attached to the front of this Audit report. It takes into account all relevant findings and conclusions, and specifies the range of uses for which the site, in its current form is suitable. The Statement of Environmental Audit also includes the EPA determination of Clean Up to the Extent Practicable (CUTEP) and the resulting Groundwater Quality Restricted Use Zone (GQRUZ) for the Stage 2A audit area.

The site (Stage 2A) in its current condition is not suitable for any beneficial uses of land under the current residential 1 zoning (R1Z) or previous public use zone (commercial/industrial) due to the following residual soil impacts as outlined in the Statement of Environmental Audit:

- Groundwater at the site is polluted. Groundwater must not be used for any beneficial use without prior testing and review of results by an environmental auditor (appointed under part IXD of the Environmental Protection Act 1970) to confirm its suitability for that use. It may be extracted for the purpose of environmental monitoring or remediation.
- Prior 31 January 2012, the Groundwater Quality Management Plan (GQMP) formulated for the site and accepted by the environmental auditor must be implemented and maintained by the Department of Treasury and Finance and future owners of the site. The GQMP provides details on the groundwater monitoring program including, the monitoring wells to be sampled, laboratory analysis program, methodology, monitoring frequency, program duration, review procedure, reporting requirements and, roles and responsibilities.
- The GQMP forms part of this Statement of Environmental Audit and must be provided to all future owners/occupiers of the site.
- The GQMP must remain in force until such time as an environmental auditor (appointed under part IXD of the Environmental Protection Act 1970) confirms in writing that the monitoring and management requirements are no longer required, and this confirmation is advised in writing to the EPA and the planning authority. The GQMP has identified a

Section 53V audit as the appropriate mechanism for cessation of the groundwater management and monitoring requirements.

- 29 February 2012, an Environmental Management Plan (EMP) must be developed for the site by a suitably qualified professional and accepted by an environmental auditor appointed under Part IXD of the *Environment Protection Act 1970*, and this acceptance advised in writing to EPA and the planning authority.
- Prior to 15 March 2012, the Department of Treasury and Finance and future owners of the site must implement and maintain the EMP.
- No disturbance of soil shall be undertaken prior to the implementation of the EMP.

The condition of the site is detrimental or potentially detrimental to all beneficial uses of land. Accordingly, I have not issued a Certificate of Environmental Audit for the site in its current condition. The terms and conditions that need to be complied with before a Certificate of Environmental Audit may be issued are as set out as follows:

- Remediation of residual groundwater impacts associated with the site to the extent that relevant beneficial uses of groundwater are restored.
- Removal of all residual soil impacts below the site.

Other related information

- The site (1136-1138 Nepean Highway Highett Stage 2A) is defined by the coordinates presented in **Figure 1** of this report.
- A separate Statement of Environmental Audit has been issued for the adjoining Stage 2 area.
- The Authority has determined that groundwater has been cleaned up to the extent practicable and the site is a groundwater quality restricted use zone (GQRUZ) (**Figure 25** of this report).
- Groundwater below the site is polluted and is not suitable for any beneficial use and should only be extracted for the purpose of environmental monitoring or remediation purposes.
- In accordance with clause 19(3) of the SEPP (Groundwaters of Victoria), the Authority may require periodic reassessment of the practicability of groundwater clean up.

11. References

Site reports

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Golder Associates, 05-Apr-95. Preliminary site Contamination Assessment Former Gasworks Site, 1136 Nepean Highway, Highett.

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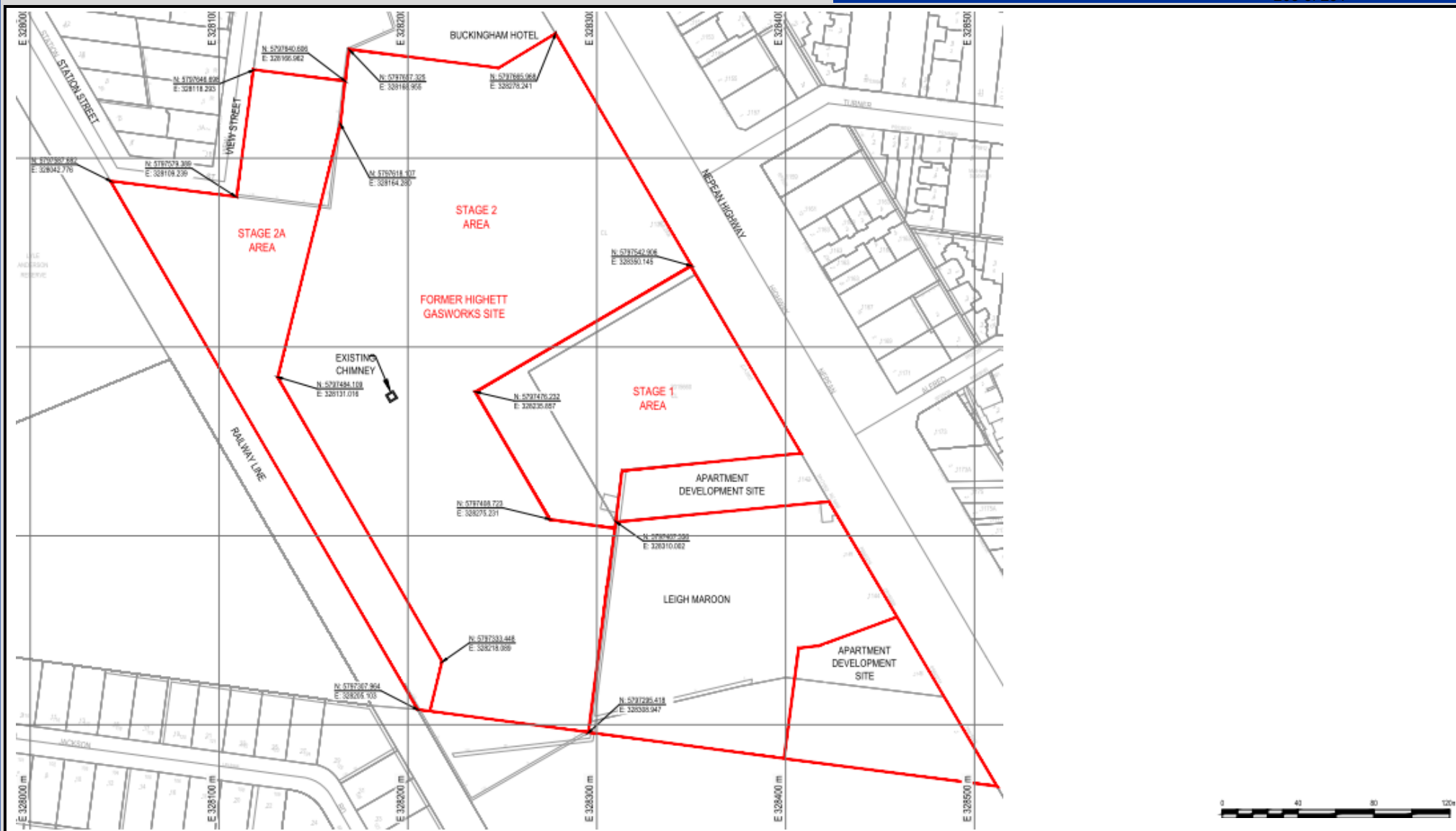
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Appendix A

Figures



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APPROX. HORIZONTAL SCALE



Source:
Golder, 22 July 2011

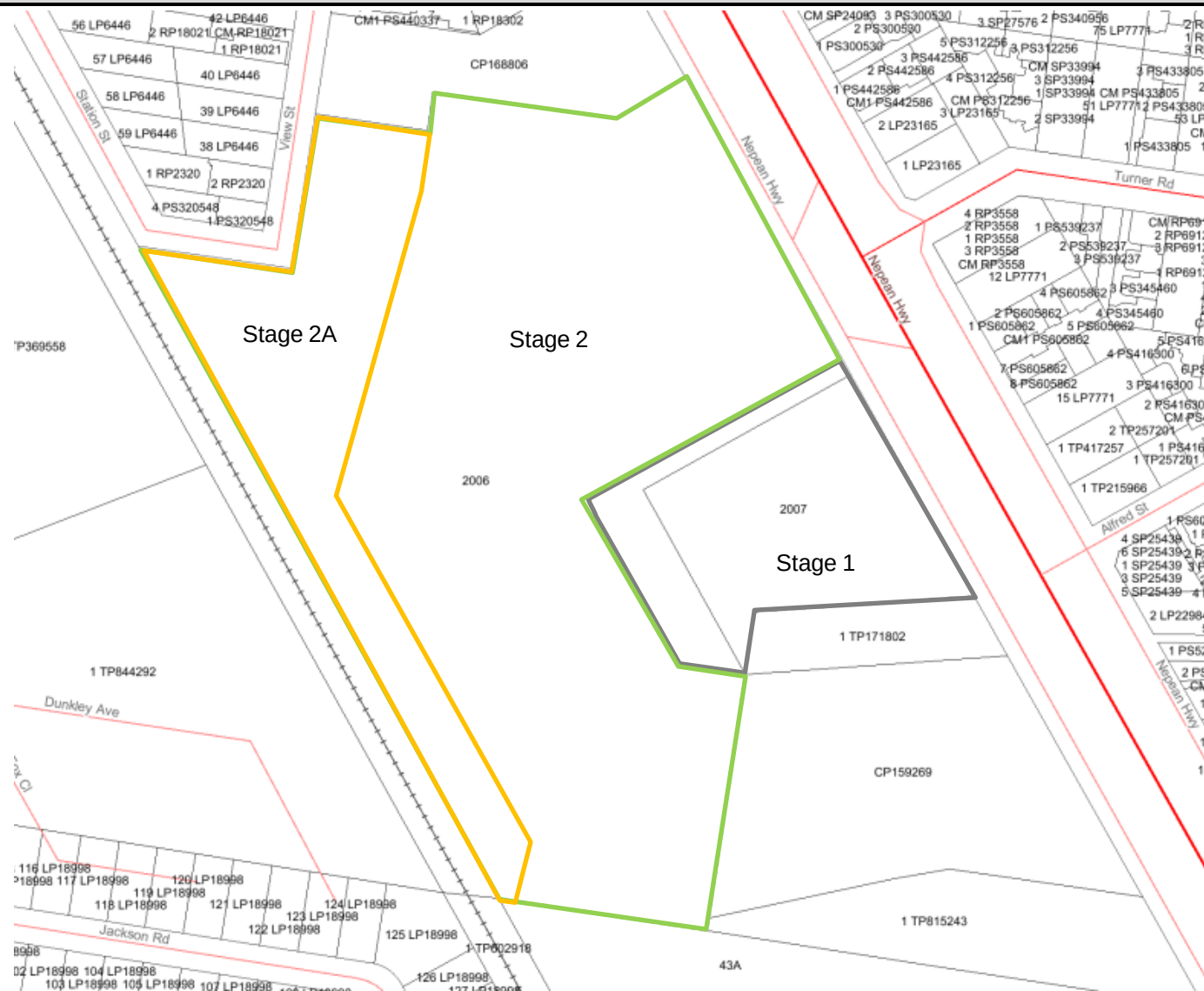


Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016

ABN 84 797 323 433

Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

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Project	Environmental Audit	File Name	
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APPROX. HORIZONTAL SCALE



