Prepared for

# Rail Corporation NSW

## Remedial Action Plan

## Former Macdonaldtown Gasworks – Burren Street, Erskineville, NSW



**Final Report**

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## Executive Summary

This Remedial Action Plan (RAP) has been prepared for the Former Macdonaldtown Gasworks located at Burren Street, Erskineville (the Site). The location of the Site is presented on **Figure 1**. The Site is located between Erskineville and Macdonaldtown railway stations and encompasses an area of 7,732m$^2$.

This RAP has been prepared to enable Rail Corporation New South Wales (RailCorp) to meet their long term objectives for the Site, including addressing unacceptable human and ecological health risks posed by site contamination and to enable beneficial re-use of the Site for rail-related activities. Therefore this RAP has been prepared to enable RailCorp to:

- Enter into a Voluntary Remediation Agreement (VRA) with the NSW Department of Environment and Climate Change (DECC);
- Seek the requirements for Environmental Assessment pursuant to Part 3A of the Environmental Planning and Assessment Act, 1979 (EP&A Act, 1979);
- Call tenders for the site remediation;
- Commence community consultation processes; and
- Document procedures and management controls for the site remediation.

The following scope of work was undertaken in preparing this RAP:

- A review of background information.
- Liaison with RailCorp and the appointed DECC-accredited contaminated land Site Auditor.
- Perform the functions of the Principal Contractor to the extent required during preparation of the RAP.
- Conduct a site inspection to document the current site conditions, new railway infrastructure in the area and identify any sensitive receptors.
- Liaise with the NSW DECC and provide RailCorp with guidance regarding site remediation and long-term site management requirements.

The Site was acquired in 1888 by the railways department and has been under ownership to the present day. It was operated as a gasworks plant between 1892 and 1958, and related gasworks activities until the mid 1970's. Since that time the Site has remained unused and vacant. An above-ground gasholder structure (Southern Gasholder) is the most prominent relic that remains extant from previous operations as a gasworks site.

The Site lithological profile consists of surface fill materials, generally to depths of 1.5 metres below ground level (mbgl) but up to 4.0mbgl along the western site boundary. Fill materials overlay stiff plastic clays weathered from the underlying Ashfield shale parent rock that is highly fractured and becomes prominent at depths beyond 6mbgl.

The Site hydrogeological profile consists of a two layered groundwater system, a shallow perched system overlaying a deeper regional bedrock system. Perched groundwater occurs generally at depths of 2.0 – 2.5mbgl, but as shallow as 1.0mbgl in some areas. Deeper groundwater is part of the regional aquifer and occurs under semi confinement at depths in the weathered zone and more competent parent rock. The water level of the deeper

groundwater is generally above the perched groundwater, given its semi-confined nature. Flow direction of both groundwater systems is toward the south east.

Past operations as a gasworks site generated considerable quantities of coal tar that remains on the Site in contamination source areas including the Tar Wells, underground pipework and the below ground remnants of the Northern Gasholder. Other sources of contamination include surface ash/coke fill and asbestos impacted demolition wastes. Contamination sources, particularly coal tars, have significantly impacted the soils and groundwater to a degree that they have been declared by the NSW DECC to pose a significant risk of harm to human health and the environment. Soils and groundwater are impacted to varying degrees by:

- monocyclic aromatic hydrocarbons (MAH), which include benzene, toluene, ethylbenzene & xylenes (BTEX));
- polycyclic aromatic hydrocarbons (PAH);
- nonhalogenated phenolic compounds;
- heavy metals (in localised fill materials); and
- asbestos (in localised fill materials).

The contaminated groundwater plumes are limited to land owned by RailCorp, which is used for operational railway purposes.

To meet the long term objectives and make the Site suitable for beneficial re-use the preferred remedial options and/or combination of options were determined to be:

1. Installation of Site Security Fencing;
2. Collection of liquid wastes/sludges and disposal at a liquid waste facility;
3. Excavation, organic stabilisation treatment (at an alternate treatment site) and disposal of soil waste at a landfill facility under the NSW DECC General Approval for Immobilisation for coal tar materials – Approval #2005/14;
4. Excavation, thermal desorption treatment (at an alternate treatment site) and disposal of soil waste at a landfill facility;
5. Excavation and disposal of soil waste at a landfill facility under the NSW DECC General Approval for Immobilisation for ash materials – Approval #1999/05;
6. Excavation and disposal of asbestos impacted demolition waste at a landfill facility;
7. Excavation and disposal of untreated fill/soil waste at a landfill facility;
8. Beneficial Reuse and Recycle (including segregation of demolition waste) of suitable materials where appropriate;
9. Insitu (passive) chemical oxidation of residual source materials at depth subsequent to excavation and disposal of above materials; and
10. Long term Environmental Management Plan (EMP) including a Groundwater Management Plan (GMP) with a Monitored Natural Attenuation (MNA) approach.

In consideration of the remedial strategy, the main approach to removing unacceptable human and environmental health risks is to remove contamination sources to the extent practicable through excavation. This will be undertaken noting limitations and site constraints. Site validation will target human health from impacted soils to a certain depth,

while deeper impacts, which cannot be removed due to limitations and site constraints, will be addressed by developing the EMP and ongoing monitoring of groundwater using the MNA approach.

Important to the site remediation process will be to consider the significant heritage importance of the existing Southern Gasholder and the sensitivity of the adjoining residential homes and local neighbourhood of Erskineville. The site is irregularly shaped and the area available to locate remediation infrastructure and undertake remediation activities is limited. In this regard, it may be necessary for any remediation treatment processes to be undertaken off site at an alternative treatment site, prior to landfill disposal.

Given the archaeological and heritage importance of the Site, remediation will require assessment under Part 3A of the Environmental Planning and Assessment Act, 1979.

Remediation will require management during the site remediation process in consideration of Occupational Health and Safety, Community Consultation, Heritage, Traffic, Excavation Works and the Environment.

A long term EMP will be developed to document the requirement and objectives to conduct ongoing management of contamination issues at the Site. In this regard, potential human health risks, heritage items and groundwater management will be addressed. Source removal, groundwater management (including monitoring) and MNA approaches are considered the key attributes to addressing the long term objectives for the Site and protecting groundwater.

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| Abbreviations | |
|---|---|
| ACLCA | Australian Contaminated Land Consultants Association |
| ANZECC | Australia New Zealand Environment and Conservation Council |
| ARHS | Australian Railway Historical Society |
| As | Arsenic |
| BaP | Benzo(a)pyrene |
| BTEX | Benzene, Toluene, Ethylbenzene & Xylenes |
| CBD | Central business district |
| CCO | Chemical Control Orders |
| Cd | Central business district |
| CLP | Community Liaison Plan |
| Cr | Chromium |
| Cu | Copper |
| DEC | Department of Environmental and Conservation |
| DECC | Department of Environment and Climate Change |
| DCP | Development Control Plan |
| DNAPL | Dense Non-Aqueous Phase Liquid |
| DNR | Department of natural resources |
| DQIs | Data Quality Indicators |
| DQOs | Data Quality Objectives |
| ENCM | Environmental Noise Control Manual |
| EAR | Environmental Assessment Requirement |
| EPA | Environment Protection Authority |
| EP&A | Environmental Planning and Assessment |
| EPL | Environment Protection Licence |
| ESC 410 | Earthworks and Formation, September 2006 |
| GDE | Groundwater Dependant Ecosystem |
| GILs | Groundwater Investigation Levels |
| GMP | Groundwater Management Plan |

| | |
|---|---|
| Hg | Mercury |
| H&SP | Health and Safety Plan |
| LNAPL | Light Non-Aqueous Phase Liquid |
| MAH | Monocyclic Aromatic Hydrocarbons |
| MNA | Monitored Natural Attenuation |
| MNES | Matters of National Environmental Significance |
| NATA | National Association of Testing Authorities |
| NEPM | National Environment Protection Measure |
| Ni | Nickel |
| PAH | Polycyclic Aromatic Hydrocarbons |
| Pb | Lead |
| PCDD/F | Polychlorinated Dibenzo Dioxins and Polychlorinated Dibenzo Furans |
| PEPs | Protection of the Environment Policies |
| PID | Photo-Ionisation Detector |
| POEO | Protection of the Environment Operations |
| POEO GR | Protection of the Environment Operations (General) Regulation |
| PPE | Personal Protective Equipment |
| QA/QC | Quality assessment / quality control |
| RAP | Remedial Action Plan |
| RISI | Rail Industry Safety Inductions |
| RSA | Rail Services Australia |
| SEPP | State Environmental Planning Policy |
| SKM | Sinclair Knight Merz |
| EMP | Environmental Management Plan |
| SROH | Significant Risk of Harm |
| SWMS | Safe Work Method Statement |
| TA act | Transport Administration Act |
| TMP | Traffic Management Plan |
| TPH | Total Petroleum Hydrocarbons |
| UCL | Upper Confidence Limits |

| | |
|---|---|
| VENM | Virgin Natural Excavated Material |
| VIP | Voluntary Investigation Proposal |
| VRA | Voluntary Remediation Agreement |
| Zn | Zinc |

# 1 Introduction

In April 2007, Rail Corporation NSW (RailCorp) engaged CH2M HILL Australia Pty Ltd (CH2M HILL) to prepare this Remedial Action Plan (RAP) for the Former Macdonaldtown Gasworks located at Burren Street, Erskineville (the Site). The location of the Site is presented on **Figure 1**.

## 1.1 Background

In August 2000 the Site was declared by the NSW Environment Protection Authority (EPA) to pose a Significant Risk of Harm (SRoH) to human health and the environment. The declaration was made in consideration of the concentrations of contaminants in the soil and groundwater reported in previous site investigations.

RailCorp wish to remediate the Site such that long term objectives can be met, including:

- Removal of the SRoH declaration;
- Removal of the health risks to future site users;
- Removal of the risks to environmental receptors; and
- To allow the beneficial use of the Site for rail related activities.

This RAP has been prepared to provide an appropriate remedial strategy that would enable the long term objectives to be met. This RAP has also been prepared for the following purposes that will enable RailCorp to:

- Enter into a Voluntary Remediation Agreement (VRA) with the NSW Department of Environment and Climate Change (DECC[1]);
- Seek the requirements for Environmental Assessment pursuant to Part 3A of the Environmental Planning and Assessment Act, 1979 (EP&A Act, 1979);
- Call tenders for the site remediation;
- Commence community consultation processes; and
- Document procedures and management controls for the site remediation.

## 1.2 Site Identification

The Site is located between Erskineville and Macdonaldtown railway stations, approximately 3km south west of the Sydney Central Business District (CBD) and encompasses an area of 7,732m$^2$. The Site is roughly triangular in shape, being part of the area referred to as the Macdonaldtown Triangle, and is bound to the north by rail land, to the south and east by a rail corridor, and to the west by a row of residences on Burren Street. **Figure 2** shows the general site layout and adjoining features.

Site identification information is presented in Table 1-1 below.

[1] *The DECC was formed in 2007 and incorporates the Department of Environment and Conservation (DEC) and the EPA which forms part of the DEC. References to the EPA and DEC should be taken as also meaning the DECC, and vice versa.*

| Table 1-1 Site Identification | |
|---|---|
| Street Address | Burren Street, Erskineville NSW 2043 |
| Lot and DP Number | Part Lot 50 in DP1001467 |
| Site Area | 7,732m$^2$ |
| Geographical Coordinates | 624700N; 343200E |
| Owner | Rail Corporation NSW |
| Zoning | Railways Zone (Sydney Regional Environmental Plan 26) |
| Current/Proposed Land Use | Vacant/Commercial-Industrial (for rail-related operations) |
| Local Government Area | City of Sydney |
| Parish | Petersham |
| County | Cumberland |

## 1.3 Areas of the Site

During recent investigations (CH2M HILL, March 2007) to delineate impacts at the Site and to enable preliminary remediation options screening, the Site was stratified into eight areas based on an understanding of historical use and impacts, as shown on **Figure 3**. The stratified areas include:

- **Gasholders:** encompasses both Gasholder structures adjoining the western boundary. The Southern Gasholder remains intact with the superstructure standing approximately 12 metres above the ground surface. The above ground structure of the Northern Gasholder has been demolished, however the brick annulus structure remains intact beneath the ground.
- **Retort:** encompasses the footprint of the former Retort House, Tar Wells, Condensers, Coal and Shale Storage areas and other building structures associated with the gasworks operations (office, amenities, etc). These buildings and structures have been demolished and associated structures are no longer visible above the ground surface. However some underground structures remain in place, including the two Tar Wells, pipework, brick flooring and foundations and concrete slabs.
- **Gas Purifier:** encompasses the footprint of the former Purifier Beds, Scrubbers and Gas Meters. Similar to the Retort Area, structures only remain buried below the ground surface, with no above ground structures remaining.
- **Northeast:** includes the majority of the northeast section of the Site.
- **South Central:** includes the portion along the central southeast boundary.
- **Southwest:** includes the majority of the southern area of the Site.
- **Retaining Wall:** includes the filled area embankment along the northern site boundary.
- **Western Lot:** includes the small rectangular section of land that extends west to Burren Street.

## 1.4 Appreciation and Objectives

It is understood that an RAP is required to facilitate and realise RailCorp's long term objectives for the Site. It is noted that in enabling the long term objectives to be met, removing risks from the Site will only be possible following implementation of the preferred remedial strategy, which will more appropriately aim to remove, to the extent practicable, unacceptable risks to the long term use of the Site for primarily rail-related purposes.

The objectives of the RAP will be to:

- Set remediation goals and validation criteria such that the remediated site will satisfy to the extent practicable the long-term land use objectives of RailCorp;
- Document the preferred remediation strategies;
- Identify the approvals and licenses required for site remediation; and
- Document the environmental management approach to mitigate impacts to the surrounding environment during site remediation.

## 1.5 Scope of Work

RailCorp engaged CH2M HILL to undertake the following scope of work:

- Review background information.
- Liaise with RailCorp and the appointed DECC-accredited contaminated land Site Auditor.
- Perform the functions of the Principal Contractor to the extent required during preparation of the RAP.
- Prepare a Safe Work Method Statement (SWMS) for RailCorp's approval prior to undertaking site inspections.
- Conduct a site inspection to document the current site conditions, new railway infrastructure in the area and identify any sensitive receptors.
- Prepare this RAP.