Source:
DSE, Data warehouse, July 2011

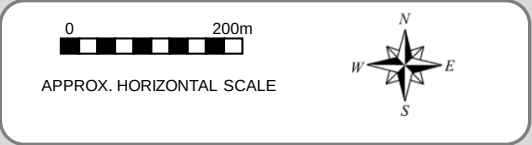


ABN 84 797 323 433

Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016

Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

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Source:
Base - Near Map
20 January 2011

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Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

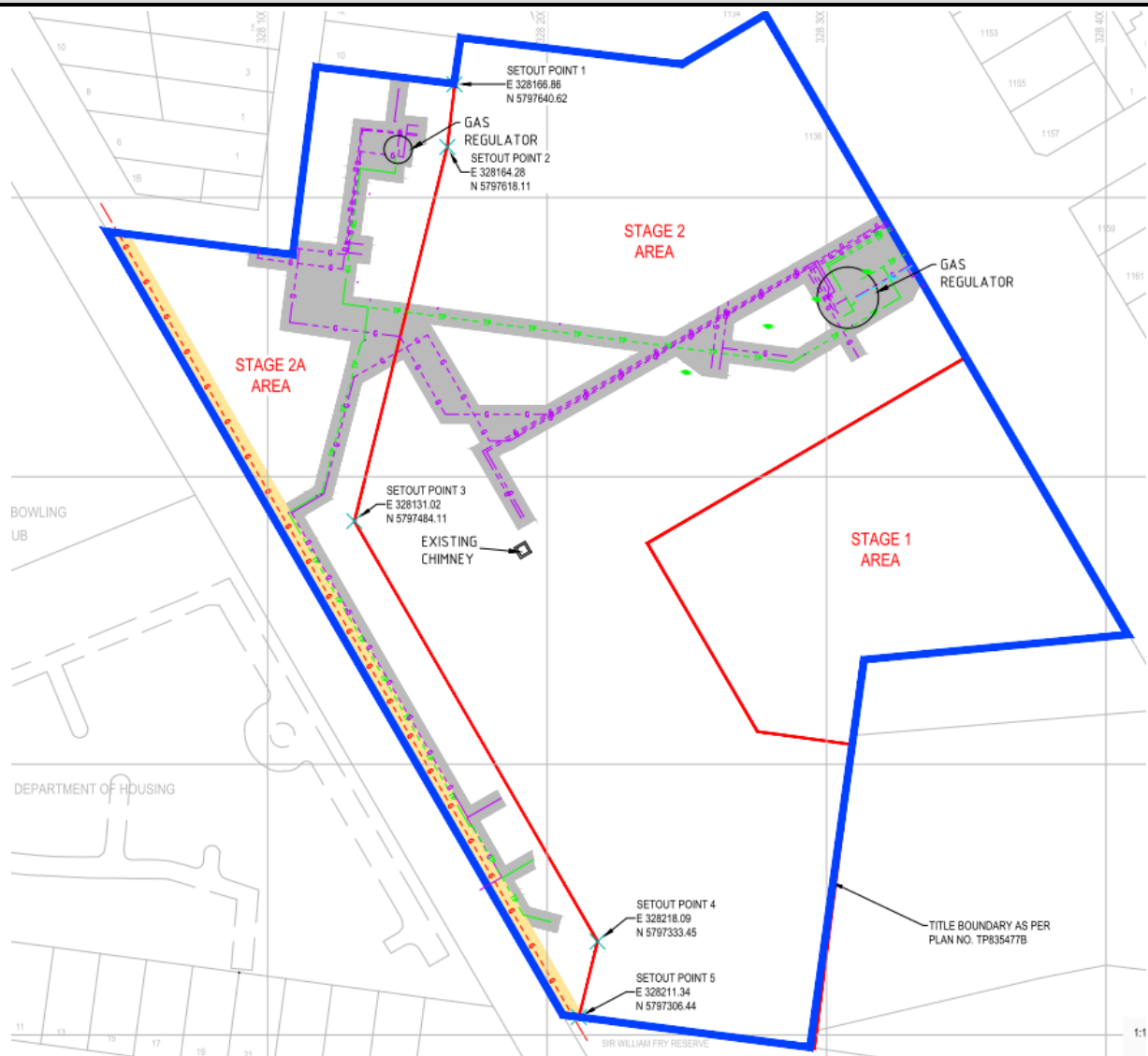
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LEGEND:

- **G** EXISTING GAS LINE TO BE REMOVED
- **TP** EXISTING TRANSMISSION PIPELINE TO BE REMOVED
- **SL** EXISTING SENSING LINE TO BE REMOVED
- EXISTING GAS INFRASTRUCTURE EASEMENT TO BE REMOVED
- **G** NEWLY INSTALLED GAS MAIN
- NEW EASEMENT
- INTERNAL BOUNDARY OF STAGES 2 AND 2A
- TITLE BOUNDARY
- + STAGE 2A SETOUT POINT

NOTE:

1. ALL COORDINATES ARE TO MGA ZONE 55



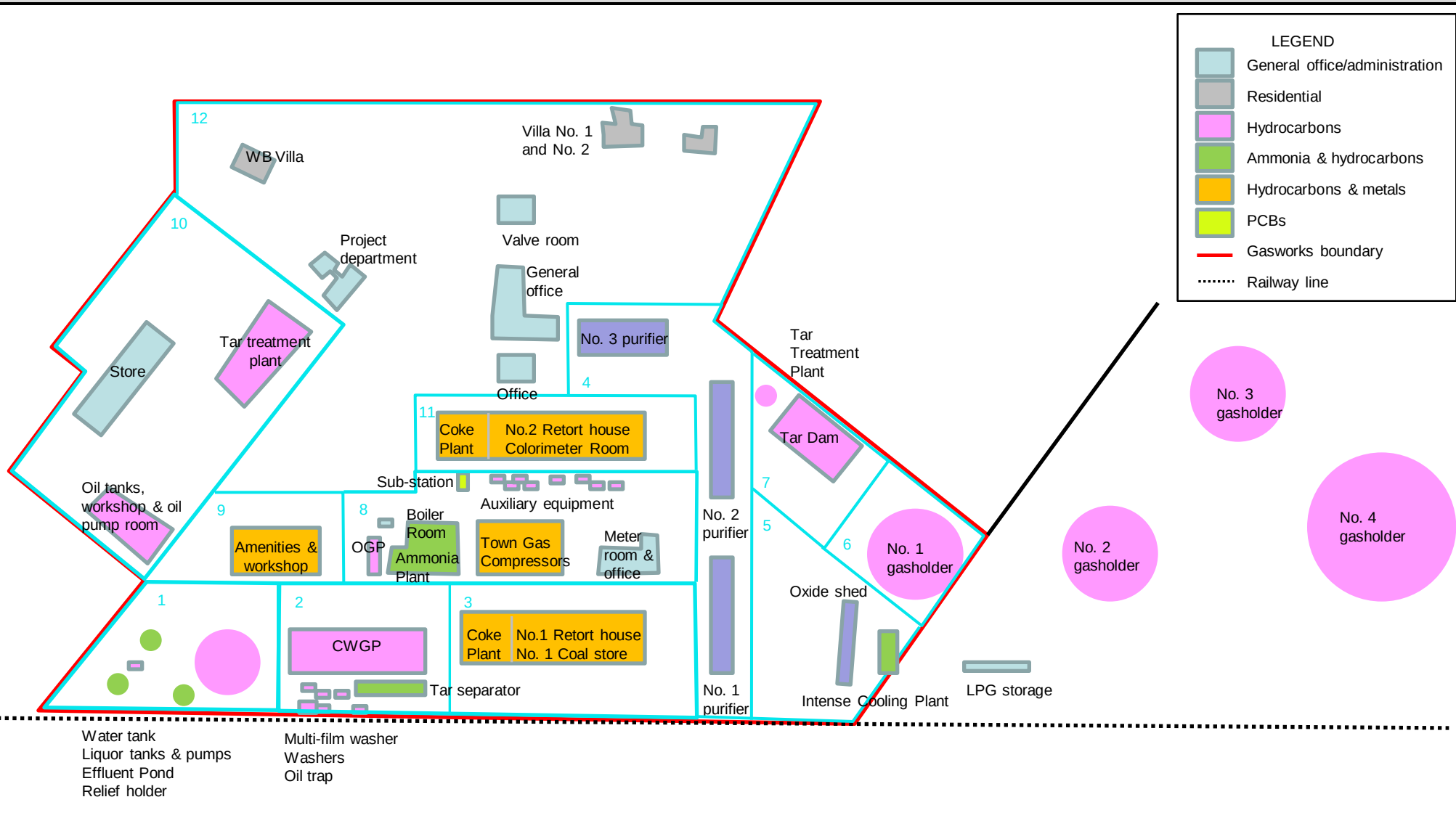
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APPROX. HORIZONTAL SCALE



Source:
Golder, Figure 3, May 2010
CUTEP report

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122
ABN 84 797 323 433
Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
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Source:
Base – Gas & Fuel, Figure 3.1,
1994

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1225
ABN 84 797 323 433
Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
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Source:
Gas & fuel, Figure 4.7, 1994
Base map – Flash Earth :
Microsoft VE