In addition to the above scope, RailCorp required CH2M HILL to liaise with the NSW DECC and provide RailCorp with guidance regarding potential use of an off site treatment facility to facilitate site remediation, if required, and long-term groundwater management requirements.

## 1.6 Previous Site Assessment

The following is a list of the reports that have previously been prepared for the Site.

- Rail Services Australia "Eveleigh Gasworks - Site History" November 1999 (RSA, Nov 1999).
- CH2M HILL Australia "Phase I & II Environmental Site Assessments" June 2000 (CH2M HILL, June 2000).

- CH2M HILL Australia "Vegetable, Soil and Sediment Sampling – Letter Report" November 2000 (CH2M HILL, Nov 2000).

- CH2M HILL Australia "Soil & Groundwater Investigations of the Former Gasworks Area and Offsite" December 2001 (CH2M HILL, Dec 2001).

- Australian Railway Historical Society "A Brief History of NSW Railway Gasworks" June 2003 (ARHS, June 2003).

- Banksia Heritage & Archaeology "Macdonaldtown Station Works - Archaeological Assessment" April 2004 (Banksia Heritage, April 2004).

- GHD "Macdonaldtown Triangle (Former Cleaning Sheds) - Delineation and Classification Sampling" September 2005 (GHD, Sept 2005).

- Sinclair Knight Merz "Macdonaldtown Triangle (Former Gasworks Site) - Human Health and Ecological Risk Assessment" April 2006 (SKM, April 2006).

- Heritage Concepts "Archaeological Assessment and Remediation Management Strategy" November 2006 (Heritage Concepts, November 2006).

- CH2M HILL Australia "Delineation & Characterisation Sampling and Review of Remedial Options" March 2007 (CH2M HILL, March 2007).

These documents will be appropriately referenced throughout this RAP.

## 1.7 Limitations

This RAP is given strictly in accordance with, and subject to, the following limitations:

- The RAP was prepared for RailCorp in accordance with the Scope of Work agreed between CH2M HILL and RailCorp.

- CH2M HILL assumes no responsibility for conditions we were not authorised to investigate.

- This report is based, in part, on unverified information supplied to CH2M HILL from several sources during the project research. Therefore, CH2M HILL does not guarantee its completeness or accuracy, and assumes no responsibility for errors or omissions related to this externally supplied information.

- An understanding of the Site conditions depends on the integration of many pieces of information; some regional, some site specific, some structure-specific and some experienced-based.

- The advice tendered in this report is based on information obtained from the field investigation locations, test points, sample points and field and laboratory data, and is not warranted in respect to the conditions that may be encountered across the Site at other than these locations. It is emphasized that the actual characteristics of the sub-surface and surface materials may vary between adjacent test points and sample intervals and at locations other than where

observations, explorations and investigations have been made. Sub-surface conditions, including groundwater levels and contaminant concentrations can change in a limited space and time.

- The previous investigations reviewed during the preparation of this RAP identified actual surface and subsurface conditions only at those locations where samples were taken and when they were analysed. This data has been interpreted and an opinion rendered regarding the overall environmental conditions

- Because of the inherent uncertainties in sub-surface evaluations, changed or unanticipated sub-surface conditions may occur that could affect total project cost and execution. CH2M HILL does not accept responsibility for the consequences of variations in the site conditions.

- This report has not been prepared for the purpose of assessing the suitability of soil and fill on the Site for foundations or any Geotechnical purpose.

- This report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way. CH2M HILL accepts no responsibility for any circumstances that arise from the issue of the report which has been modified as outlined above.

- This report has been prepared for the exclusive use of the Client relating to the property as described in the report. No warranty, expressed or implied, is made. There are no beneficiaries to this report other than the Client, and no other person or entity is entitled to rely upon this report without the written consent of CH2M HILL, and a written agreement limiting CH2M HILL's liability.

# 2 Site Overview

This section provides a summary of site history, heritage and other site information.

## 2.1 Site History

The Site was acquired in 1888 by the NSW State Government railways department and has been under State ownership to the present day.

The Site operated as a gasworks plant between 1892 and 1958. Gas was produced from coal and shale raw products and stored in two gasholders. Operations included raw product storage, gas production, waste disposal, filling and storage of tar wastes. To facilitate these operations, site structures and buildings included a Retort House, a Boiler, Condensers, Purifier Beds, a Scrubber, Tar Wells, above ground tar tanks, two Gasholders, service pipework, raw store areas for coal and shale, and other buildings likely to be offices, washrooms and compressors.

The historical layout of the former gasworks operation is presented on **Figure 2**.

The following gives the chronology of the Site, pre and post operation:

- 1891:- Design plans approved;
- 1892:- Construction completed. The detailed layout of the various components of the operation are slightly different to the design plans;
- 1942:- The use and location of two tar wells is documented on plans;
- 1950's:- The use of inferior coal during the coal strike of the 1950's causes damage to the plant machinery and as a consequence the gasworks ceased operations. The two Gasholders are used to store gas that was manufactured and piped from the Mortlake operations;
- 1958:- The gasworks is demolished, with the exception of the Southern Gasholder, which remains extant;
- 1970's:- During the mid 1970's the Site closed down and is no longer used for storing and pumping gas product;
- Present:- The Site remains as vacant railway land. The only significant above ground structure remaining is the Southern Gasholder.

## 2.2 Site Heritage

The Southern Gasholder is listed on the State Heritage Register and the Sydney Regional Environment Plan 26 (SREP 26) as part of the Eveleigh Railway Workshops. This structure is the only item from the gasworks site to be listed on the register.

## 2.3 Setting and Condition

The Site is generally a triangle shape that is somewhat irregular and completely secured with a perimeter fence. A narrow rectangular area extends west from the

northwest corner of the 'triangle' to Burren Street. The Site area is vacant land that has tall trees growing along the western and northern boundaries.

The Southern Gasholder is a prominent relic of the past gasworks operations that stands against the western boundary and reaches approximately 12m from the ground surface. Other structures include:

- brickwork at ground level, associated with the former Northern Gasholder;
- the in-ground Tar Wells located adjacent and to the north east of the Northern Gasholder brick annulus, that appear as two circular concrete lids at the ground surface;
- a small shed known as the Connection Shed located in the Southwest Area;
- retaining walls/embankments along the northern boundary including the small rectangular portion of the Site adjoining Burren Street; and
- a concrete service trench and a shallow surface drain located along the western boundary.

The ground surface appears hard and gravelly in the main central sections of the Site and overgrown with grasses and shrubs in the outer perimeter areas along fence lines. The health of existing vegetation appears to be generally in good condition, given the overgrown state of grasses and shrubs. No dead or dieing vegetation was observed or signs of vegetative stress.

Other features of the Site include small stockpiles of materials such as ballast, decaying vegetation (tree stumps) and spent car tyres.

A photographic record of the Site along with locations of photographs is presented in **Appendix A.**

### 2.3.1 Topography

The Site is generally flat with a gentle grade that falls toward the south east. Along the western boundary that adjoins residential properties, the ground level falls off sharply to the backyards of the residential homes forming an embankment. This is considerable in the southern corner where there is a surface level difference of approximately four metres.

The ground surface of the adjoining northern property (Stabling Yards) is approximately 2m higher than the gasworks site, and this surface elevation extends into the gasworks site up to five metres in some places, where an old retaining wall was constructed.

## 2.4 Lithology

The Sydney Geological Series Sheet 9130 (C. Herbert, 1999) indicates that the geological formation underlying the Site is the Wianamatta Group Ashfield Shale comprising black to dark-grey shale and laminite.

The Sydney Soil Landscape Series Sheet 9130 (G. A. Chapman et. Al, 1999) indicates that the Site soils are of the Residual Blacktown Grouping, consisting of:

> *Landscape – gently undulating rises on Wianamatta Group shales and Hawkesbury shale. Local relief to 30m, slopes are usually <5%. Broad rounded crests and ridges with gently inclined slopes. Cleared woodland and tall open-forest.*
>
> *Soils – shallow to moderately deep (<100cm) Red and Brown Podzolic Soils (Dr3.21, Dr3.11, Db2.11) on crests, upper slopes and well-drained areas; deep (150-300cm) Yellow Podzolic soils and Soloths (Dy2.11, Dy3.11) on lower slopes and areas of poor drainage.*
>
> *Limitations – moderately reactive highly plastic subsoil, low soil fertility, poor soil drainage.*

### 2.4.1 Fill Material

Based on the findings of previous investigations, the fill materials identified at the Site can be grouped as follows:

- Ash and Coke Gravels – observed across the majority of the Site in surface and near surface layers from ground level to approximately 0.5m depth.
- Reworked Clays – observed in subsurface layers in some site areas between 0.5m depth to approximately 1.5m depth. This material was observed in the majority of areas as general filling.
- Sands and Gravels – observed in subsurface layers in some site areas between 0.5m depth to approximately 1.5m depth. This material was observed in the North East, South Central and Gas Purifier areas.
- Gravely Sand and Clay with Minor Ash – observed in surface and subsurface layers in some site areas from ground level to approximately 3.5m depth. This material was predominantly observed in the South West area of the Site as general filling.
- Gravel, Sand and Demolition Wastes – observed in the fill embankment of the Retaining Wall and inside the annulus of the Northern Gasholder. This material was observed to mainly consist of sandy gravels and some ash gravels. It also consisted of demolition wastes and rubble including bricks, metal pipes, tiles, fibro-cement sheeting and Asbestos Containing Material (ACM) and other building rubble in a gravely sand matrix.

### 2.4.2 Natural Soil

Based on the findings of previous investigations, the natural soil materials identified at the Site can be grouped as follows:

- Silty Clay – observed generally from between 1.5m depth to approximately 2.5m depth. This material exists across the majority of Site areas. This horizon was predominantly a saturated zone, which sustained the perched groundwater system.

- Red/Grey Mottled Clay – observed generally from between 2.5m depth to approximately 4.0-6.0m depth. The soil profile is consistent with a Red Podzolic soil, being moderately to highly plastic, stiff to very stiff, moist and mottled red/grey.
- Weathered Shale – observed underlying the natural clay. This material grades from extremely weathered to moderately weathered at depths of up to 10m depth. At depths beyond 6m, fracturing of the material is common.

### 2.4.3 Tar Impacts

A number of areas of fill/natural soil materials were observed to be impacted by tar. The tar impacts have been categorised as follows:

- Soil/fill impacted by free tar – consisting of soil and fill materials impacted to a high degree with black ooze, highly odorous, liquor type material;
- Tarry soils – consisting of soil and fill materials with minor tar impacts and moderate odours; and
- Dark Stained Impacts – this material was observed as dark brown to black staining in the deep soils and Weathered Shale within the soil pores and shale fractures zones underneath the Southern Gasholder. This material was also moderately odorous.

Soil/fill impacted by free tar is material predominately associated with former gasworks infrastructure, which include the:

- Tar Wells – shallow subsurface and deep natural soils immediately adjacent to these two structures;
- Northern Gasholder – deep natural soils immediately adjacent to the brick base annulus; and
- Old gasworks pipework – inside pipes and immediately adjacent fill/natural soils.

Tarry soils are present at similar locations, however there is spatial separation between former gasworks infrastructure and tarry soils given tars have not migrated significant distances from gasworks infrastructure. Therefore there is a layer of highly impacted soils (free tar impacts) surrounding these structures followed by less impacted tarry soils. Tarry soils are located in the following areas:

- Tar Wells, Northern Gasholder and Gas Purifier – soil and fill surrounding these source areas in surface/subsurface fill and deeper natural soils;
- Retort – fill and deep soil across the majority of this area;
- Gas Purifier – Sandy fill and deeper soils; and
- Localised impacted fill – observed in one localised pocket in the Northeast Area.

Dark stained impacts were associated with:

- the Southern Gasholder – deep soils below the base annulus.

The dark stained impacts are likely to be secondary sources within the strata in localised areas associated with the Southern Gasholder.

## 2.5 Hydrogeology

Previous investigations (CH2M HILL, 2000) reviewed the regional hydrogeological conditions and determined that there were 35 registered groundwater bores within a 3km radius of the Site. The nearest bore was located approximately 2km due southeast, where the majority of the bores were situated in the Botany Sands geological formation of Quaternary Sediments.

Considering this information and new information obtained from the NSW Department of Natural Resources (DNR[2]) website, it can be said that there are no registered bores located within the shale bedrock for purposes other than groundwater monitoring within 3km of the Site, and there are unlikely to be any users of extracted groundwater in the vicinity of the Site and down gradient in the extent of the plume that lies beneath RailCorp owned land.

The groundwater system exists as a shallow perched groundwater layer and a deep bedrock layer. The shallow groundwater exists within fill materials and silty clay above the natural clay (as shallow as 1m below ground surface), and the deeper groundwater exists within the Ashfield Shale bedrock under semi-confinement.

The groundwater flow gradient was determined in previous investigations (CH2M HILL, 2000 and 2001; SKM, 2006) to be toward the south/southeast for both shallow and deep groundwater systems, however flows are likely to be influenced by underground structures, including the gasholders annuli and underground waste pits and services associated with gasworks sites. It is possible there may be some interconnectivity given the similar direction of flow gradient.

Flow velocities within the shallow groundwater are estimated to be 6.2 – 13.7m/year, while within the deep groundwater are 12.2 – 36.5m/year (SKM, 2006). However, these values do not correlate with the lateral extent of the plume, given that gasworks operations began over 100 years ago.

## 2.6 Future Site Use

The exact future use of the Site is unknown. However, considering the current zoning and rail land bordering the north and south of the Site, it is anticipated that the future use of the Site will be rail-related under a commercial/industrial land use scenario.

[2] *The DNR is now part of the Department of Water and Energy (DWE)*

# 3 Site Contamination Status

The results from analytical testing and characterisation of the Site are discussed in the following sections. This section draws on the results of the previous investigations listed in **Section 1.6**, including the most recent delineation investigation by CH2M HILL (2007).

The contamination status of the Site soils is relative to the existing and proposed commercial/industrial land use setting and corresponding land use criteria.

## 3.1 Soils

The analytical results for all previous fill and natural soil samples are provided in **Table 1** and **Table 2** in the Tables section at the rear of this RAP. The locations of previous sampling points are presented on **Figure 3**.

Representative samples were collected using a combination of test pits, trenches and bore holes.