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Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
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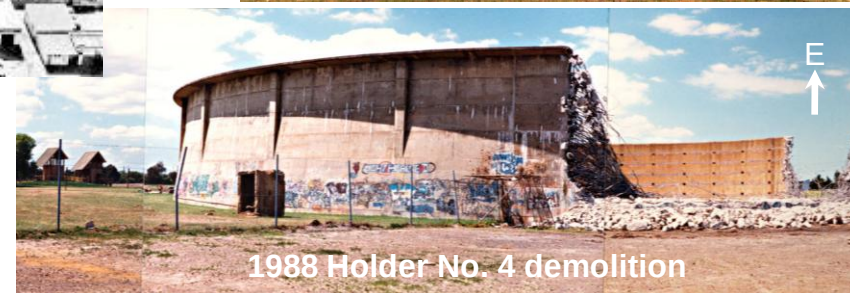
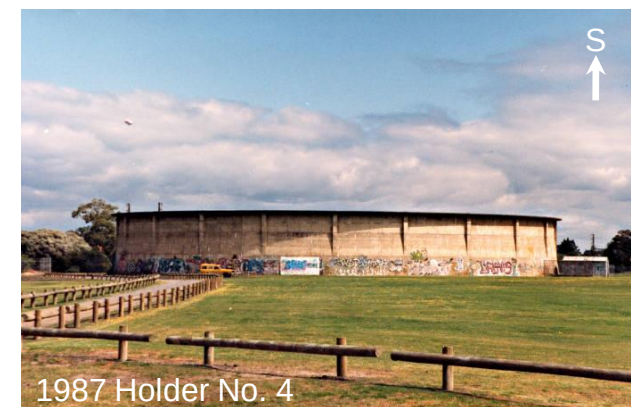
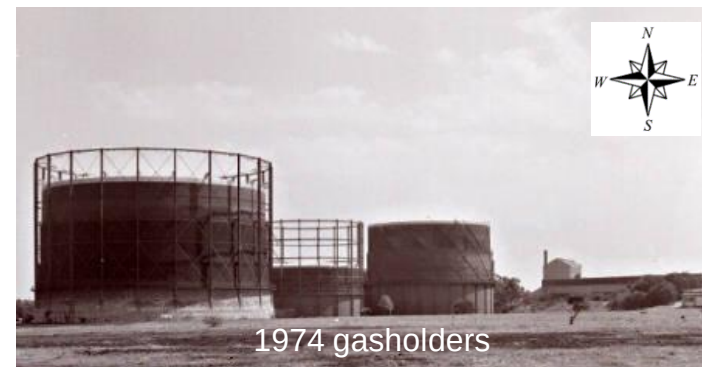
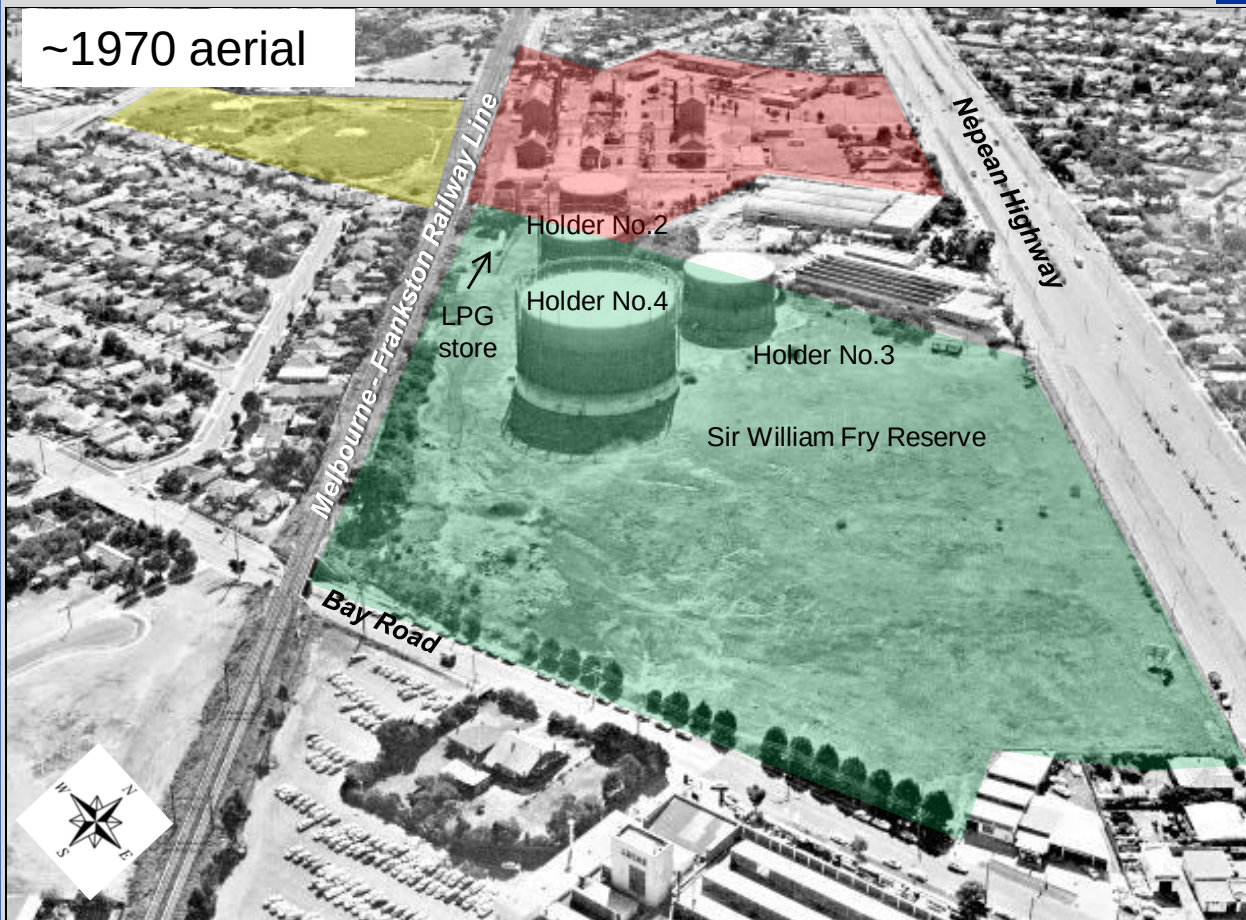


Sources:
Base - Near Map
20 January 2011

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125+
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Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
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~1970 aerial



0 50m

APPROX. HORIZONTAL SCALE

Source:
City of Kingston website

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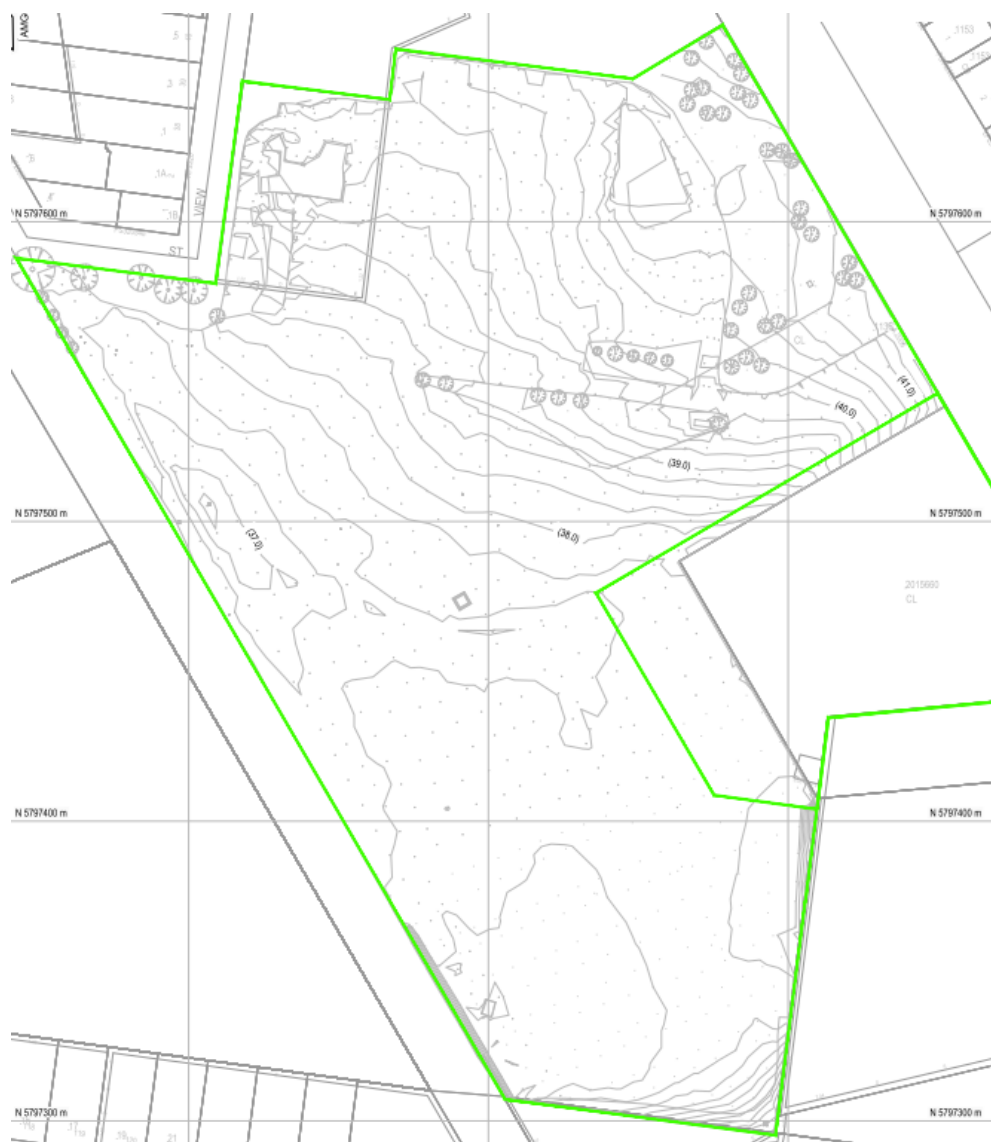
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~1970 aerial



APPROX. HORIZONTAL SCALE

Source:
City of Kingston website



LEGEND

- (40.0) —— EXISTING SITE CONTOUR
- (0.2m INTERVALS) ——
- SITE BOUNDARY

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APPROX. HORIZONTAL SCALE

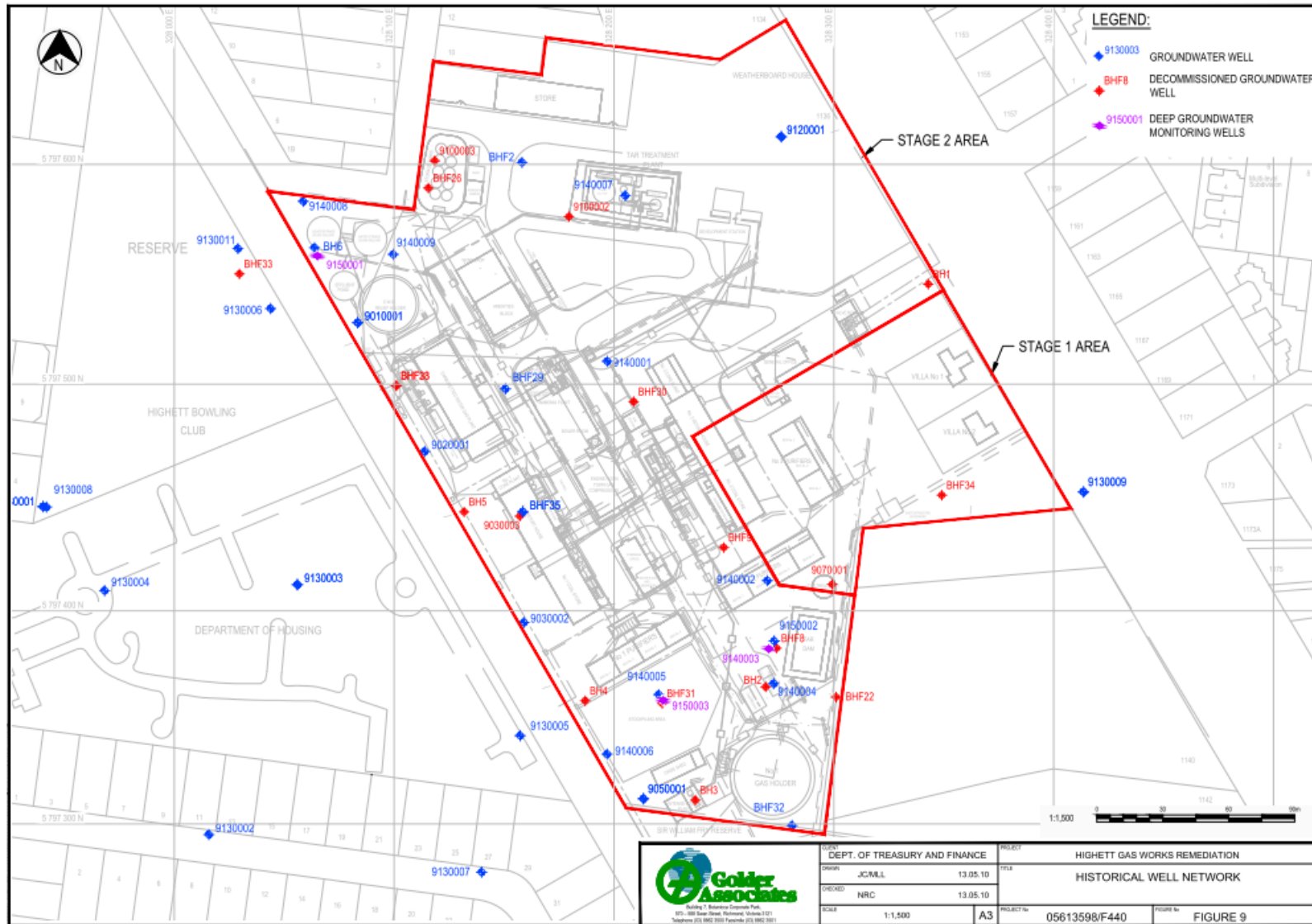


Source:
Golder , 22 July 2011



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Telephone +61 3 9861 1111
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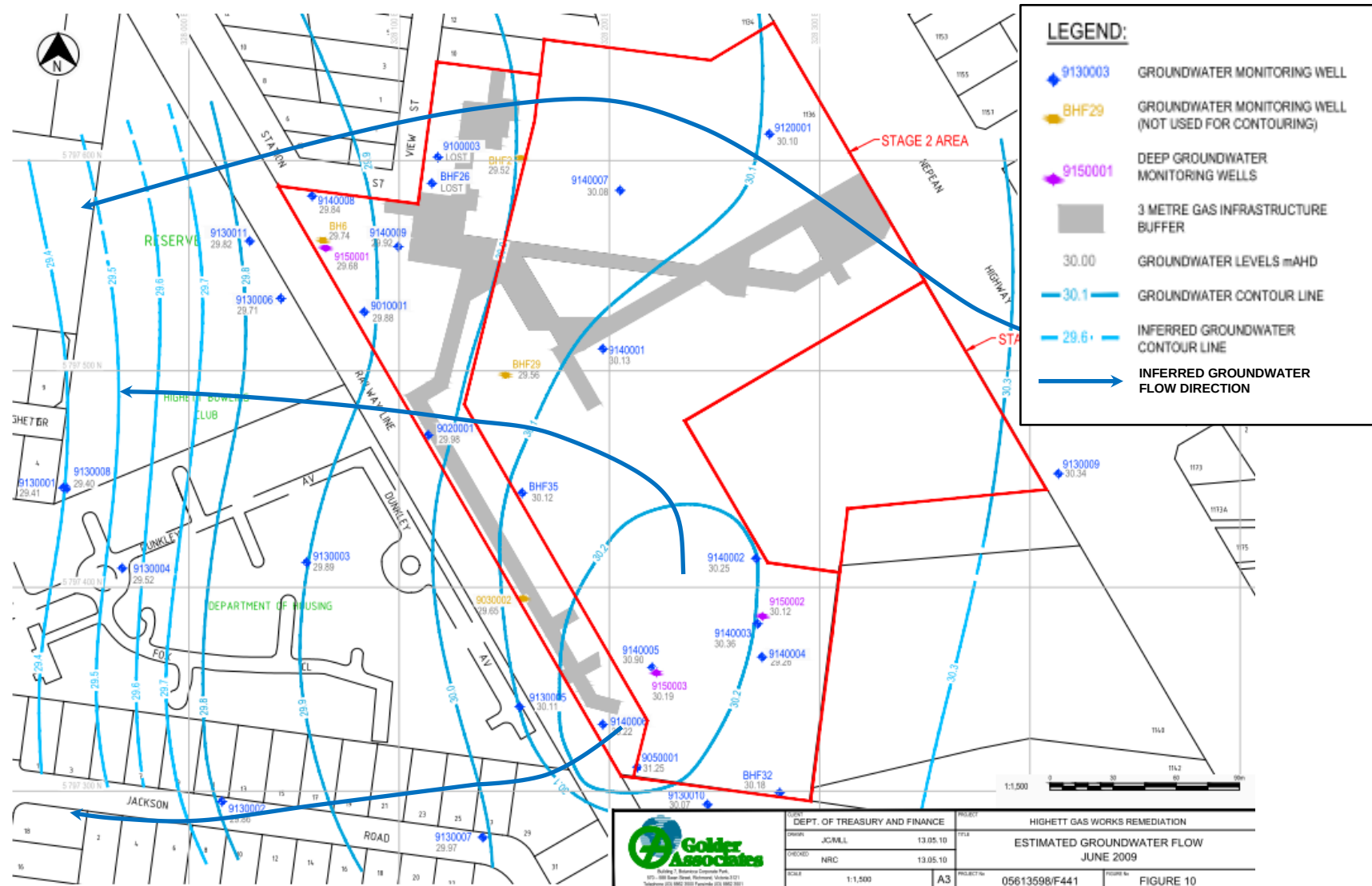
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Environmental Audit

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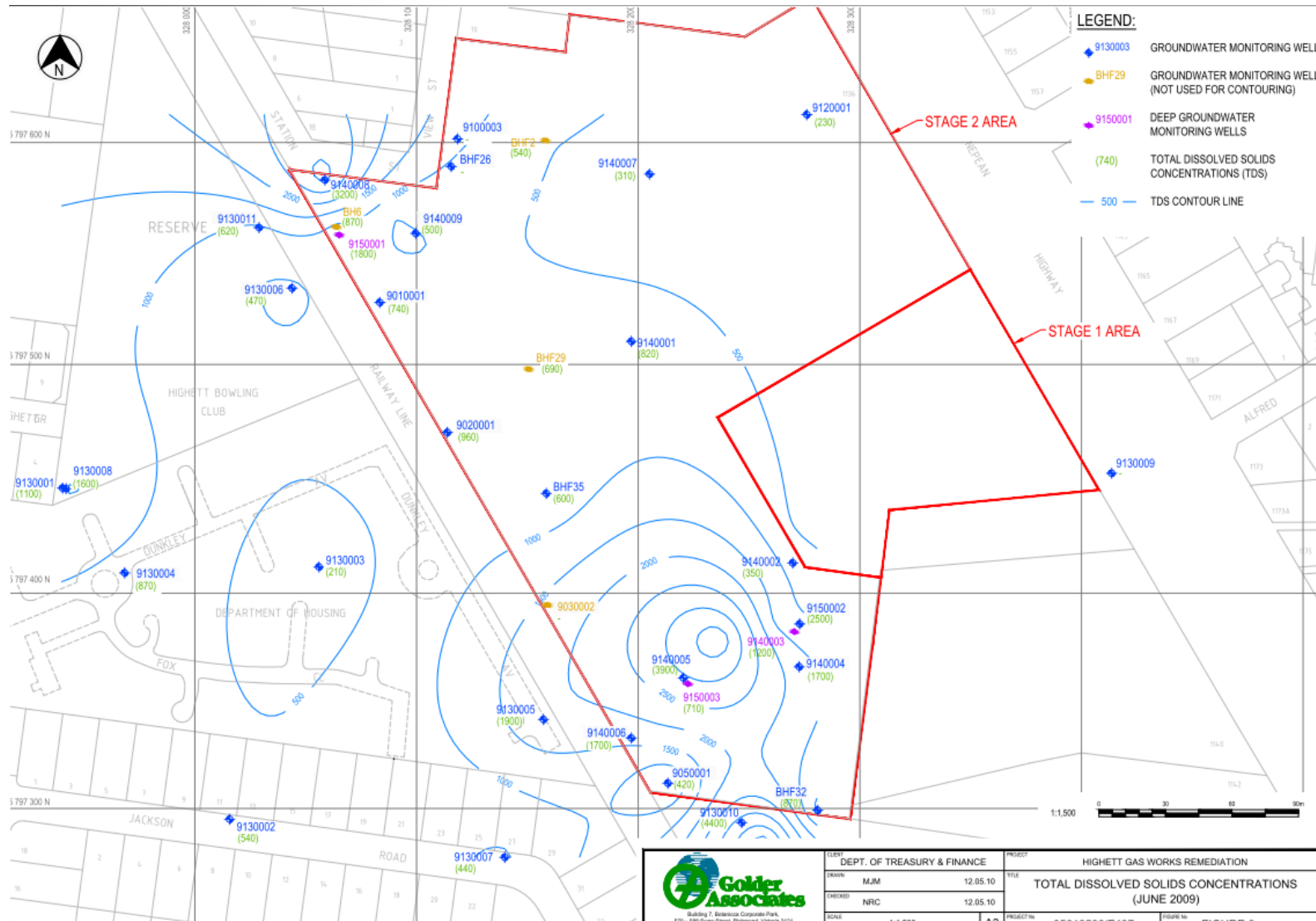
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ASB 84 797 323 433
Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