### 3.1.1 Fill

***Organic Compounds***

The results indicate that the following contaminants report a high number of samples that exceed the relevant commercial/industrial land use land use criteria. The contaminants include:

- benzo(a)pyrene (BaP);
- total polycyclic aromatic hydrocarbons (PAH);
- total petroleum hydrocarbons (TPH) ($C_{10}$-$C_{36}$);
- benzene; and
- xylenes (total).

PAH and B(a)P impacts are governed by the presence of tar in fill material proximal to source areas including underground tar pipes, the Retort area, Tar Wells and the Gas Purifier. The other major source of PAH and B(a)P impacts is a layer of ash/coke material covering the majority of the Site surface to a depth of approximately 0.5m.

TPH impacts can be attributed to the presence of PAH, considering analytical results indicate that the main constituents of the TPH impacts comprise aromatic compounds (SKM, April 2006). Therefore, it can be said that impacts from TPH are directly linked to the presence of PAHs. This is important for understanding the contaminants of concern (**Section 3.5**) and setting validation criteria (**Section 4**).

Benzene and xylene impacts are related to the presence of tar in fill material proximal to source areas and also to the surface ash/coke fill layer. One benzene impacted area was identified within ashy fill within the Retaining Wall at location TP44.

The remainder of the organic contaminants report relatively low concentrations that meet the relevant land use criteria.

#### *Inorganic Compounds*

The majority of metal contaminants report concentrations that meet the land use criteria, with the exception of three samples that exceed the criterion for lead (Pb). These samples include sample number MG04/0.5m, which represents the fill material inside the annulus of the Northern Gasholder, while sample numbers VP01_6 and VP02_2 represent the surface fill material in an area south of the Southern Gasholder.

Reported cyanide contaminant concentrations meet the relevant land use criteria.

#### *Asbestos*

All fibrous cement fragment samples collected from the surface and subsurface layers indicate the presence of asbestos. Fill samples collected from inside the Northern Gasholder (MG04) and from the Retaining Wall (TP12) also indicate the presence of asbestos.

The asbestos present in these samples is within a bonded matrix. However, the age and weathered state of these materials may have the potential to generate free fibres.

### 3.1.2 Natural Soil

#### *Organic Compounds*

The results indicate similar high numbers of samples that exceed the relevant land use criteria for some organic compounds as listed for fill materials (**Section 3.1.1**).

In particular, the volatile compounds benzene, xylenes and TPH ($C_6$-$C_9$) were reported with a higher ratio of exceeding values compared to fill material. The reasons for this occurrence are likely to be a combination of:

- Higher solubility rates of shorter chained hydrocarbons that become mobile with infiltrating water or migrating groundwater;
- Volatilisation of these compounds from shallower fill materials;
- Higher impacts from leakage of tarry wastes from deep subsurface storage areas, especially from the Tar Wells and the Gasholders; and
- Vertical fracturing of natural clays and weathered shales, which provide a preferential pathway into deeper soils.

The remainder of the organic contaminants report relatively low concentrations that meet the relevant land use criteria.

#### *Inorganic Compounds*

Metal and cyanide contaminants report relatively low concentrations that meet the relevant land use criteria.

### 3.1.3 Tar Material

#### *Tar Impacted Soils*

Tar material within the fill/natural soil matrix is prevalent in areas proximal to the former gasworks structures and specific site areas including:

- the Tar Wells (Retort area);
- the network of underground pipes;

- the base annulus of the Northern Gasholder (Gasholder area); and
- the Retort and Gas Purifier areas – where tar exists in soil pores and soil fractures.

These areas are providing a source of gross contamination and appear as hotspot[3] areas for one or more of the contaminants, PAH, TPH and BTEX.

Table 3.1 below presents the results of tar impacted fill and natural soils (refer to **Figure 3** for sample locations).

**Table 3.1 – Tar Impacted Soils**

| Sample Location | Site Area | Sample Depth (m) | Contaminants of Concern - Concentrations in mg/kg | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | BaP | Total PAH | TPH (C6-C9) | Total C10-C36 | Benzene | Ethylbenzene | Total Xylenes |
| **Fill Profile** | | | | | | | | | |
| MG02 | Gasholder | 1.8 | **178.0** | **5,301.9** | **189.0** | **36,140.0** | **3.0** | 30.2 | **165.8** |
| BH07 | Retort | 1.4-1.5 | **26.0** | **1,144.8** | - | - | Nd | 8.0 | **32.0** |
| TPA | Retort | 1.6 | **8.4** | **536.9** | **100.0** | **3,200.0** | **1.6** | 7.0 | **65.0** |
| TPC | Retort | 1 | **8.4** | **750.6** | - | - | Nd | 9.0 | **48.0** |
| MG06 | Retort | 1.0 | 2.0 | **135.0** | 18.0 | **1,270.0** | 0.2 | 3.0 | 9.5 |
| MG08 | Retort | 1.5 | **444.0** | **15,237.6** | 51.0 | **435,100.0** | 0.2 | 3.6 | 10.6 |
| MG08 | Retort | 2.1 | **6.9** | **321.2** | **97.0** | **2,790.0** | 0.3 | 12.3 | 6.0 |
| MG09A1 | Retort | 0.7 | **8.2** | **416.6** | 39.0 | **3,520.0** | **1.7** | 2.4 | 21.0 |
| BH18 | Gas Purifier | 1.7-1.8 | **28.0** | **2,160.8** | - | - | **7.0** | **80.0** | **210.0** |
| MG11 | Gas Purifier | 2.0 | **48.8** | **728.8** | 10.0 | **7,750.0** | Nd | Nd | Nd |
| TP16 | Northeast | 1.0 | **39.4** | **425.1** | **166.0** | **7,640.0** | **3.1** | 6.4 | **61.2** |
| **Natural Soil Profile** | | | | | | | | | |
| BHC | Gasholder | 6.0 | **17.6** | **1,906.4** | **559.0** | **8,760.0** | **6.4** | 40.8 | **246.7** |
| BHD | Gasholder | 7.0 | Nd | Nd | 8.0 | Nd | **5.4** | 0.7 | 1.6 |
| BH12A | Retort | 4.2 | **13.9** | **515.6** | **228.0** | **5,350.0** | **20.0** | 8.3 | **94.9** |
| MG06 | Retort | 2.0 | 0.8 | **101.5** | 41.0 | **1,600.0** | Nd | 6.9 | 22.7 |
| TP15 | Retort | 2.8 | **10.8** | **426.2** | **107.0** | **2,090.0** | **1.8** | 17.5 | **56.2** |
| TP15 | Retort | 4.1 | 0.5 | 18.1 | **65.0** | Nd | **2.7** | 4.9 | 24.8 |
| TP15A | Retort | 6.0 | Nd | 0.8 (naphthalene) | Nd | Nd | Nd | Nd | Nd |
| BHG | Retort | 6.0 | 1.0 | 76.6 | 24.0 | 380.0 | **2.4** | 1.3 | 8.7 |
| BHF | Gas Purifier | 7.0 | Nd | 0.8 (naphthalene) | 7.0 | Nd | 0.8 | Nd | 1.0 |
| BHF | Gas Purifier | 8.5 | 1.1 | **134.6** | 22.0 | **1,260.0** | 0.8 | 1.9 | 9.8 |

*Notes:*

**Bold –** Exceeds investigation criteria.

**Bold and shaded** – Exceeds contamination hotspot criteria.

Nd – Not detected.

[3] *Chemical concentrations exceed 250% of the site land use criteria.*

The results show that tar impacts are limited to the former gasworks footprint area (i.e. Gasholders, Retort, Gas Purifier) and are unlikely to persist in areas away from the former gasworks footprint, such as in the Northeast, South Central, Southwest, Retaining Wall or the Western Lot site areas. However, the presence of a localised tar impact in the Northeast Area of the Site at sample location TP16 indicates there is the potential for other areas of localised impact where tarry material may have been dumped or buried on site.

Although the network of gasworks related pipework was delineated to some extent in the previous investigation report (CH2M HILL, March 2007), it should be noted that in areas that were not delineated, pipework, if present have the potential for additional tar impacts that may be encountered during remedial excavation works.

### *Tar Source Material*

Samples of tar were collected from three tar source structures (one Tar Well and the content of two buried pipes). These samples comprised minimal (if any) soil material. The results of these samples are presented in Table 3.2.

**Table 3.2 – Tar Source Material**

| Sample Identication | MG09B/PIPE | RP/PIPE | TAR WELL #2 |
|---|---|---|---|
| **Analyte** | | | |
| Benzo(a)pyrene | **595.0** | **491.0** | **164.0** |
| PAHs total | **26,805.3** | **20,889.8** | **25,557.6** |
| TPH C6 - C9 | **3,770.0** | **70.0** | **6,690.0** |
| TPH C10 - C36 | **1,180,000.0** | **24,660.0** | **98,700.0** |
| Benzene | **576.0** | **2.0** | **814.0** |
| Ethylbenzene | **156.0** | 1.1 | **254.0** |
| Toluene | **1,210.0** | 3.6 | **1,680.0** |
| Xylene Total | **1,516.0** | **47.4** | **3,170.0** |

*Notes:*
**Bold –** Exceeds investigation criteria.
**Bold and shaded** – Exceeds contamination hotspot criteria.
All values in mg/kg.

These results indicate significantly high concentrations of contaminants, which is discussed further in terms of waste classifications in **Section 3.1.5**.

### *Dark Stained Impacts*

Dark stained material was observed as dark brown to black staining in the deep soils and Weathered Shale within the soil pores and shale fractures zones underneath the Southern Gasholder. This material appears different in nature to the tars observed at the base of the annulus of the Northern Gasholder. Dark stained materials were only observed underneath the Southern Gasholder.

Minimal contamination impacts were reported beneath the Southern Gasholder, this includes benzene impacts at 10m depth at a concentration of 1.6mg/kg.

The primary source of tar at the Site originates from the former gasworks structures listed in **Section 3.1.3**, whereas the dark stained impacts are likely to be secondary sources within the strata in localised areas associated with the Southern Gasholder.

***Dioxins/Furans***

A sample of tar was analysed for polychlorinated dibenzo dioxins and polychlorinated dibenzo furans (PCDD/F), which reported a concentration of 1.1pg/g. This concentration is marginally above the laboratory detection limit (0.0409pg/g) and well below the lower comparison criterion (USEPA, 1998) of 5,000 – 20,000pg/g, indicating that PCDD/F at these concentrations would not pose a human health or ecological risk. Additionally, dioxin at these levels would not require remedial action.

### 3.1.4 Leaching Potential

Neutral water leaching tests were conducted on three deeper natural soil samples collected from between 7.0m and 8.5m depth from areas below the Southern Gasholder, below the Northern Gasholder, and below the Gas Purifier area.

The results indicate that contaminants will leach under neutral conditions from the Northern Gasholder and Retort (deep tar impacted soil) source areas. The results show the contaminants that are likely to leach include benzene, xylene, naphthalene and $C_{10}$-$C_{14}$ fraction TPH (from aromatic compounds). The propensity for these particular compounds to leach correlates well with higher water soluble compounds being prevalent in deep soil layers (**Section 3.1.2**).

The results also indicate that contaminants are unlikely to leach under neutral conditions from the Southern Gasholder. This supports the scenario that the dark staining is unlikely to be providing a contamination source and there is unlikely to be a source of tar material below this gasholder.

### 3.1.5 Preliminary Waste Classifications

The previous delineation investigation (CH2M HILL, March 2007) provided preliminary waste classifications on waste materials existing at the Site. This information is summarised below.

In general, soil/fill impacted by free tar (i.e. materials impacted with gross quantities of tar) can be classified as hazardous waste based on the concentrations of B(a)P and PAH. This follows the guidance provided in NSW EPA (1999) Waste Guidelines. However, the waste classification is likely to be dependent on the quantity of free tar within the soil media and the proximal location to source areas.

Tarry soils (i.e. soil and fill that has been impacted with tar to a lesser degree) can be classified as either hazardous or industrial wastes, dependent on the degree of impact. This can be seen in areas away from the source areas, such as the soils underlying the Retort.

The majority of ash/coke surface fill can be classified as hazardous waste primarily based on concentrations of B(a)P.

The material buried within the annulus of the Northern Gasholder is industrial waste given the leachable concentrations of lead and the presence of asbestos containing demolition materials.

Other general fill materials away from the main gasworks area can be classified as either solid waste or inert waste. However, fill materials within the Retaining Wall contain asbestos containing materials such as fibro sheeting fragments and would need to be classified accordingly as asbestos impacted-solid waste material.

### *NSW EPA General Approval for Immobilisation*

Two general approvals can be applied to the waste materials at the Site. These are:

- Approval # 1999/05 – which can be applied to ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials; and
- Approval # 2005/14 - which can be applied to coal tar contaminated soil from former gasworks sites, which has been treated in accordance with the approval specifications.

When applied appropriately, the general approvals give an indicative waste classification for:

- Ash/coke fill as – "solid waste";
- Tar impacted soils after treatment – "solid or industrial waste".

The general approval for coal tar contaminated soil cannot be applied to materials unless they have been treated specifically to immobilise the contaminants. Also, the general approval cannot be applied to materials that contain concentration of contaminants in the untreated waste that exceeds the following limits:

- Polycyclic aromatic hydrocarbons (PAHs) – 13,000 mg/kg
- Benzo(a)pyrene (BaP) – 500 mg/kg
- Non-halogenated phenols – 2,000 mg/kg
- Total cyanide – 4,000 mg/kg

For example, the tar source material in Table 3.2 contain B(a)P and PAH concentrations that exceed the approval specifications.

Copies of the applicable general approvals are provided in **Appendix E**.

## 3.2 Groundwater

Previous investigations included the installation of groundwater monitoring wells on the Site and off site on RailCorp owned land down gradient of the Site.

Elevated concentrations of inorganic and organic contaminants have been reported in both groundwater systems. Concentrations of PAH, TPH (predominantly $C_{10}$-$C_{36}$), metals, phenols and BTEX exceed the ANZECC (2000) guidelines. The concentration of TPH in the $C_6$-$C_9$ range also exceeds the solubility limit in water in the deep groundwater system in the vicinity of the Gasholders, although no light-non-aqueous-phase-liquids (LNAPL) have previously been encountered in any groundwater monitoring wells. Also, there has been no identification of dense-non-aqueous-phase-liquid (DNAPL) in any groundwater monitoring wells.