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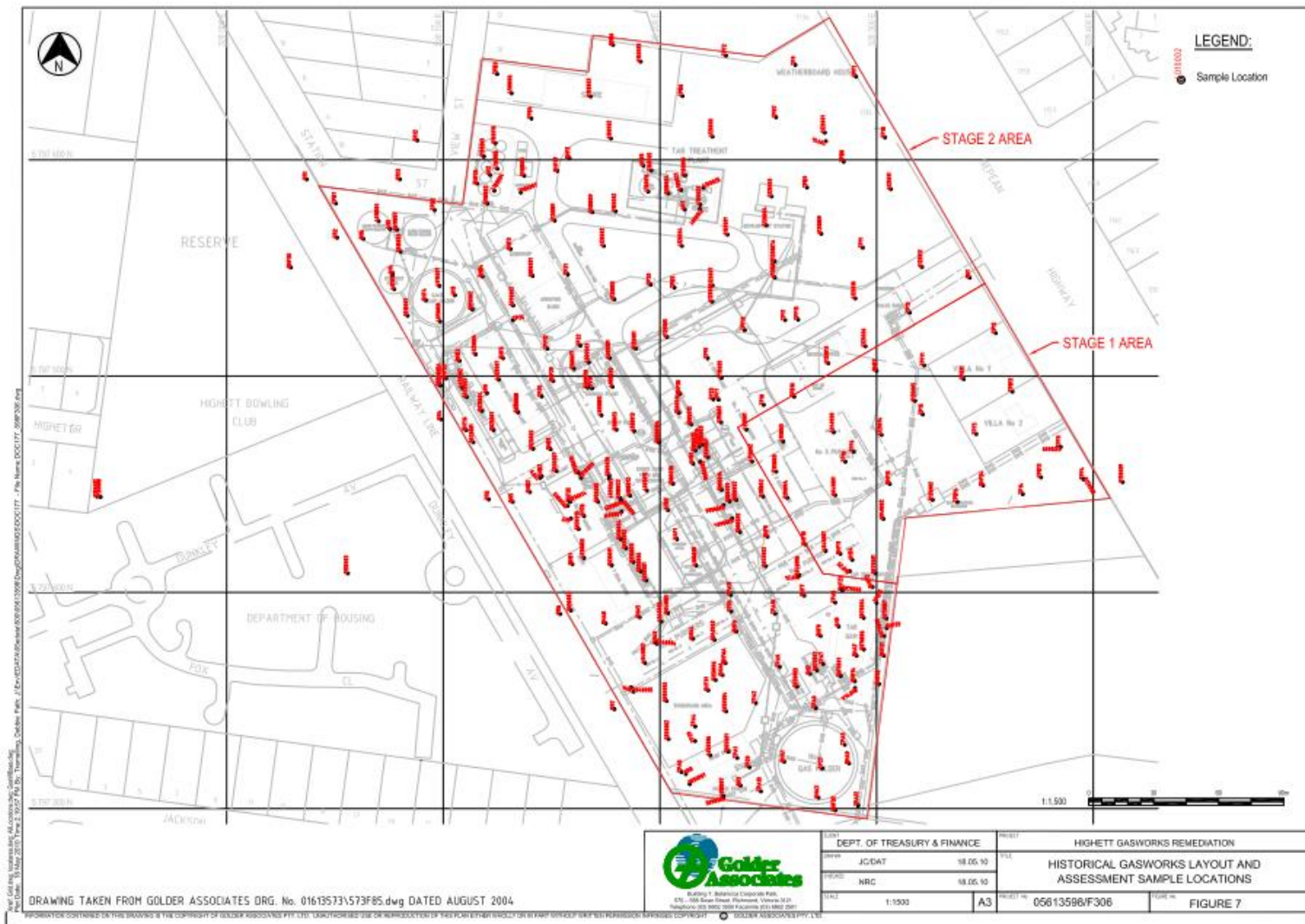
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Sources:
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20 January 2011
Insert – GoogleMap 2 Nov 2011

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Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
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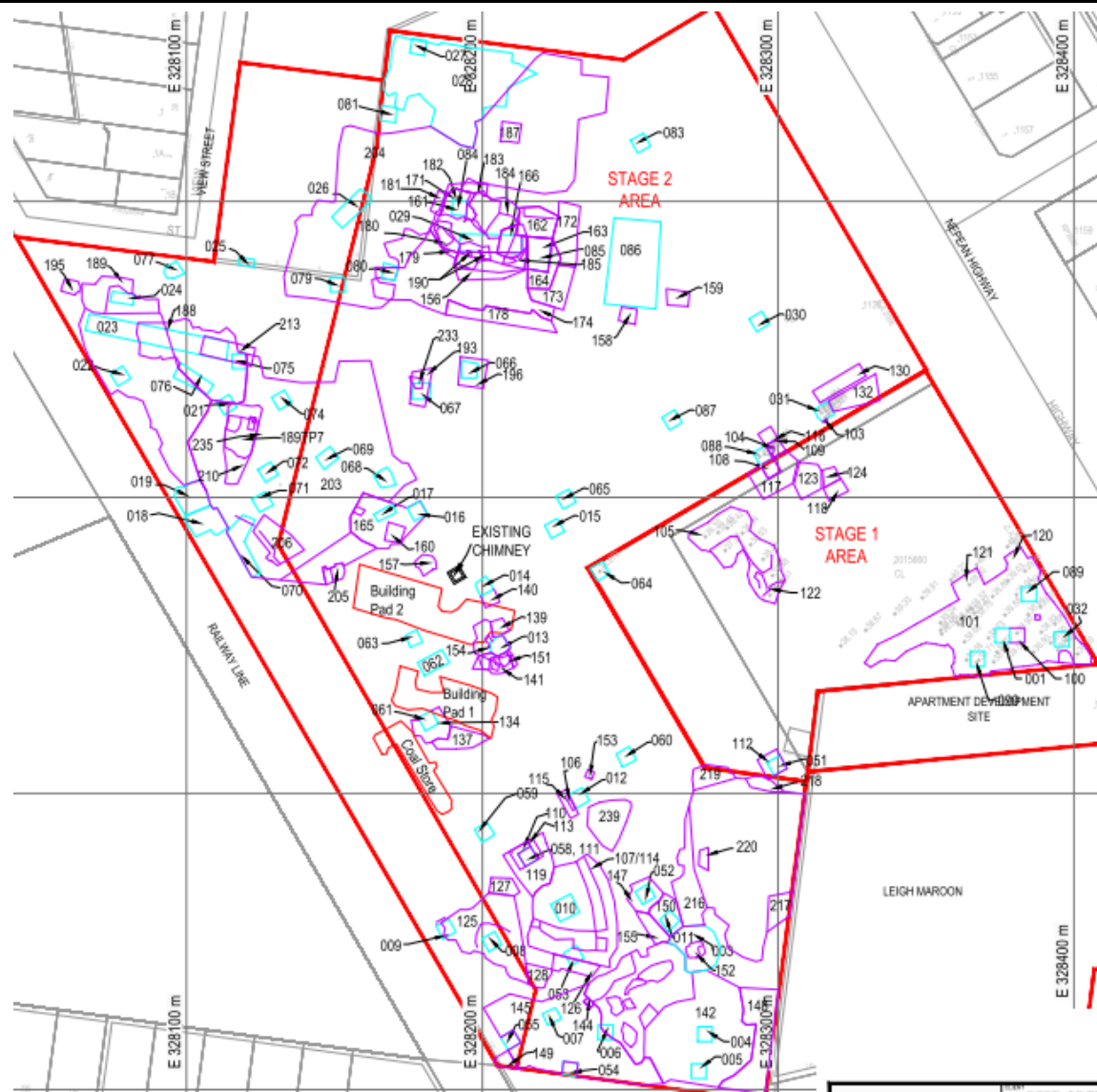