Concentrations of contaminants are lower in the shallow groundwater compared to the deeper groundwater, indicating that the source of groundwater contamination is most likely the tarry waste and sludge accumulated in the Tar Wells and the base annulus of the Northern Gasholder.

The shallow groundwater contamination plume extends 75m to the south and 50m to the east of the Site, while the deep groundwater contamination plume extends 160m to the south and 50m to the east. Off site monitoring of groundwater has determined that the plumes are limited to RailCorp owned land. This land is used for operational railway purposes.

The background water quality at the site is also impacted by some heavy metals, including cadmium, copper, nickel and zinc.

Table 3.3 below provides a summary of the groundwater contamination at the Site.

**Table 3.3 – Summary of Groundwater Contamination**

| | Criteria | Shallow Groundwater | | | Deep Groundwater | | |
|---|---|---|---|---|---|---|---|
| **Analyte** | **ANZECC 2000** | **Concentration Range** | **Highest Conc. Location** | **Site Area** | **Concentration Range** | **Highest Conc. Location** | **Site Area** |
| As | 24 (AsIII) | nd - 12 | MW42s | Northeast | nd - 20 | MW42d | Northeast |
| Cd | 0.2 | nd - 2.6 | MW13s | Southwest | nd - 1.5 | MW06d | Gasholders |
| Cr(total) | - | nd - 15 | MW04s | South Central | nd - 7 | MW04d | South Central |
| Cu | 1.4 | nd - 220 | MW42s | | 0.001 - 208 | MW42d | Northeast |
| Pb | 3.4 | nd - 174 | MW42s | Northeast | nd - 140 | MW03d | South Central |
| Hg | 0.06 | nd | - | - | nd - 0.0003 | MW03d | South Central |
| Ni | 11 | nd - 10 | MW04s | South Central | nd - 92 | MW36d | Offsite |
| Zn | 8 | 0.033 - 1,570 | MW13s | Southwest | 0.015 - 869 | MW42d | Northeast |
| Cyanide (total) | 7 | 0.02 - 0.479 | MW20s | Gasholders | nd - 14.9 | MW03d | South Central |
| Benzene | 950 | nd - 704 | MW07s | Gasholders | nd - 14,000 | MW03d | South Central |
| Toluene | - | nd - 117 | MW07s | Gasholders | nd - 792 | MW03d | South Central |
| Ethylbenzene | - | nd - 213 | MW07s | Gasholders | nd - 317 | MW03d | South Central |
| Total Xylenes | 550 (o & p) | nd - 417 | MW07s | Gasholders | nd - 5,010 | MW03d | South Central |
| TPH (C6 - C9) | - | nd - 2,170 | MW07s | Gasholders | nd - 28,800 | MW03d | South Central |
| TPH (C10 - C36) | - | nd - 9,495 | MW07s | Gasholders | nd - 18,220 | MW07d | Gasholders |
| Total PAHs | 16 (naphthalene) | nd - 1,677 (naphthalene 1,460) | MW07s | Gasholders | nd - 4,208 (naphthalene 3,840) | MW07d | Gasholders |

*Note: "nd" is 'Non Detect', or less than the laboratory Limit of Reporting (<LOR).*
*All concentrations in µg/L.*

## 3.3 Surface Water

Previous sample results indicate that water accumulated in the Site structures are impacted to varying degrees with both organic and inorganic contaminants. These structures constitute the main sources of surface water at the Site and include the Tar Wells, the Northern and Southern Gasholders, and shallow fill material. Generally the organic contaminants include the more soluble compounds including naphthalene and BTEX. Also, the waters show moderate to high concentrations of TPH. Metal impacts include cadmium, copper, lead nickel and zinc.

## 3.4 Vapours

The SKM (March 2006) investigation reported results of soil gas samples and the results of a computer simulation of potential vapour generation, based on actual soil and groundwater concentrations. The soil-gas assessment was targeted at volatile (BTEX) and some semi-volatile contaminants (PAH).

The results of the soil gas analyses indicated:

- Concentrations of benzene, ethylbenzene and xylenes below the LORs;
- Concentrations of toluene ranging from below the LOR to 28mg/$m^3$;
- Concentrations of PAH below the LORs; and
- Concentrations of naphthalene ranging from below the LOR to 0.00541mg/$m^3$.

The report concluded that:

> *"All test results measured concentrations of BTEX and PAHs well below the WorkCover Exposure Guidelines."*……and……*"These results suggest there may be a low risk that soil-gas vapours at the former gasworks site are an environmental media of concern."*

The results of the computer simulation indicated a significant difference to the soil-gas analyses, where:

- Concentrations of benzene, ethylbenzene and xylenes were simulated as ranging from below LOR to 103mg/$m^3$, 39.2mg/$m^3$ and 64.9mg/$m^3$, respectively;
- Concentrations of toluene were simulated as below LOR;
- Concentrations of naphthalene were simulated as ranging from below the LOR to 661mg/$m^3$; and
- Concentrations of the remaining PAH were simulated as ranging from below the LORs to marginally above the LOR.

The report concluded the reasoning behind the significant differences as:

> *"……the results of the computer analyses show that much higher soil-gas levels may occur if the higher volatile concentrations measured in the earlier groundwater monitoring rounds and/or higher soil concentrations measured in some shallow soil samples are more representative of site conditions."*

Based on this conclusion, there is a potential for vapours to be generated by impacted soil and groundwater that may be a potential risk to human health if exposed.

## 3.5 Contaminants of Concern

The following are considered contaminants of concern for the Site, based on historic site operations and the contaminants detected during the previous site investigations.

The contaminants for soil media include:

- monocyclic aromatic hydrocarbons (MAH), being benzene, toluene, ethylbenzene & xylenes (BTEX));
- polycyclic aromatic hydrocarbons (PAH);
- phenolic compounds (phenol and cresol isomers);
- heavy metals (localised fill materials); and
- asbestos.

The contaminants for water include those contaminants for soil above (excluding asbestos) and also:

- metals including arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), lead (Pb), nickel (Ni) and zinc (Zn); and
- cyanides.

The contaminants for vapours (soil gas) would include those volatile compounds above, which include:

- BTEX and naphthalene (PAH).

TPH were excluded from the list of contaminants of concern considering the main components of TPH are aromatic compounds (SKM, March 2006), which includes the total concentrations of BTEX, PAH and phenolic compounds.

## 3.6 Areas of Environmental Concern and Contamination Sources

The areas of environmental concern and contamination sources at the Site include:

- Tar in the Tar Wells;
- Tar residues in the network of underground pipework;
- Tar residues in the base annulus of the Northern Gasholder;
- Tar in soil pores and soil fractures in former gasworks areas;
- Potential tar residues in the base annulus of the Southern Gasholder (although not a major source, this area should be identified as a secondary source given the historical use and the marginally elevated concentrations of contaminants;
- Demolition wastes containing asbestos sheeting; and
- Ash and Coke fill materials across the majority of the Site in the surface and shallow subsurface layers

## 3.7 Exposure Routes and Receptors of Contamination

The human health and ecological risk assessment (SKM, March 2006) concluded that contamination at the Site would present an unacceptable health risk to onsite long term RailCorp employees and onsite short term construction/maintenance workers. The exposure routes determined by SKM for these receptors are:

- Onsite long-term RailCorp employees via dermal contact or ingestion of soils.
- Onsite short-term construction/maintenance workers via dermal contact or ingestion of soils, and dermal contact with groundwater.

The risk assessment concluded that contamination at the Site would present a low health risk to other identified receptors including residents or construction workers at neighbouring residential properties and freshwater aquatic ecosystems at the head waters (stormwater drainage) of the Alexandra Canal.

The vapour risk modelling undertaken during the human health and ecological risk assessment (SKM, March 2006) indicates the potential for the generation of vapours at concentrations that may pose an unacceptable risk to site users listed above (refer to **Section 3.4**). Therefore inhalation of vapours should also be considered as an exposure route to the identified receptors.

## 3.8 Rationale for Soil Remediation

To meet the long term objectives for the Site, remediation is required to protect the health of the receptors listed above by removing or controlling the identified unacceptable health risks.

The contaminants that drive the health risks are the known carcinogens, benzene and B(a)P. These contaminants have a direct relationship to the tar source material and the ash/coke surface fill. Therefore remediation of the tar sources and the ash/coke fill will mitigate the health risks these contaminants pose on the receptors. This will manage the risks by restricting direct exposure.

Remediation of the tar sources accumulated in the Northern Gasholder annulus and the Tar Wells, and remediation of tarry impacted soils from the Retort and Gas Purifier areas will also protect the environmental values of the site groundwater by focusing on source removal and a reduction in mass contamination. This will manage the risks by minimising or preventing future leaching of contaminants to groundwater.

## 3.9 Extent of Remediation

CH2M HILL, March 2007 provided the following summary of the extent of required remediation. This is summarised in Table 3.4

**Table 3.4 – Summary of Remedial Extent**

| Remediation Area | Impacted Area | Estimated Volume ($m^3$) | Waste Material |
|---|---|---|---|
| **Tar Wells** | Base annulus and immediate area | 1,000 | Soil/fill impacted by free tar |
| | Tar Well contents | 100 | Tar sludge |
| **Northern Gasholder** | Base annulus and immediate area | 2,100 | Soil/fill impacted by free tar |
| | Gasholder contents | 640 | Impacted water |
| | | 320 | Tar sludge |
| | Buried wastes inside annulus | 1,900 | Demolition |
| **Former Gasworks Area** | Shallow Fill/Soils | 9,225 | Tarry soils - fill and natural clays |
| | Deeper Soils | 2,375 | Tarry soils - natural clays and weathered shales |

| | | | |
|---|---|---|---|
| | TP16 Hotspot | 115 | Tarry soils - fill and natural clays |
| **Site Surfaces** | | 2,950 | Ash and Coke Gravels |
| **Retaining Wall** | | 1,765 | Gravel Sand and Demolition Wastes |
| **Hotspots** | BH14 | 100 | Fill and natural clays |
| | MW13s | 140 | Fill |
| | MW04s | 100 | Fill and natural clays |
| **Pipework** | Varying across site | unknown | Tar/ scrap metal |

The required remediation and the selection of the preferred remedial approach is discussed further in **Section 5**.

## 3.10 Evaluating Risk Posed by Contaminated Groundwater

The management of groundwater contamination will be a long term objective of the soil remediation project. Previous investigations (CH2M HILL, March 2007) had concluded that groundwater remediation was not considered necessary given:

- groundwater conditions have been adequately assessed under previous site investigations;
- existing groundwater data concludes that the contaminated groundwater plumes are limited to land owned by RailCorp, which is used for rail and rail-related industrial purposes;
- adjoining residential properties (along Burren Street) have not been impacted by contaminated groundwater, considering that migration is toward the south east away from these properties;
- no sensitive receptors of groundwater are present in the area down gradient of the Site (i.e. on RailCorp industrial land);
- the Groundwater Embargo area (Zone 2) established by the Department of Natural Resources (DNR) is located immediately down gradient of RailCorp land, which bans the extraction of groundwater for domestic purposes; and
- groundwater quality will be improved subsequent to removal of contamination sources and contaminated fill and soil materials. The removal of these source materials will mitigate ongoing groundwater contamination.

It is therefore considered that active groundwater remediation is not required as part of site remediation, however ongoing management (including monitoring) of groundwater is likely to be a requirement of future site management.

The points above are further supported by the following appraisal of the environmental values of the Site groundwater in its regional context and resource value.

Relevance of Beneficial Use of Site Groundwater:- Both shallow and deep groundwater systems are not sustainable groundwater resources given the aquifer

yields (both regional and local) would be insufficient to sustain a use for the groundwater. The shallow system is perched, discontinuous and limited in storage capacity; moreover the deeper system is within shale rock of the Ashfield Shale formation of low storage value. There are no registered bores located within 3km of the Site that utilise deeper groundwater within the shale bedrock for purposes other than groundwater monitoring. Therefore there are unlikely to be any users of extracted groundwater in the vicinity of the Site and down gradient in the extent of the plume. Based on this, the groundwater resource is considered to be of low value.

Protecting Aquatic Ecosystems:- Assimilative capacity and self-purification can be dependent on microscopic organisms in the groundwater. The localised groundwater system is likely to sustain a Groundwater Dependant Ecosystem (GDE) as a hypogean system (refer to NSW State Groundwater Dependency Policy, Department of Land and Water Conservation, April 2002). These organisms have water quality benefits – where microfauna in the groundwater help 'clean-up' contaminants. The urban setting of the Site suggests direct protection of the GDE may not be possible due to the existing degraded groundwater system(s). Therefore maintaining the groundwater from degrading further by specifically removing sources from the gasworks site would be the objective of protecting the GDE.

Potable Water:- The groundwater is not identified as a drinking water supply by the NSW DNR. There are no registered groundwater users in the site vicinity or within the plume, while a groundwater Embargo Area for domestic use exists down gradient of RailCorp land including the Site. Low yields and salinity levels would preclude the groundwater as a potable water resource.

Relevance of other Environmental Values:- Given low yields and sustainability, the groundwater is an unlikely resource for irrigation or agricultural activities. The release to surface water environments is unlikely given impacts have been continuing for over 100 years and the contamination plume has only migrated 160m from the Site. The nearest surface water receptor is the Alexandra Canal, located approximately 1.5km to the southeast of the Site, therefore contaminated groundwater is unlikely to discharge into the Canal. Consequently no recreational, aesthetics or aquaculture environmental values need protecting.

The above appraisal indicates that the value of the groundwater resource is relatively low at the Site and down gradient of the Site.

# 4 Remediation Goals and Validation Criteria

This section presents the determination and rationale behind setting the remediation goals and validation criteria.

## 4.1 Soil Validation Criteria

The primary component of soil remediation is to address unacceptable human health risks and to protect groundwater from ongoing impacts. Tar sources are the main component of contamination risk in that regard and are likely to drive the extent of soil remediation. A set of criteria needs to be established that define an appropriate end point to the extent of remediation that consider the protection of sensitive receptors.

Future site users will be short-term construction/maintenance workers and long-term RailCorp employees. To address the human health risks, these receptors would need protection from dermal contact, ingestion of impacted soils and potential inhalation of vapours, as indicated in **Section 3.7**. The significance of these exposure routes would be directly related to a certain depth, beyond which these health risks would be low or negligible, given that the exposure pathway would be incomplete or not existent. Below this certain depth the importance of protecting the site groundwater would become the main objective rather than protecting human health. For this reason, generic criteria can be used to a certain depth, beyond which risk-based criteria can be used.