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ASBN 84 797 323 433
Level 15, 28 Freshwater Place
Southbank Vic 3006
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Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
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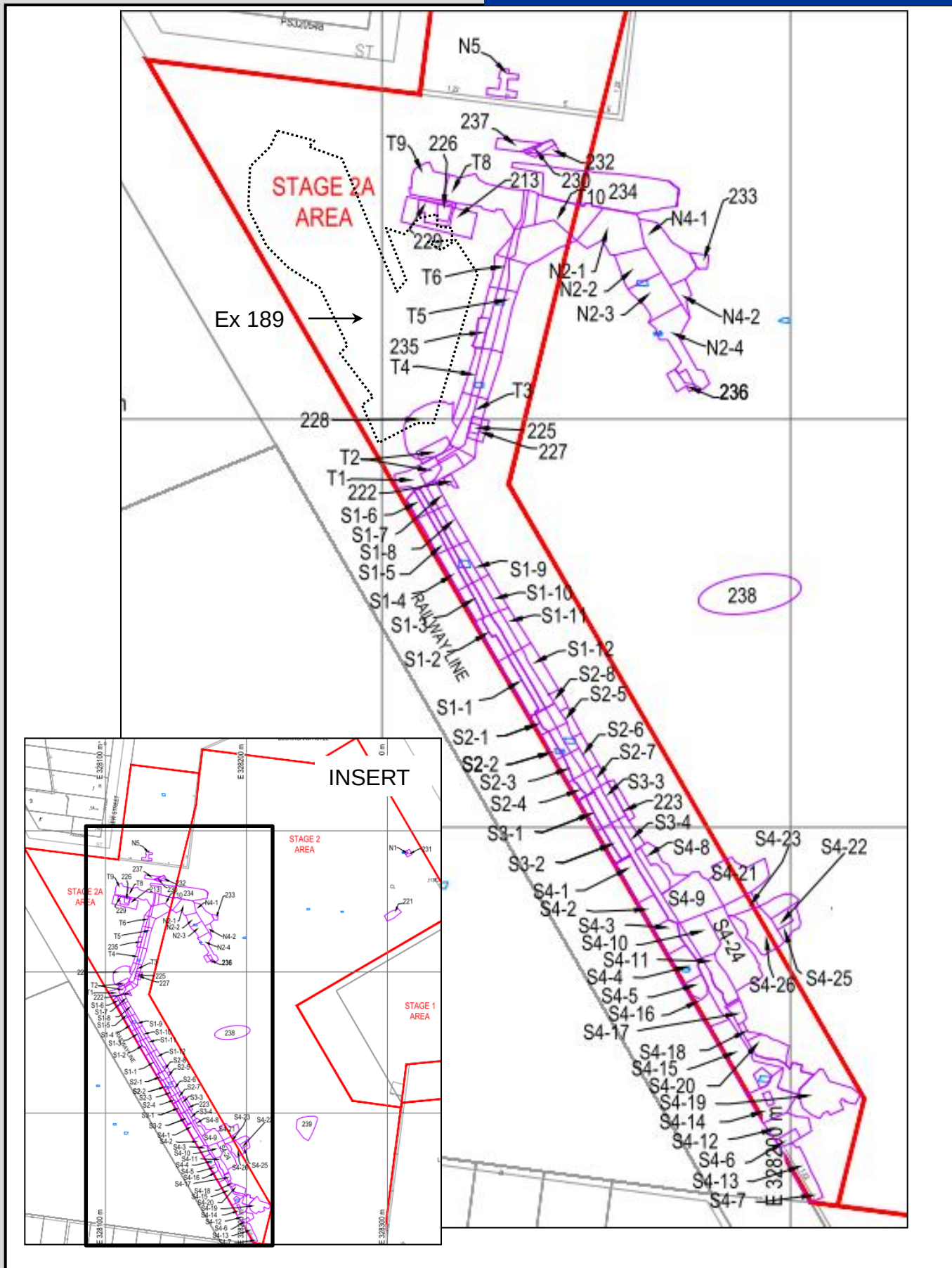
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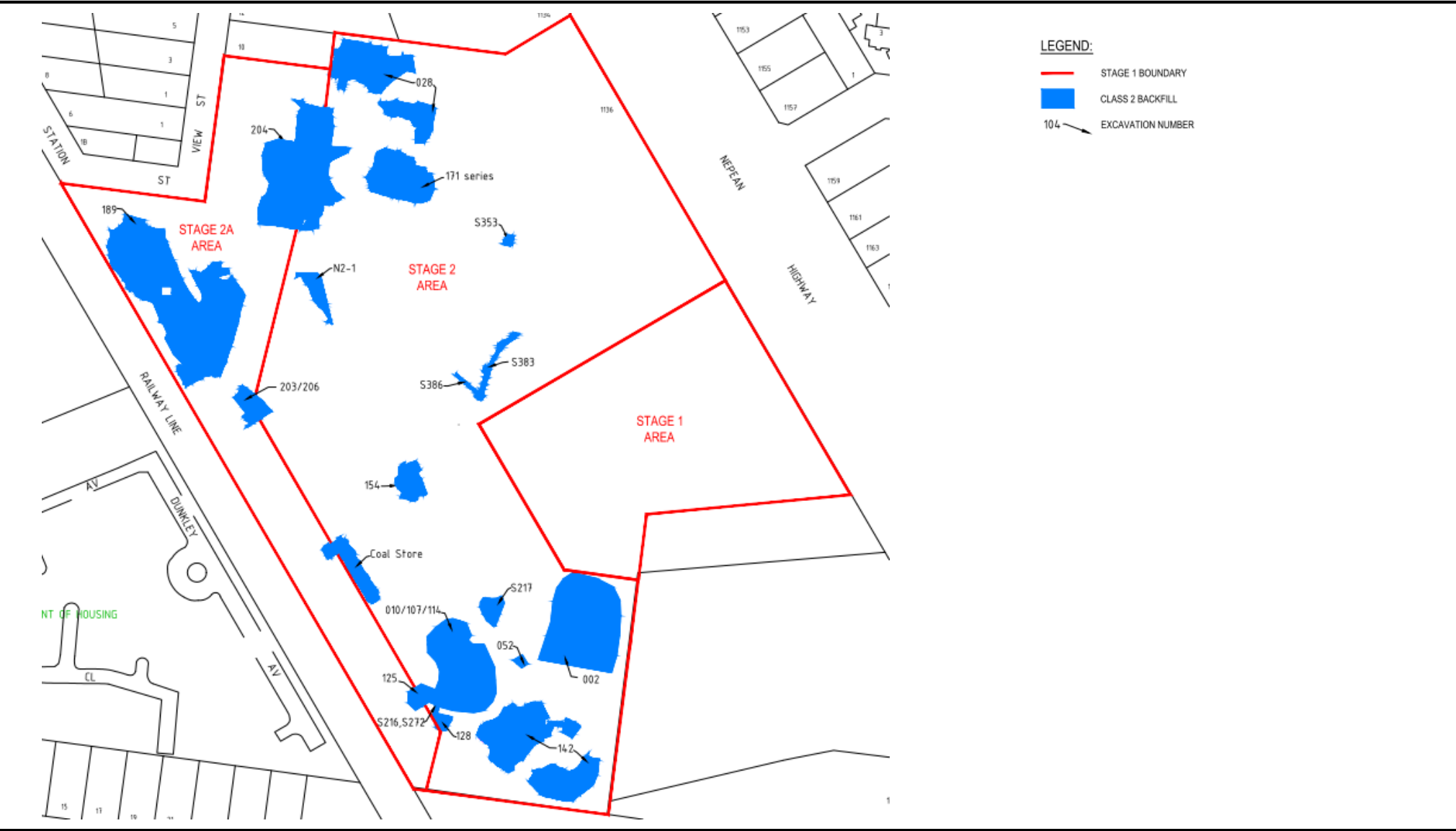
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1888
ABN 84 797 323 433
Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

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Figure 18 – Remediation phase - excavations backfilled with Class 2 material

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Source:
Golder, 22 July 2011

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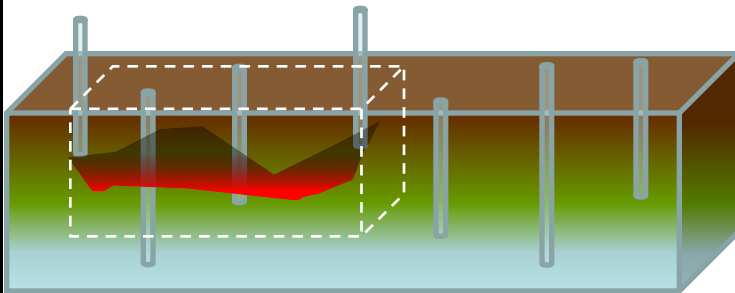
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Southbank Vic 3006
PO Box 19016

Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

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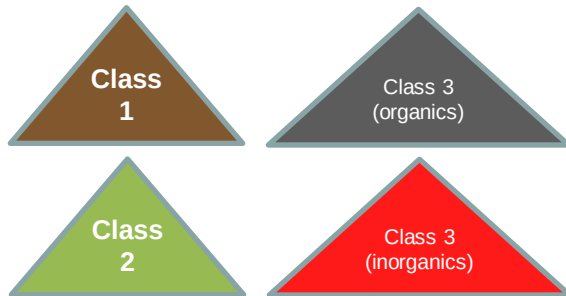
Site assessment & in situ soil classification



- Site assessment & in situ soil classification
- Marking out of proposed excavations
- Estimating of volumes of Class 1, 2 & 3 soils
- Based on a 30m grid sampling density

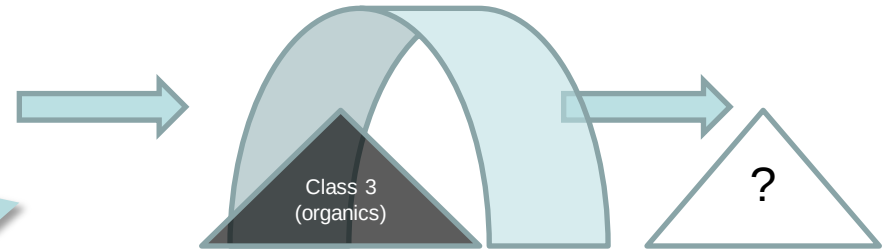


Stockpiling & Classification



- Categorisation of soil classification into the following:
 - Class 1 – on site re-use
 - Class 2 – on site re-use below 1mbgl
 - Class 3 (organics with Class 2 or 1 inorganics) – on site treatment
 - Class 3 (inorganics &/or organics) – off site disposal

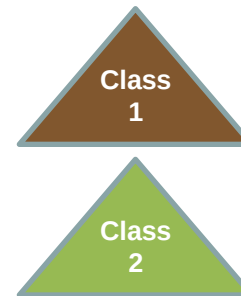
Treatment of Class 3 & re-classification



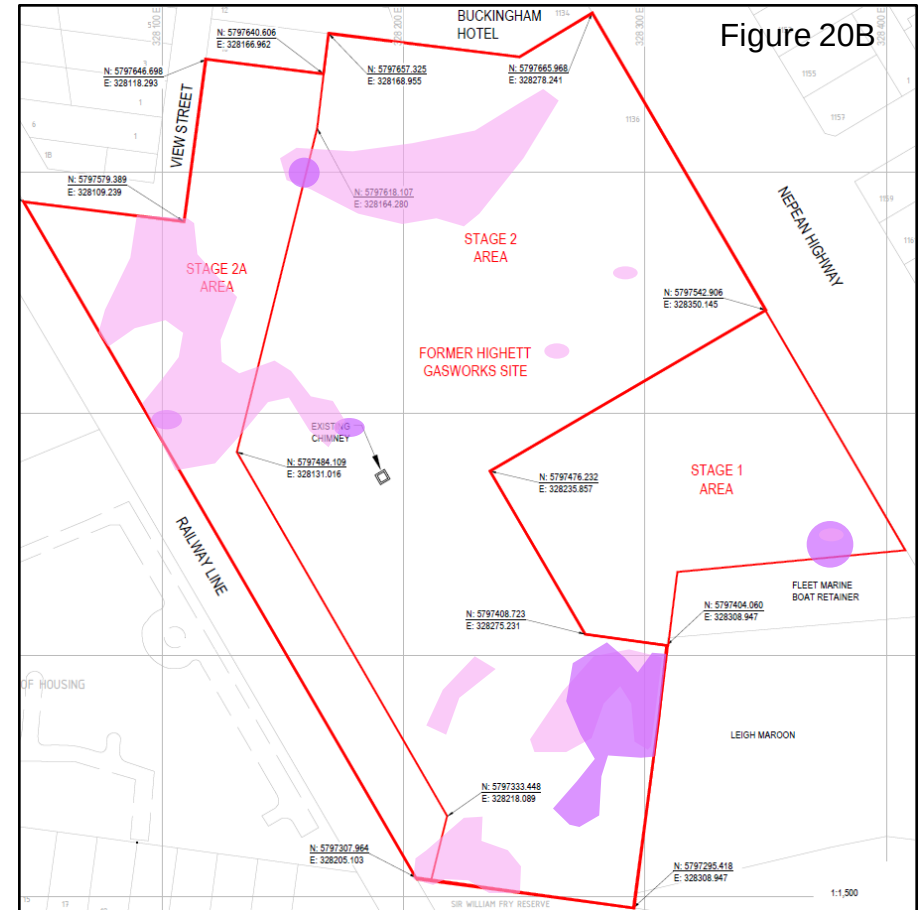
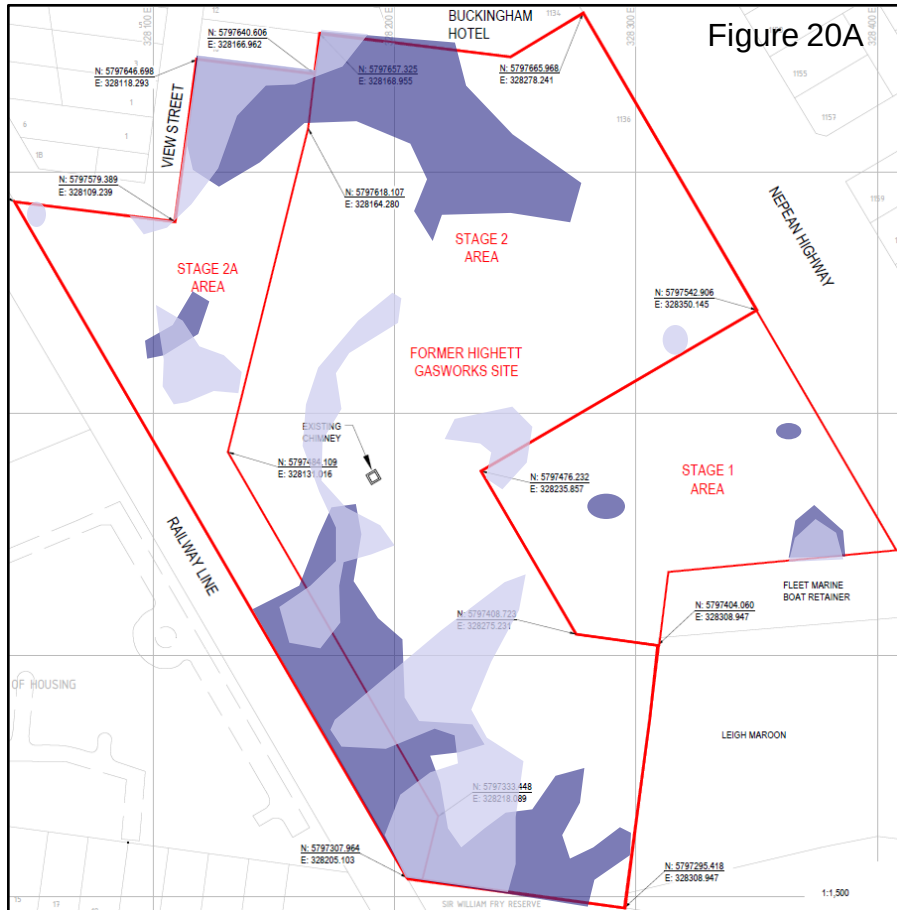
- Thiess validate the stockpile/batch prior to treatment
- Thiess & Golder validate the batch through the ETC doors prior to removal & cooling
- Post treatment validation sampling rate of 17 samples/batch (700t)



On site re-use



- Class 1 material can be re-used anywhere on site
- Class 2 material can be re-used on site below 1m
- The location and elevation of Class 2 material must be surveyed by Thiess
- The Statement of Audit must contain this information



Legend of contaminated soil

- Class 1 exceedences (0.0 -1.0m) - inorganics (pH, metals, sulphate)
- Class 2 exceedences (>1.0m) - inorganics (pH, metals, sulphate)

Legend of contaminated soil

- Class 1 exceedences (0.0 -1.0m) - hydrocarbons (BTEX, PAHs, TPHs, phenols)
- Class 2 exceedences (>1.0m) - hydrocarbons (BTEX, PAHs, TPHs, phenols)



APPROX. HORIZONTAL SCALE



Source:
Golder , 22 July 2011





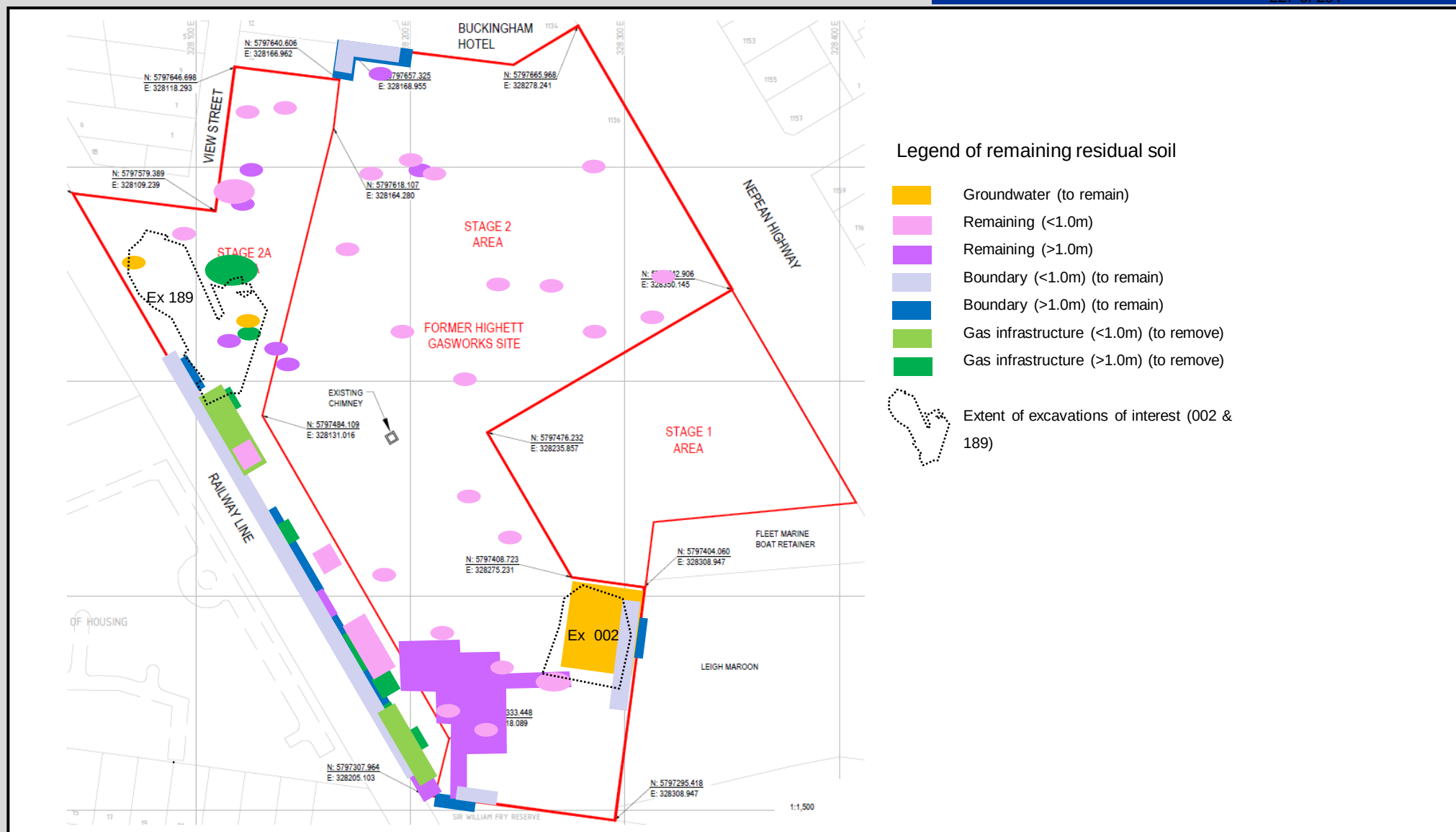
0 90m
APPROX. HORIZONTAL SCALE

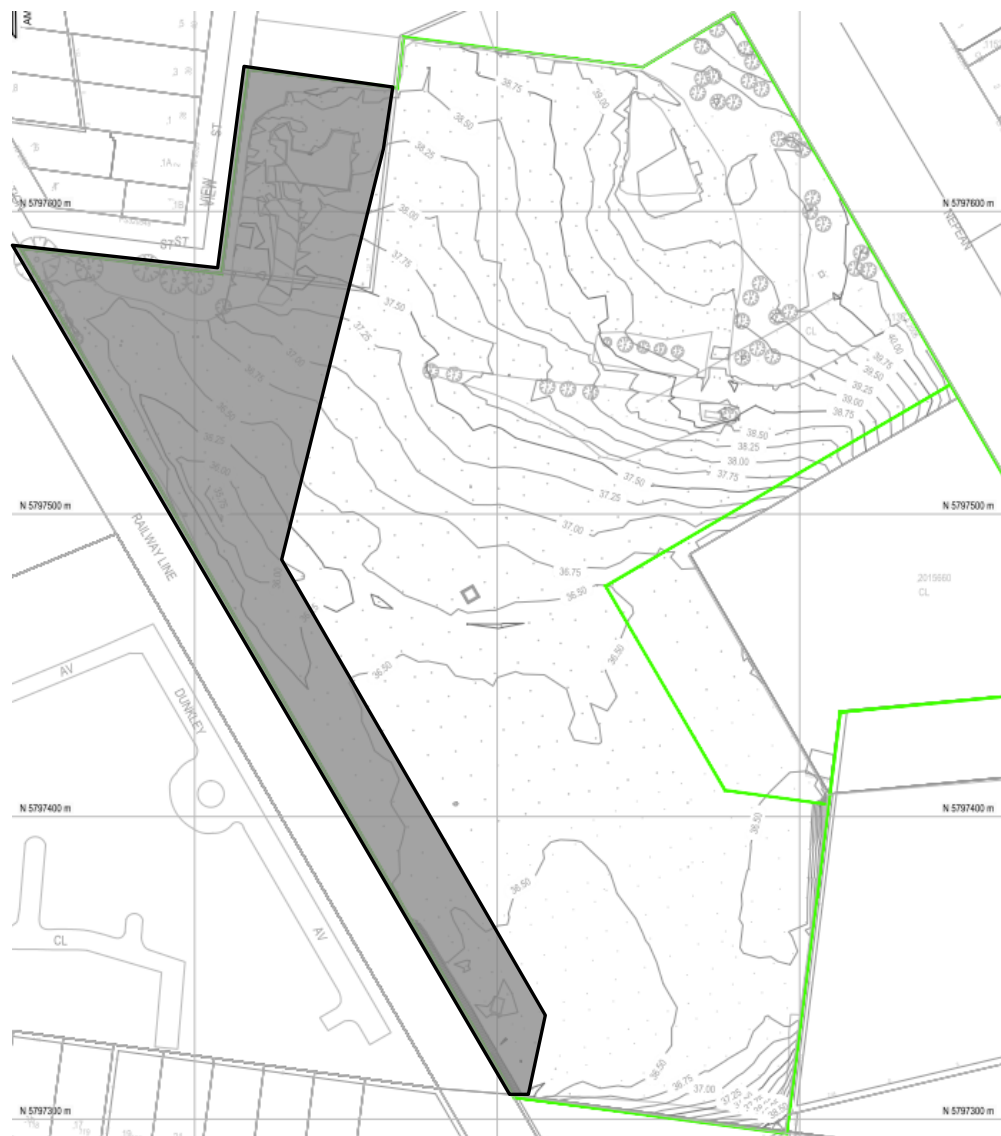


Source:
Golder, May 2010 CUTEP report
(Figures 19 & 20)