The health risk assessment (SKM, April 2006) indicated that dermal contact and ingestion of soils would be exposure scenarios that exist for human receptors in the surface and near surface soils. The health risk assessment indicated that the soil material from the ground surface to a depth of 1.5m would present the greatest exposure risk, using a likely scenario of a construction/maintenance worker working in an excavated trench. Therefore the depth at which potential exposure of human receptors to impacted soil would be limited to 1.5m below the ground surface. Beyond that depth, dermal or ingestion exposure routes would be considered a low risk to humans. However, the potential exposure of humans to inhalation of vapours could still exist with respect to contamination below a depth of 1.5m.

Generic conservative criteria that are protective of human receptors to dermal and ingestion exposure risks associated with impacted soils from the ground surface (0.0m) to a depth of 1.5m have been adopted for validation of soils, as discussed in **Section 4.1.1**.

Site-specific risk-based depth criteria that are protective of human receptors to potential inhalation exposure risks associated with impacted soils will be adopted for validation of soils below 1.5m depth to a depth of 8.0m, as discussed in **Section 4.1.2**.

The approach to protect groundwater from ongoing impacts is discussed in **Section 4.1.3**.

### 4.1.1 Generic Criteria for Shallow Soils

The generic criteria that will be used for soil validation to a depth of 1.5m have been adopted from the Health Investigation Levels (HILs) listed in the NSW DEC

*Contaminated Sites: Guidelines for the NSW Site Auditor Scheme* (2nd Edition), 2006 (DEC, 2006).

In consideration of the proposed future land use of the Site, HILs in Column 4 of Appendix II in NSW DEC (2006) relating to commercial and industrial land use scenarios, referred to as NEHF F[4] or HIL F, will apply.

In addition, the NSW EPA, *Contaminated Sites: Guidelines for Assessing Service Station Sites*, 1994 (NSW EPA, 1994), guidance document has been used to provide generic threshold concentrations for BTEX in soil to 1.5m depth.

There are currently no national or DECC-endorsed guidelines relating to human health or environmental investigation of material containing asbestos (DEC, 2006)[5]. The Department of Health issued a letter in September 2000 to the NSW EPA advising that there be no free asbestos fibres at the ground surface, for the purpose of protecting human health.

For the purposes of the remediation the validation criteria for asbestos follows that outlined in the Australian Contaminated Land Consultants Association (ACLCA), *Asbestos in Soils – Code of Practice, 2002*. The criteria adopted will be:

- No detection of fibres in surface soil; and
- No visible fragments in the surface soil.

The adopted generic (and specific risk-based as discussed below) criteria for contaminants of concern are summarised in Table 4.1.

The Site is currently being considered by RailCorp for continued commercial/industrial land use, therefore provisional phytotoxicity-based Investigation Levels (PBILs) will not be used to assess the suitability of the Site soils. This is based on the decision process for assessing urban redevelopment sites outlined in NSW DEC, 2006, which does not require that PBILs be considered for industrial/commercial land uses.

### 4.1.2 Risk-Based Criteria for Soils at Depth

The health risk assessment (SKM, April 2006) did not identify the inhalation of vapours generated by impacted fill and groundwater as an unacceptable health risk to human receptors. However, the health risk assessment presented results of a computer simulation of soil vapour generation potential, which indicated that vapour generation could be a risk based on previously reported contaminant concentrations in soil and groundwater. Therefore, to protect future site users from potential vapour inhalation (accumulated within buildings) it is considered appropriate to develop risk-based depth criteria to validate soil in remediated areas deeper than 1.5m (with regards to human health risks).

The potential for vapours to generate may still exist beneath this depth if source removal is limited to an extent that is practicable, however it is considered appropriate that residual source material may remain at depth if concentrations in the

*[4] NEHF refers to the former National Environmental Health Forum monographs, and is now known as enHealth.*

*[5] It is noted that enHealth produced Guidelines for the Management of Asbestos in the Non-Occupational Environment, and while these are not currently endorsed by DECC they do provide useful reference for management of asbestos in soil. Further, there are particular regulatory requirements relating to asbestos including those in the Protection of the Environment Operations (Waste) Regulation 1996.*

soil are below risk-based theoretically-derived criteria and are managed appropriately.

Risk-based criteria for soil concentrations have been developed using the Johnson and Ettinger (1991) one-dimensional analytical model to determine theoretical values that would apply to soil at depths below 1.5m based on a potential to generate vapours at levels that would pose a risk to future site users. The depths that the model was applied correspond to 2.5m, 4.0m and 8.0m below the ground surface.

The generation of vapours from residual sources below 8m depth may present a potential risk; however, the risk is considered low and no specific risk-based criteria were developed given the factors outlined below:

- residual source material at or below 8m depth would be managed by implementing a long term Environmental Management Plan (EMP);
- vertical migration of vapours is expected to be restricted in the pore spaces of compacted backfill material, which would limit migration to the ground surface;
- there will exist considerable spatial distance between residual source and human receptors (i.e. at least 8m);
- there will be a limitation on constructing basement structures on the Site (as indicated by RailCorp and to be documented in the EMP), therefore there will be a low potential for vapours to accumulate in underground structures; and
- perched groundwater would intercept vertically migrating vapours, effectively trapping vapours below the perched groundwater.

The adopted risk-based criteria for contaminants of concern are summarised in Table 4.1.

**Appendix B** provides a summary of the technical approach to developing these criteria, including the rationale for selecting specific contaminants (e.g. whether they are sufficiently toxic and/or sufficiently volatile).

### 4.1.3 Protecting Groundwater from Ongoing Impacts

As part of the soil remediation strategy, prevention or minimising further migration of contaminants from source materials to groundwater will be a beneficial outcome of soil remediation. The source material in the Tar Wells, the Northern Gasholder, old gasworks pipes and residual contaminants in soil (pores) is likely to be acting as a source for continued contamination of groundwater.

To remedy this scenario, the NSW DEC Groundwater Guidelines (March 2007) provides guidance on a remedial strategy to affect contamination source removal as a strategy to manage contaminated groundwater. This strategy is documented in the guidelines under section 3.5 – *Source Control*. These guidelines provide specific actions that should be undertaken to affect source control. Specifically, the following actions can be applied to the Site:

- Non-Aqueous Phase Liquid (NAPL) must be cleaned up to the extent practicable; and

- Contaminated soils should be remediated to remove the potential risks to groundwater quality, considering the leaching potential of contaminants from soil to groundwater, and that HILs do not take groundwater protection into account.

Of particular importance at the Site is control of tar material (i.e. the NAPLs). Therefore, it can be said that the remedial strategy is one that will affect tar removal to the extent practicable. And following the guidance provided in the Groundwater Guidelines, the remedial strategy should meet the following remedial goals:

- facilitate the protection of human and ecological health against tar impacts;
- reduce the migration of contaminants from subsurface tar to groundwater; and
- reduce tar mass to the extent practicable.

Managing groundwater contamination is discussed further in **Section 5.6**.

Considering the above, the approach to protect groundwater from ongoing impacts will be based on the remedial strategy to affect tar removal to the extent practicable. No specific risk-based criteria will be adopted to validate soil materials at depth on the basis of protecting groundwater. Potential impacts to groundwater will be addressed by implementing a program of Monitored Natural Attenuation (MNA) as part of the long term EMP, which is discussed in **Section 10**.

## 4.2 Adopted Soil Criteria

The generic and risk-based depth criteria being adopted for the remediation are provided in Table 4.1. These criteria are for the protection of human health.

The following important explanations should be considered when applying the criteria:

- Metals – metals are not considered a contaminant of concern (**Section 3.5**), other than in localised fill material. Therefore metals criteria shall only apply to surface (0.0m – 1.5m) layer.
- BTEX – more conservative ecological health based criteria from NSW EPA, 1994 are used for toluene, ethylbenzene and xylenes in the surface (0.0m – 1.5m) layer, given values are more comparable to human health based benzene criteria and provide a conservative screening value to assess for malodourous materials (i.e. aesthetic criteria **Section 4.6**).
- Benzene and Xylenes – risk-based criteria developed using the Johnson and Ettinger (1991) one-dimensional analytical model indicate values that are below the laboratory analytical limit of reporting (LORs) and the generic criteria. Given this situation, less conservative criteria provided in NSW EPA, 1994 shall apply to all shallow and deep soil layers.

| Table 4.1 – Soil Validation Criteria (all values in mg/kg) | | | | |
|---|---|---|---|---|
| **Analyte** | **Depth** | | | |
| | **0.0m – 1.5m** | **1.5m – 2.5m** | **2.5m – 4.0m** | **4.0 - 8.0m** |
| **Metals** | | | | |
| As (total) | 500 | - | - | - |
| Cd | 100 | - | - | - |
| Cr | 500[1] | - | - | - |
| Cu | 5,000 | - | - | - |
| Hg (inorganic) | 75 | - | - | - |
| Ni | 3,000 | - | - | - |
| Pb | 1,500 | - | - | - |
| Zn | 35,000 | - | - | - |
| **BTEX[2]** | | | | |
| Benzene[3] | 1 | 1 | 1 | 1 |
| Toluene | 1.4 | 2.6 | 4.0 | 7.9 |
| Ethylbenzene | 3.1 | 11.1 | 17.6 | 34.8 |
| Total Xylenes[3] | 14 | 14 | 14 | 14 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | |
| PAH – total | 100 | - | - | - |
| Benz(a)pyrene | 5 | NOC | NOC | NOC |
| Naphthalene | - | 3.8 | 6.0 | 11.8 |
| Acenaphthene | - | NOC | NOC | NOC |
| Fluorene | - | NOC | NOC | NOC |
| Pyrene | - | NOC | NOC | NOC |
| Benzo(b)fluoranthene | - | NOC | NOC | NOC |
| Chrysene | - | NOC | NOC | NOC |
| **Phenolic Compounds** | | | | |
| Phenol | 42,500 | - | - | - |
| **Cyanide (complex)** | 2,500 | - | - | - |
| **Asbestos[4]** | No detection of fibres in surface soils (0.5m depth) No visible fragments in the surface soils (0.5m depth) | - | - | - |

*[1] This value is for Cr(VI) and used as a conservative concentration as a preliminary screening value for Chromium.*

*[2] Criteria for toluene, ethylbenzene and xylenes at 0.0m – 1.5m are ecological health based, and considered appropriate to screen for aesthetic criteria (i.e. malodourous material) in surface soils.*

*[3] Risk based values are lower than laboratory analytical limits of reporting (LORs) and HILs, therefore less conservative HILs applied to all depths.*

*[4] Australian Contaminated Land Consultants Association, Asbestos in Soils – Code of Practice, 2002. Based on a depth to 0.5m below the ground surface.*

*NOC – Not of Concern. Based on the outcomes of the Johnson and Ettinger (1991) risk-based model, the contaminant has a low vapour potential at the nominated soil temperature of 15°C.*

*(-) refers to no criteria value.*

## 4.3 Groundwater

The NSW DEC Groundwater Guidelines (March 2007) provide a hierarchy of clean-up objectives for contaminated groundwater. Using these objectives, the soil remediation strategy to affect source control (tar removal) can extend to the long-term objective of groundwater clean-up. However, it should be noted that this RAP addresses the remediation of soil materials, while groundwater is not considered to require remediation as discussed in **Section 3.10**.

The hierarchy is listed as:

1. Clean up so that the natural background water quality is restored;
2. Clean up to protect the relevant environmental values of groundwater, and human and ecological health; and
3. Clean up to the extent practicable.

The Guidelines conclude that regardless of the clean-up approach, the remedial approach should ultimately strive to restore water quality to its natural background condition. Therefore, the soil remediation strategy should consider the potential for ongoing impacts to groundwater. In that regard and considering that groundwater restoration should be a remedial goal, a program of MNA will complement tar removal to the extent practicable to monitor and understand the ongoing impacts to groundwater.

An evaluation on the progress of MNA will be based on the set of metrics as detailed in **Section 10.3.2**. In that regard, specific groundwater criteria will not be used to assess risks presented by contaminated groundwater. More so, the success of the remediation and mitigation of known risks will be assessed based on the restoration of the groundwater conditions within the MNA program. However, generic Groundwater Investigation Levels (GILs) and background groundwater quality should be used on a comparison basis. Baseline conditions of the Site are to be adopted from the groundwater monitoring event immediately after source removal. These baseline conditions can be compared with ongoing MNA data that is to be collected to evaluate the Site relative to the ultimate goal of achieving pre-development (i.e. natural conditions).

In this regard, generic GILs should be adopted from the following sources:

- ANZECC Australian and New Zealand guidelines for Fresh and Marine Water Quality 2000 – trigger values;
- NSW EPA Contaminated Sites: Guidelines for Assessing Service Station Sites, 1994;
- NEPC National Environment Protection Measure, Schedule B (1), 1999 (NEPM); and
- Netherlands (Dutch) Intervention Values – Water, 2000 (where appropriate).

Background groundwater quality should be established by sampling groundwater monitoring wells in non-impacted locations upgradient of the remediation area.

## 4.4 Surface Water

Surface water has the potential to migrate off site during and subsequent to the site remediation, although the potential can be minimised by implementing surface water controls during remediation works and landscaping following remediation. Generic criteria for protecting fresh water ecosystems should be adopted from ANZECC 2000. The trigger values provided in these guidelines should be used to protect human health and environmental receptors.

## 4.5 Aesthetic Considerations

### 4.5.1 Soil Odour

In consideration of the NSW DEC (2006) decision-making process for assessing urban redevelopment sites, soils exhibiting odours should be assessed for their suitability at the Site given the proposed land use as commercial/industrial. In this regard, odorous soils would be considered unsuitable at the final ground surface.

# 5 Site Remediation

This section provides information on the NSW DECC-endorsed remediation policy, a review of remedial options screening and the selected preferred remedial option.

## 5.1 Objectives

The remediation objectives follow RailCorp's long term objectives for site use (refer to **Section 1.1**).

## 5.2 Remediation Policy

The preferred remediation hierarchy for this RAP is in accordance with the *Australia and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, ANZECC[6] 1992. This policy is also followed by the NSW DECC. These guidelines state that the preferred order of options for remediation and management are:

- On-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level; and
- Off-site treatment of excavated soil which, depending on the residual levels of contamination in the treated material, is then returned to the site, removed to an approved waste disposal facility or used as landfill.

Should it not be possible for either of these options to be implemented, then other options that should be considered include:

- Removal of a contaminated soil to an appropriate site or facility, followed where necessary by replacement with clean fill;
- Isolation of the soil on the site by covering with a properly designed barrier;
- Choosing a less sensitive land use to minimise the need for remedial works which may include partial remediation; and
- Leaving contaminated material in-situ providing there is no immediate danger to the environment or community and the site has appropriate controls in place.

If remediation is likely to cause a greater adverse effect on any aspect of the Site or surrounds than what would occur if the Site was left undisturbed, then remediation should not proceed.

## 5.3 Review of Potentially Suitable Remedial Options

A remedial options screening was undertaken as part of the scope of work for the CH2M HILL (March 2007) investigation. Specific remedial options were screened from a "long-list" of options as being potentially suitable, and were consolidated into a "short-list" of options, as summarised below. The "short-list" of options included:

- No Action;

[6] *Australian and New Zealand Environment and Conservation Council (ANZECC)*

- Institutional Controls including an Environmental Management Plan (EMP) and site access restrictions;
- Insitu Physical/Chemical Treatment including chemical oxidation and soil vapour extraction;
- Insitu Thermal Treatment;
- Exsitu Biological Treatment including biopiles, composting and land-farming;
- Exsitu Physical/Chemical Treatment including solidification/ stabilisation/ immobilisation and chemical extraction;
- Exsitu Thermal Treatment including incineration/co-burning and thermal desorption;
- Containment including capping and containment;
- Off site Disposal; and
- Reuse and Recycle.

As part of this RAP, these options have been further evaluated to determine the preferred remedial options based on:

- Effectiveness;
- Technology risk;
- Timeframe;
- Permissibility;
- Compatibility;
- Health and Safety Risk;
- Costs; and
- Ongoing Management.

**Appendix C** presents the outcomes of the remedial options evaluation in terms of *preferred* and *not preferred* options, including the advantages and disadvantages of each "short-list" remedial option.

## 5.4 Preferred Remedial Options

The evaluation of the "short-list" remedial options provided in **Appendix C** shows that the overall preferred remedial strategy will be one that primarily affects contamination source removal and implements long term management of environmental receptors under a site-specific EMP. The preferred remedial options and/or combination of options are:

1. Installation of Site Security Fencing;
2. Collection of liquid wastes/sludges and disposal at a liquid waste facility;

3. Excavation, organic stabilisation treatment (at an alternate treatment site) and disposal of soil waste at a landfill facility under the NSW DECC General Approval for Immobilisation for coal tar materials – Approval #2005/14 (refer to **Section 3.1.5**);
4. Excavation, thermal desorption treatment (at an alternate treatment site) and disposal of soil waste at a landfill facility;
5. Excavation and disposal of soil waste at a landfill facility under the NSW DECC General Approval for Immobilisation for ash materials – Approval #1999/05 (refer to **Section 3.1.5**);
6. Excavation and disposal of asbestos impacted demolition waste at a landfill facility;
7. Excavation and disposal of untreated fill/soil waste at a landfill facility;
8. Beneficial Reuse and Recycle (including segregation of demolition waste) of suitable materials where appropriate;
9. Insitu (passive) chemical oxidation of residual source materials at depth subsequent to excavation and disposal of above materials; and
10. Long term Environmental Management Plan (EMP) including a Groundwater Management Plan (GMP) with a Monitored Natural Attenuation (MNA) approach.

It is the opinion of CH2M HILL that the proposed combination of preferred remedial options is practical and will facilitate RailCorp in meeting the long term objectives for the Site. The approach also follows the remediation hierarchy outlined in the *Australia and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, ANZECC 1992.

The features that demonstrate these qualities include:

- Use of proven techniques which are known to be capable of providing a safe solution due to past experience with the techniques, the level of confidence provided by the techniques and the technology being well understood;
- The use of a remediation strategy which can be applied in a relatively short time frame;
- An approach that appreciates the relative sensitivity of the adjoining residential properties, providing protection from long term noise, odours, dust and visual impacts;
- The use of a remedial option that removes or reduces the contamination liability enabling beneficial re-use of the Site for rail-related activities; and
- The use of a remedial option that protects groundwater from ongoing impacts.

CH2M HILL's preferred options are summarised in Table 5.1, and the information presented in **Section 5.5** is also based on these options. This table also provides the likely constraints that may impact implementation of the selected remedial option for each nominated site area. Reference is made to **Figure 4** to identify the Site areas.

**Table 5.1 – Preferred Remedial Options**

| Site Area | Material Type | Extent of Impact | Expected Quantity ($m^3$) | Remedial Option | | Waste Classification | | Potential Remedial Constraints |
|---|---|---|---|---|---|---|---|---|
| | | | | Pre-treatment/ Treatment | Remedial Action | Preliminary | After Treatment/ Immobilisation Approval | |
| Site Wide | NA | NA | NA | NA | Environmental Management Plan (EMP) | NA | NA | • None |
| Site Wide | NA | NA | NA | NA | Site Security Fencing | NA | NA | • None |
| Tar Wells | Tar sludge | Contained within Tar Wells | 100 | Potential pre-treatment to improve handling | Liquid Waste Disposal | Hazardous | NA | • Onsite odours<br>• Handling and Transport |
| | Soil/fill impacted by free tar | Base annulus and proximal soils (within pink shaded area on Figure 4 to a depth of 8m-10m) | 1,000 | Potential pre-treatment to improve handling (i.e. lowering moisture content, breakdown clay clods to expose higher surface area) | Stabilisation or Thermal Desorption treatment and landfill disposal – Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14) | Hazardous | Industrial or Solid | • Regulatory approval<br>• Available site area<br>• Available alternate treatment site<br>• Regulatory approval for alternate treatment site<br>• Underground services<br>• Onsite odours<br>• Aesthetic issues for neighbouring residents (noise, odours, dust, visual impact)<br>• Groundwater management during excavation<br>• Transport approvals<br>• Ground stability of western and northern boundary during excavation (protect adjoining properties/structures) |

**Table 5.1 – Preferred Remedial Options**

| Site Area | Material Type | Extent of Impact | Expected Quantity ($m^3$) | Remedial Option | | Waste Classification | | Potential Remedial Constraints |
|---|---|---|---|---|---|---|---|---|
| | | | | Pre-treatment/ Treatment | Remedial Action | Preliminary | After Treatment/ Immobilisation Approval | |
| Northern Gasholder | Tar sludge | Contained within Base of Gasholder | 320 | Potential pre-treatment to improve handling | Liquid Waste Disposal | Hazardous | NA | • Potential heritage value of below ground annulus<br>• Regulatory approval<br>• Available site area<br>• Available alternate treatment site<br>• Regulatory approval for alternate treatment<br>• Aesthetic issues for neighbouring residents (noise, odours, dust, visual impact)<br>• Underground services nearby<br>• Management of water and tar inside the Gasholder<br>• Health and Safety issues with asbestos waste<br>• Groundwater management during excavation<br>• Ground stability of western and northern boundary during excavation (protect adjoining properties/structures)<br>• Protection of the heritage value and stability of the Southern Gasholder during excavation<br>• Handling and Transport |
| | Impacted Water | Contained within Gasholder | 640 | NA | Liquid Waste Disposal | Hazardous | NA | |
| | Soil/fill impacted by free tar | Base annulus and proximal soils (within pink shaded area on Figure 4 to a depth of 8m-10m) | 2,100 | Potential pre-treatment to improve handling (i.e. lowering moisture content, breakdown clay clods to expose higher surface area) | Stabilisation or Thermal Desorption treatment and landfill disposal – Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14) | Hazardous | Industrial or Solid | |
| | Demolition Waste | Buried inside Gasholder annulus (blue shaded area on Figure 4) | 1,900 | Potential pre-treatment to remove free tar or segregate oversize materials | Landfill disposal or Recycling | Asbestos/ Industrial | NA | |

**Table 5.1 – Preferred Remedial Options**

| Site Area | Material Type | Extent of Impact | Expected Quantity ($m^3$) | Remedial Option | | Waste Classification | | Potential Remedial Constraints |
|---|---|---|---|---|---|---|---|---|
| | | | | Pre-treatment/ Treatment | Remedial Action | Preliminary | After Treatment/ Immobilisation Approval | |
| Retort and Surrounding Former Gasworks Source Areas | Shallow Tar Impacted Soil and Fill | Lateral extent shown as orange shaded area on Figure 4 to a depth of at least 4m | 9,225 | Pre-treatment – Physical amendment to break down material with high clay content (i.e. lowering moisture content, breakdown clay clods to expose higher surface area)<br>Likely alternative site for pre-treatment and remedial treatment | Stabilisation or Thermal Desorption treatment and landfill disposal – Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14) | Hazardous or Industrial | Industrial or Solid | • Potential heritage value of Retort floor (brick layers) below ground<br>• Available site area<br>• Available alternate treatment site<br>• Regulatory approval for alternate treatment site<br>• Aesthetic issues for neighbouring residents (noise, odours, dust, visual impact)<br>• Underground services<br>• Groundwater management during excavation<br>• Ground stability of western and northern boundary during excavation (protect adjoining properties/structures)<br>• Protection of the heritage value and stability of the Southern Gasholder during excavation<br>• Handling and Transport |
| | Deep Tar Impacted Natural Soil | Lateral extent shown as pink shaded area on Figure 4 in the vicinity of boreholes BHE and BHF location to a depth of 8m-10m | 2,375 | | | Hazardous or Industrial | Industrial or Solid | |
| | Tar Impacted Contamination hotspot at TP16 location | Lateral extent shown as green shaded area on Figure 4 to a depth of 1m-2m | 115 | | | Hazardous or Industrial | Industrial or Solid | |
| Existing Site Surfaces | Ash/Coke Fill | Lateral extent shown as yellow shaded area on Figure 4 to a depth of at least 0.5m | 2,950 | NA | Landfill disposal – application of NSW DEC immobilisation approval (Approval #1999/05) | Hazardous | Solid | • Items of potential heritage value<br>• Aesthetic issues for neighbouring residents (noise, odours, dust, visual impact)<br>• Underground services<br>• Ground stability during excavation along western boundary embankment<br>• Protection of the heritage value of the Southern Gasholder during excavation<br>• Retained (protected) vegetation |
| Retaining Wall | General Fill and demolition waste | Entire Northern boundary (shaded blue on Figure 4) | 1,765 | Pre-treatment – segregation of oversize materials | Landfill disposal or Beneficial Reuse or Recycling | Solid | NA | • Items of potential heritage value<br>• Physical segregation of oversize materials<br>• Aesthetic issues for neighbouring residents (noise, odours, dust, visual impact)<br>• Ground stability during excavation (protect adjoining properties/structures)<br>• Retained (protected) vegetation<br>• Health and Safety issues with asbestos<br>• Unexpected materials (e.g. Asbestos material)) |

**Table 5.1 – Preferred Remedial Options**

| Site Area | Material Type | Extent of Impact | Expected Quantity ($m^3$) | Remedial Option | | Waste Classification | | Potential Remedial Constraints |
|---|---|---|---|---|---|---|---|---|
| | | | | Pre-treatment/ Treatment | Remedial Action | Preliminary | After Treatment/ Immobilisation Approval | |
| Contamination Hotspots | Impacted Fill at locations BH14, MW13s and MW04s | Lateral extent shown as green shaded area on Figure 4 to a depth of 1m-2m | 340 | NA | Landfill disposal or Beneficial Reuse | Solid | NA | • Items of potential heritage value<br>• Aesthetic issues for neighbouring residents (noise, odours, dust, visual impact)<br>• Underground services<br>• Ground stability during excavation (protect adjoining properties/structures) |
| Site Wide | Old Gasworks Pipes | Varied | Unknown | NA | Tar removal by chemical extraction or other physical process | Hazardous (tar) or Industrial (scrap metal, demolition waste) | NA | • Items of potential heritage value<br>• Regulatory approval<br>• Aesthetic issues for neighbouring residents (noise, odours, dust, visual impact)<br>• Underground services<br>• Ground stability during excavation (protect adjoining properties/structures)<br>• Unknown quantity of tar wastes inside pipes<br>• Unknown extent |
| Site Wide | Fill and natural soil materials | NA | Unknown | NA | Beneficial Reuse | NA | NA | • Required to meet beneficial reuse criteria (**Section 9.4)** |
| Deep Excavations proximal to Source Areas | Residual tar sources – subsequent to source removal | Unknown | Unknown | NA | Insitu (passive) chemical treatment - to enhance biodegradation and promote long term MNA | NA | NA | • Stiff/hard clay and weathered shale<br>• Targeting residual sources in soil fractures |

## 5.5 Remedial Options Activities

Based on the selected remedial options, information on the works required prior to, during and at the completion of remedial works is provided below.

### 5.5.1 Security Fencing

The Site is currently bounded by a chain wire fence that provides adequate security and restricts access to the Site by the general public. The adequacy of the existing fencing may need to be reconsidered prior to any remedial works being undertaken, particularly in regard to site access (**Section 8.3.1**).

### 5.5.2 Liquid Waste Disposal

Much of the liquid wastes are contained within the Tar Wells or the Gasholders. The liquids within the Tar Wells are considered to be coal tar sludge, while the liquids within the Gasholders are considered to be impacted waters. However, liquids at the base of the Northern Gasholder are also likely to contain coal tar sludge.

Free flowing liquids and sediments may be removed by a specialised vacuum truck that will store and transport the liquids to the waste disposal facility.

Pre-treatment may be required to remove coal tar sludge, for example, by heating the material to lower the viscosity and facilitate vacuum removal. Alternatively, handling and transport may be improved by additives such as fly ash.

### 5.5.3 Off Site Landfill Disposal

Non-liquid wastes that are classified as either inert, solid or industrial (in accordance with the NSW EPA Waste Guidelines, 1999) can be disposed at a licensed landfill. This also applies to wastes that are impacted with asbestos. The landfill should be licensed to accept the prescribed wastes being generated from a site. Any hazardous wastes would require treatment to a lower waste classification to enable disposal to landfill, or storage until such treatment can be undertaken.