PB PARSONS BRINCKERHOFF
125 YEARS
ABN 84 797 323 433
Level 15, 26 Freshwater Place
Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

Client Department of Treasury & Finance	Job No. 2125064A
Project Environmental Audit	File Name
1	Rev. A





LEGEND

— 40.00 — INDICATIVE TOP OF CLASS 2
CONTOURS
(0.25m INTERVALS)

— SITE BOUNDARY

Stage 2 A
Class 2 material is
present in the top 1m
of soil in many
locations in Stage 2A

0 50m

APPROX. HORIZONTAL SCALE



Source:
Golder , 22 July 2011

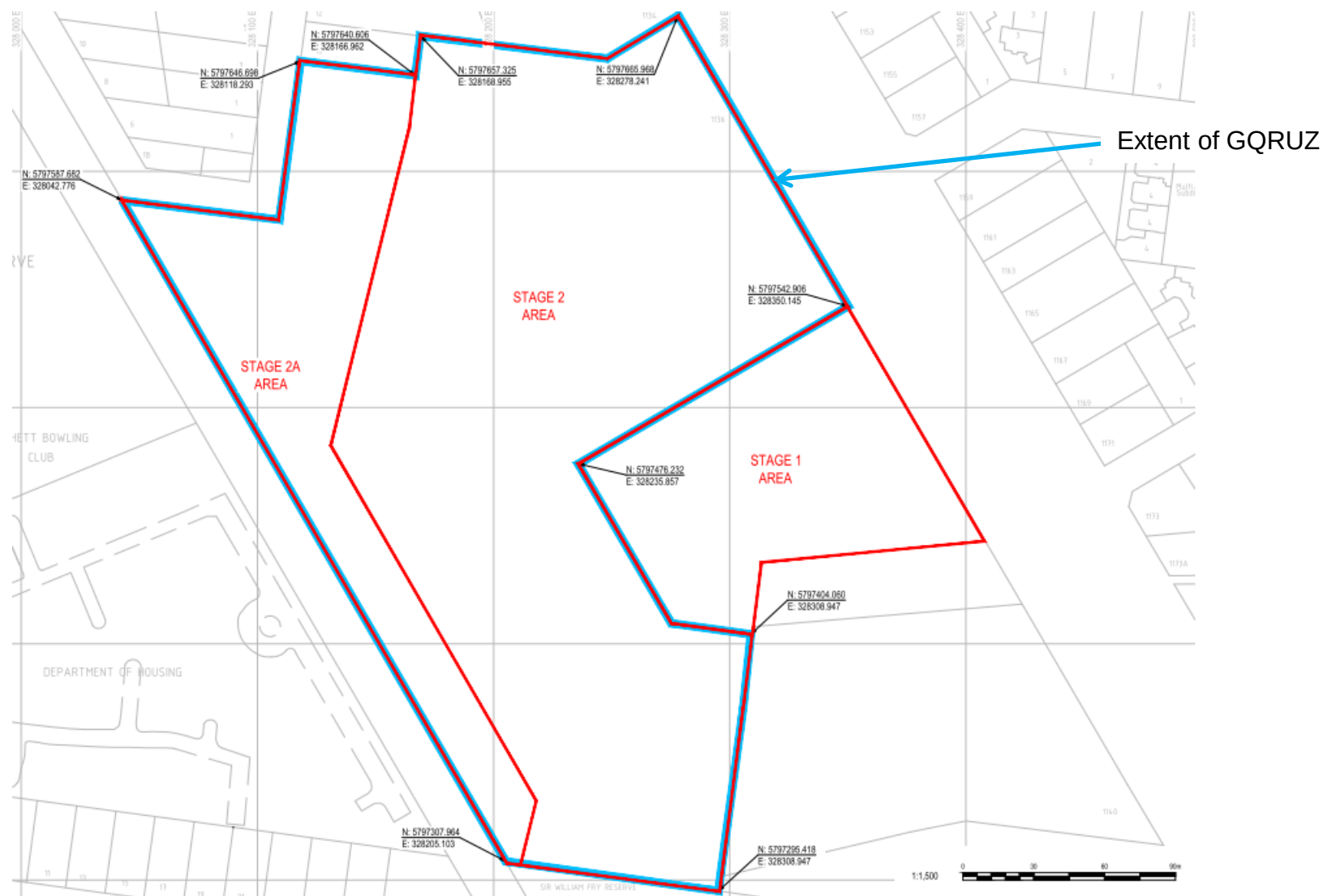
**PB PARSONS
BRINCKERHOFF**
125th

Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016

ABN 84 797 323 433

Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

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Project	Environmental Audit	File Name	
		Rev.	A
		1	



0 90m
APPROX. HORIZONTAL SCALE



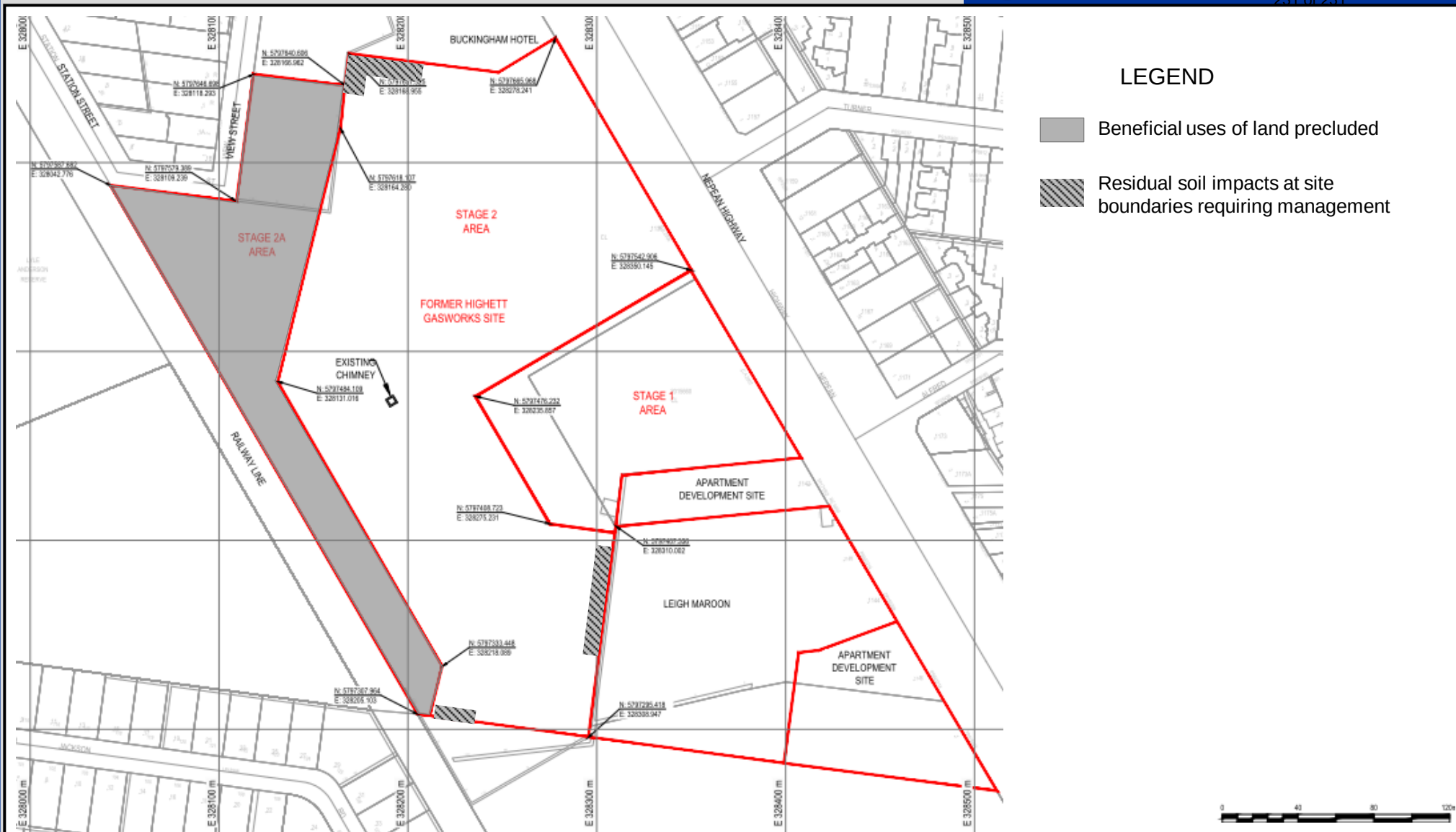
Source:
Golder, May 2010 CUTEF report

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125+
ABN 84 797 323 433
Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016
Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

Client	Department of Treasury & Finance	Job No.	2125064A
Project	Environmental Audit	File Name	
		Rev.	A
		1	

Figure 26 – Residual soil posing potential vapour risk to residential site users





0 60m

APPROX. HORIZONTAL SCALE


Source:
Golder , 22 July 2011

PB PARSONS BRINCKERHOFF

Level 15, 28 Freshwater Place
Southbank Vic 3006
PO Box 19016

ABN 84 797 323 433

Telephone +61 3 9861 1111
Facsimile +61 3 9861 1144
Email: melbourne@pb.com.au

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