#### *Demolition Wastes (Northern Gasholder and Retaining Wall Material)*

A large amount of the demolition wastes buried within the Northern Gasholder and Retaining Wall fill material may be screened to remove oversize materials (i.e. bricks, concrete blocks and metal piping) to reduce the quantity to be disposed at the landfill. However, consideration should be given to the asbestos impacts (i.e. fibro sheeting) and the likely tar impacts at the base of the gasholder.

#### *Ash and Coke Surface Fill*

**Section 3.1.5** provides detail for the use of general approvals for immobilisation, which can be applied to the ash/coke fill material at the Site. This material can be classified based on leachable concentrations of Benzo(a)pyrene alone. However, if these materials contain other contaminants, they need to be classified accordingly.

### 5.5.4 Treatment Options and Landfill Disposal

An alternative site is likely to be required to conduct treatment processes prior to disposal, given the on site constraints such as limited space and the sensitivities of adjoining residential properties (further discussed in **Section 8.3.7**).

Soil conditions will present constraints given that excavated natural soils will be stiff clay material (refer to **Section 2.4**). Pre-treatment is likely to be required to ensure the impacted soils are appropriately amended to enable sufficient mixing or blending to improve consistency of the material to be treated.

Pre-treatment activities may also require the use of an alternative site.

#### *Stabilisation*

Soils impacted by tar can undergo soil stabilisation to enable the general approval for immobilisation of coal tar (**Section 3.1.5**) to apply to this material for off site disposal. Specifically, the general approval nominates treatment by immobilisation by the addition of a reagent that consists of calcium or magnesium oxide based cement to immobilise contaminants. Other specific conditions include:

- Ratio mixing must not exceed 2 parts reagent to 1 part untreated waste;
- Mixing must be sufficient to ensure that contaminants are completely encapsulated; and
- The unconfined compressive strength of the treated waste must be 1MPa or greater prior to disposal.

The treated material can be classified based on leachable concentrations alone. However, if these materials contain contaminants other than those specified in the general approval, then they will need to be classified accordingly.

Importantly, only untreated materials with concentrations less that the specified levels provided in the general approval (#2005/14) are covered by the approval. Refer to **Section 3.1.5** and **Appendix E** for further detail.

#### *Thermal Desorption*

Soils impacted by tars can undergo thermal desorption, as either direct or indirect heat treatment. Contaminants are removed from the solid media by volatilisation, but without combustion of the media.

After treatment, the soil material can be classified for disposal at a licensed landfill facility. Classification for off site disposal should be undertaken in accordance with the NSW DEC Waste Guidelines (2004). One outcome of this process will be to treat the materials so that a classification of solid waste, or at least industrial waste, is achieved for off site disposal.

### 5.5.5 Beneficial Reuse and Recycling

Materials that may be potentially suitable for beneficial reuse will need to meet the criteria provided in **Section 9.4.**

It will be necessary for any demolition waste materials that may be potentially suitable for recycling to be initially segregated from fill/soil wastes and inspected for gross contamination impacts. Only materials free from impacts should be recycled. Impacted materials are likely to be disposed off Site under a waste classification. Potential materials for recycling are likely to include bricks and concrete, and should exclude fibro cement sheeting wastes that may contain asbestos.

### 5.5.6 Insitu Chemical Treatment

Passive chemical treatments will be used to enhance biodegradation of residual contaminants through the use of oxygen-releasing compounds. The application of these reagents can be varied, but should provide a long term source of oxygen into the groundwater system and also target residual source material at the base of excavations. The approach of application should consider:

- Concentrated liquid injection – to target source material remaining in deeper soil fractures; and
- Broad scale mixture with backfill material at depth – to provide coverage and mass to enable long term release of the chemical agent.

## 5.6 Managing Groundwater Contamination

### 5.6.1 Source Control

The nature of the tar is such that complete removal of all tar material would be impracticable. This can be said given the tar materials Dense NAPL (DNAPL) characteristic, having a propensity to migrate vertically downward from the structures that contain these tars. However, the geological conditions (i.e. stiff clays and weathered shales) are likely to adsorb tars and retarded migration to some degree.

The extent of the migration is highly variable and is dependent on available pathways, nature of releases (types, rates, temperature and pressure), and other factors such as dissolution rates. Therefore the scenario involving DNAPLs is usually one where soils are impacted to varying degrees throughout the soil profile and at varying depth intervals.

Therefore it can be said that given the nature of the tar, complete removal of tar would be impracticable when considering the limitations and constraints of site remediation presented in Table 5.1. The factors that govern these limitations can be summarised as:

- Removal of tar source will be limited by the capability of excavation machinery and the ability to chase-out deep impacted zones, especially where site area limits the capacity for combinations of activities such as deep excavation requiring benching, remediation equipment, pre-treatment facilities, vehicle access, etc.
- Specialised machinery may be required to remove tar material from weathered shale rock layers (i.e. within fractures of weathered shale). In this regard, excavation limits may be governed by the ability to remove impacted rock, therefore a decision can be made on whether the extent practicable has been reached.
- The timeframe to undertake remediation may be significantly impacted if specialised removal requirements were pursued, which would also have financial, community and regulatory implications.

- The high costs and uncertain benefit of undertaking such work presents the basis to the extent practicable approach, where costs are balanced against the environmental benefit of continuing source removal.
- Limitations on the vertical and lateral extent of source removal below the Northern Gasholder will be governed by the retention of the adjacent Southern Gasholder and the need to control the risk of undermining the ground stability. This also applies to the adjacent neighbouring residential properties, the northern adjoining Stabling Yards and the operation rail tracks to the south of the gasworks. This constraint also applies to the extent of source removal below the Tar Wells given similar requirements.

### 5.6.2 Supportive Measures of Source Control

Tar removal to the extent practicable can be undertaken to address tar source material. The following supportive measures and factors will also form part of the strategy and further protect ongoing impacts to groundwater and potential receptors of groundwater.

- Passive application of an oxidising agent will be undertaken at the base of excavations to promote biodegradation of residual organic contamination.
- A continued program of MNA (refer to **Section 10**) will be conducted.
- A Groundwater Management Plan (GMP), will be included as part of the long term EMP (refer to **Section 10**).
- The groundwater contamination plume has migrated from the Site boundary; however, the plume has not migrated from the adjoining railway land and is therefore not posing a current risk to human health beyond RailCorp-owned land.
- The EMP for the Site is to document the restriction of groundwater use or extraction on the Site and potentially on the adjoining railway land. Areas that are hydraulically down gradient of RailCorp-owned land have been declared by the DNR as an embargo area for domestic use of groundwater.

### 5.6.3 Determining the Extent of Source Control

This section provides the information and personnel that will be used to determine the extent of tar removal considering the Site limitations and constraints of excavation. The extent of tar removal will be governed by the following points.

- The ground stability and the need to protect the Southern Gasholder – the extent of excavation is to be determined by a geotechnical/structural engineer.
- The weathered shale layer will to be used as a vertical limit to excavation, but at least 8 mbgl in source zones, to be determined by an environmental engineer.

- Spatial distribution and the need to remove tar will be based on whether the net gain to the environment to remove small quantities of tar material would be beneficial, considering time and financial resources of the project. The decision makers at this point should be RailCorp, the environmental consultant and the appointed Site Auditor.
- Visual observations will be used to assess tar residues and validation data (walls and floor of excavations) will be collected by an environmental consultant.

### 5.6.4 Rationale for Source Control

The measures to be implemented to achieve source control to the extent practicable can be justified by considering the protection of the values of human health and the groundwater environments. The protection of these values can be linked to those identified in the risk assessment (SKM, April 2006) (**Section 3.7**) and the requirement of the NSW DEC Groundwater Guidelines to address source material to protect ongoing impacts to groundwater environments (**Section 4.1.3**).

The following measures will be implemented to protect relevant on-Site and off-Site values. Human health will be protected onsite by remediating the surface soils (i.e. to depths of 1.5m) to remove dermal contact, ingestion and vapour inhalation exposure pathways; and by remediating soils at depth (i.e. below 1.5m) to the remove the vapour inhalation exposure pathway. Human health and the shallow groundwater environment will be protected and improved onsite by affecting tar removal to the extent practicable and remediating impacted fill and soils. The shallow groundwater environment will be protected and improved off site by affecting tar removal to the extent practicable and remediating impacted fill and soils.

Considering the limitations of tar removal to the extent practicable strategy, the on-Site and off-Site shallow and deep groundwater environments may continue to be impacted to some degree given that complete tar removal is likely to be unachievable. However, this is an unknown scenario. Nevertheless shallow and deep groundwater quality is likely to be improved in the long-term. Monitoring of the groundwater environments will enable a better understanding of potential ongoing impacts. A program of MNA will be implemented to understand the unknown long-term impacts to groundwater. Further discussion on the long-term management of the Site and the MNA program is provided in **Section 10.3.3**.

# 6 Environmental Planning and Approvals

This section of the RAP provides information on the required planning approvals for the site remediation to commence.

## 6.1 State Environmental Planning Policy 55 – Remediation of Lands

State Environmental Planning Policy (SEPP) 55 provides the planning framework for the remediation of contaminated land within NSW. Clause 9 of SEPP 55 defines Category 1 remediation works as works that require consent. Clause 9 (e) includes remediation which is to be carried out on an area or zone which is affected by a heritage conservation classification under an environmental planning instrument. Therefore, given the existence of the Southern Gasholder, the remediation of the Site falls within Category 1 of SEPP 55.

## 6.2 State Environmental Planning Policy (Major Projects)

SEPP (Major Projects), 2005 lists development works to which Part 3A of the Environmental Planning and Assessment (EP&A) Act 1979 applies. Clause 28 of Schedule 1 of SEPP (Major Projects) includes Category 1 remediation works within the meaning of SEPP 55 carried out on a 'remediation site'. The Site is under a Voluntary Remediation Proposal (VRP) and is not currently declared a 'remediation site' under the CLM Act, thus this provision does not apply.

The Site is identified as a *Redfern-Waterloo Authority Site* under Schedule 3 of SEPP (Major Projects). Part 5, Clause 5 of Schedule 3 of SEPP (Major Projects) states that development within a Redfern-Waterloo Authority Site with a capital investment value of more than $5 million is to be a Part 3A project. Therefore, considering the capital investment required to remediate the Site, the remediation will fall under Part 3A of the EP&A Act.

## 6.3 Environmental Planning and Assessment Act

The remediation of the former gasworks site will require assessment under Part 3A of the EP&A Act.

The Site contains a Gasholder that is listed on the State Heritage Register as part of the Eveleigh Railway Workshops in accordance with the Heritage Act, 1977. The Site is also listed as a Heritage Item under Schedule 4 of the Sydney Regional Environmental Plan 26 – City West (SREP 26). **Figure A** below provides the decision process in determining the requirement for assessment under Part 3A of the EP&A Act for the site remediation.

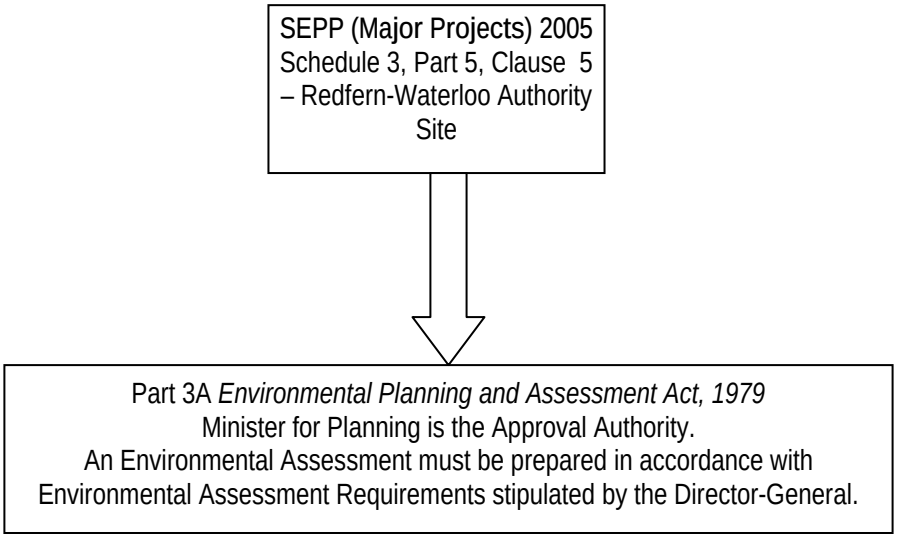
Section 75U of Part 3A of the EP&A Act lists other Acts and their provisions that no longer apply under Part 3A EP&A Act. Included in this list is:

- Section 12 of the Native Vegetation Act, 2003.
- Section 87 and section 90 of the National Parks and Wildlife Act, 1974.
- Approvals under Part 4 or an excavation permit under section 139 of the *Heritage Act 1977*.

- Division 8 of Part 6 of the Heritage Act 1977, which addresses controlling harm to buildings, works and relics not listed on the State Heritage Register.

Approval is no longer required to carry out development works under these Acts. The Minister for Planning will forward the Development Application and Preliminary Environmental Assessment to the Ministers administering these Acts for comment and recommendations for Environmental Assessment Requirement (EAR).

Figure A – Application of Part 3A



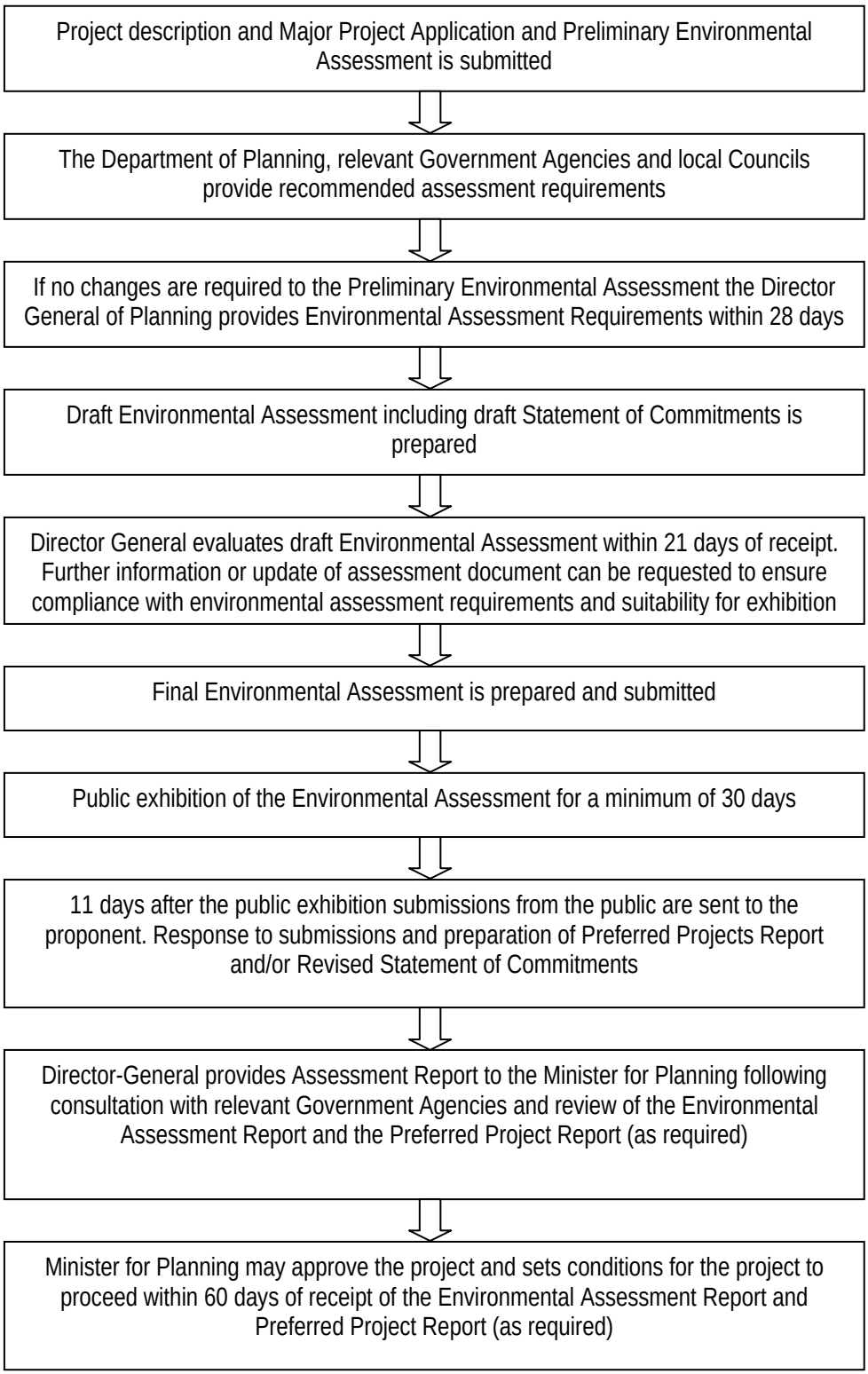

### 6.3.1 Environmental Planning and Assessment Regulation

Clause 8B of Part 1A of the EP&A Regulation, 2000 sets out the matters that must be considered by the Minister for Planning when making a determination under Part 3A of the EP&A Act. These matters include:

- An assessment of the environmental impact of the project;
- Any aspect of the public interest that the Director General for Planning considers relevant to the project; and
- Copies of submissions received by the Director General for Planning in connection with public consultation.

Part 1A of the EP&A Regulation also sets out the timing and time limits for the assessment process under Part 3A of the EP&A Act. These have been incorporated into **Figure B** below (Part 3A Planning Process).

Figure B - Part 3A Planning Process



### 6.3.2 Other Legislative and Regulatory Requirements

The assessment of the remediation via the Part 3A process, with the Minister for Planning being the approval body, means that while Sydney City Council will be asked to provide recommendations for the EARs, a number of local environmental planning instrument (EPI) provisions will not be applicable. These include:

- Sydney Regional Environment Plan No. 26 – City West;
- Sydney Local Environment Plan 2005;
- City of Sydney Contaminated Land Development Control Plan 2004; and
- Redfern-Waterloo Authority Act 2004, which grants power to the Redfern-Waterloo Authority to make determinations under Part 4 of the EP&A Act.

## 6.4 Contaminated Land Management Act

The object of the Contaminated Land Management (CLM) Act, 1997 is to establish a process for investigating and remediating land areas where contamination presents a significant risk of harm (SRoH) to human health or some other aspect of the environment. The CLM Act gives the EPA (now DECC) the power to direct a public authority to investigate or remediate contaminated land. The CLM Act also provides for the voluntary investigation and remediation of land.

The Site is currently the subject of a Voluntary Investigation Proposal 19013 (VIP), which was issued 22 May 2002. Investigations have been carried out in accordance with the VIP, with results and conclusions provided in the previous investigations listed in **Section 1.6**.

Section 26 of the CLM Act provides for voluntary remediation proposals by agreement (Voluntary Remediation Agreement - VRA) with the EPA. This allows a person to furnish the EPA with a proposal to remediate land that is considered to be contaminated. The EPA may agree to the voluntary remediation if they believe that the terms of the proposal are appropriate. Should the EPA agree to the terms of the proposed remediation, the EPA will not issue a remediation order against the parties to the voluntary remediation proposal.

An independent Site Auditor accredited by the NSW EPA will oversee the process in order to secure compliance with the VRA. The Site Auditor must produce a Site Audit Report, containing a critical review of the information collected during the audit. The auditor must furnish the EPA with a Site Audit Statement containing the findings of the audit.

The site audit is to be carried out, and a site audit report and site audit statement are to be prepared and furnished, by an accredited site auditor:

- in compliance with the provisions of this Act and the regulations;
- in accordance with the guidelines; and
- having regard to the effects of Part 3A EP&A Act.

### 6.4.1 Voluntary Remediation Agreement Process

One of the purposes of this RAP is to provide RailCorp with a basis to enter into a VRA with the NSW DECC. The process by which the VRA will be made between RailCorp and the NSW DECC follows the provisions in the Contaminated Land Management Act, 1997, Division 3, Subsection 26.

The process for establishing a VRA shall be to furnish the NSW DECC with a proposal to remediate the land. The NSW DECC is to agree to the proposal and also agree not to issue a remediation order provided the terms of the proposal are appropriate. The terms are required to qualify remediation strategies and plans, timeframes and milestones, provision of notices and reporting. The VRA must be in writing and shall be issued to RailCorp.

## 6.5 Protection of the Environment Operations Act

The Protection of the Environment Operations Act, 1997 (POEO Act) commenced operation on July 1 1999. Chapter 3 of the POEO Act provides for a single licensing arrangement to replace the different licenses and approvals that were required under separate Acts relating to air pollution, water pollution, noise pollution and waste management. Under the POEO Act, the NSW EPA is made the regulatory authority for activities carried out by State or public authorities, activities that require a license under Schedule 1 of the POEO Act and other activities for which a license regulating water pollution is required.

A review of the scheduled activities requiring an Environment Protection Licence (EPL) under the POEO Act found that the scheduled activity that is relevant to the remediation project is "contaminated soil treatment works". The listing applies to contaminated soil treatment works that handle contaminated soil originating exclusively from the Site on which the works are located and that treats (other than by incineration) and stores more than 30,000 $m^3$ of contaminated soil or disturbs an aggregated area of impacted soil in excess of 3 hectares. The current site is not likely to meet these criteria, thus it is unlikely that an EPL will be required under the POEO Act for the site.

The listing also applies to treatment works that handle more than 1,000$m^3$ per year of contaminated soil not originating from the Site on which the works are located. Treatment of the contaminated soil on the Site is limited by the available site area and consideration of an alternative treatment site should be made. RailCorp may be required to obtain a licence under the POEO Act for the treatment of the contaminated soil at an alternative treatment site, if the treatment activities at the alternative site will process more than 1,000$m^3$ in any one year.

An application for a licence under the POEO Act should be made in accordance with the DEC's Guide to Licensing under the Protection of the Environment Operations Act 1997 (1999). Section 45 of the POEO Act lists factors to be considered when deciding if a licence is to be granted. These factors include:

- Any Protection of the Environment Policies (PEPs);
- The objectives of the EPA as listed in section 6 of the Protection of the Environment Administration Act, 1991;

- The impact on the environment of any pollution likely to be caused by the activity or work; and
- Any relevant environmental impact statement received under the Environmental Planning and Assessment Act, 1979.

A licence may be granted with conditions (Section 63, POEO Act), which may include requirements to monitor, to provide certification of compliance with a licence, to undertake and comply with a mandatory environmental audit program and pollution studies, reduction programs and financial assurances (Sections 65-76, POEO Act).

The Protection of the Environment Operations (General) Regulation 1998 (POEO GR) provides for the payment of licence and administrative fees.

Part 2 of Schedule 1 of the POEO Act also lists transporting of hazardous, industrial, Group A, Group B or Group C wastes in loads exceeding 200kg. Therefore, transport of the contaminated soil from the Site to a landfill facility or an alternative treatment site will also require a licence under the POEO Act.

## 6.6 Environment Protection and Biodiversity Act

The Environment Protection and Biodiversity (EPBC) Act, 1999 commenced in July 2000. The EPBC Act requires approval from the Commonwealth Minister for the Environment for actions which have, may have, or are likely to have a significant impact on Matters of National Environmental Significance (MNES). The Act identifies seven MNES:

- World Heritage properties;
- National heritage places;
- Wetlands of international importance (Ramsar wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

A search of the EPBC Register revealed no MNES within the site area. The search disclosed a number of species listed as threatened within the City of Sydney Local Government Area; however, the disturbed nature of the Site means that it is unlikely that MNES will arise during the remediation process.

## 6.7 Environmentally Hazardous Chemicals Act, 1985

The NSW DEC controls prescribed activities relating to chemicals and declared chemical waste by making Chemical Control Orders (CCOs) under the Environmentally Hazardous Chemicals Act 1985, in relation to the chemical or declared chemical waste. A CCO may:

- Prohibit or control the carrying out of prescribed activities (for example manufacturing, processing, keeping, distributing, conveying, using, selling and disposing or any related act) in relation to a chemical or chemical waste; and
- As a condition of the order require that any prescribed activity be only carried out under the authority of a licence issued by the DEC.

The following is a list of the current CCOs sourced from the DEC website:

- Dioxin Contaminated Waste Materials
- Aluminium Smelter Wastes
- Organotin Waste Materials
- PCB Wastes
- Scheduled Chemical Wastes.

Previous investigations carried out on the Site found no detection of chemicals that are subject to CCOs, therefore this Act would not apply.

## 6.8 Heritage Act

The New South Wales Heritage Act, 1977 provides protection for natural and cultural heritage by providing for the listing of heritage items or places on the State Heritage Register and providing for the making of interim heritage orders for the protection of heritage items or places.

Eveleigh Railway Workshops and Eveleigh Railway Workshops Machinery are listed on the State Heritage Register. Section 57 of the Heritage Act prohibits a person from undertaking certain activities without an approval from the Heritage Council. However, as remediation of the Site will fall under Part 3A of the EP&A Act it will not be necessary to obtain approval under the *Heritage Act*.

**Section 8.4** of this RAP provides further detail for provisions of heritage items during the site remediation work.

## 6.9 Transport Administration Act

Part 2 of the Transport Administration Act, 1988 (TA Act) establishes RailCorp as a State owned corporation. One of the objectives of RailCorp under the TA Act is to conduct its operations in compliance with the principles of ecologically sustainable development where its activities affect the environment.

The remediation of contaminated land for the safe use of the present and future land users satisfies the principles of ecologically sustainable development and provides for inter and intra-generational equity, the precautionary principle and the conservation of biological diversity. The TA Act does not contain any provisions relating to planning approvals.

# 7 Remediation Planning and Permits

This section provides information on the required regulatory permits and approvals to undertake work tasks as part of the remediation.

## 7.1 Transportation of Materials and Equipment

According to the City of Sydney Contaminated Land Development Control Plan (DCP), 2004, all haulage routes for trucks transporting soil, materials, equipment or machinery to and from the Site shall be selected to meet the following objectives:

- must comply with all road traffic rules;
- must aim to minimise noise, vibration and odour to adjacent premises; and
- must utilise State roads and minimise use of local roads.

The information provided in **Section 8.5** should be followed in this regard.

**Section 6.5** (POEO Act) provides information for the requirement to obtain a license to transport particular materials. Tar materials are considered hazardous, therefore a license to transport this material will be required.

## 7.2 Materials Containing Asbestos

Work consisting of remediation of materials containing asbestos must be conducted in accordance with the *Occupational Health and Safety Regulation 2001* made under the *Occupational Health and Safety Act 2000* and this requires an application for a work permit from WorkCover at least 7 days prior to the work commencing.

All asbestos remediation work conducted on the Site must be undertaken by a licensed contractor that holds a current WorkCover AS1 Friable Asbestos Licence.

Monitoring of the ambient air must be undertaken continuously during all works consisting of asbestos remediation. This work must be conducted by a qualified Industrial Hygienist or consulting firm qualified to undertake such work.

All asbestos waste materials are required to be disposed off site at a NSW EPA approved landfill facility.

## 7.3 Excavations

### 7.3.1 Western Boundary Sewer Line

An operational sewer line runs the length of the western boundary that services the neighbouring residential properties. At this stage it is unknown which residential properties are serviced by the sewer line. Excavations in this area could impact the integrity of this service.

Information obtained from the utility owner (Sydney Water) sourced from their Quick Check Agent indicated that two options were available for this service line, either protection or deviation. Further discussions with a Water Service Co-ordinator showed that deviation was the likely option given the proposed extent of excavations proximal to the sewer line. To follow this process a Water Service Coordinator would be engaged to undertake the following:

- Lodge an application with Sydney Water to deviate the sewer, and include a design for the deviation;
- Gain three quotes for the construction, and pay a bond to Sydney Water;
- Gain approval for the works to commence;
- Complete works to deviate and reinstate the sewer, requiring certification by Sydney Water; and
- Once certified, the bond will be returned.

This work should be conducted by a certified Hydraulic Engineer or equally qualified plumber. Also, there will need to be liaison and agreement with the affected property owners prior to undertaking such works.

### 7.3.2 Rail Services

Currently there exist railway services contained within an aboveground concrete trough that runs the length of the western boundary, then underground existing the northern boundary. The services are likely to contain communications and signalling cables.

Reference is made to the RailCorp document "Guide to Working in and around the Rail Corridor". This guide provides specific detail, which will be required when undertaking excavation proximal to rail services. Approval from RailCorp will be required prior to excavation near rail services.

### 7.3.3 Shoring and Piling

Given that rail tracks are present to the south (Illawarra rail line) and to the north (Stabling Yard) of the gasworks site, a geotechnical assessment must be performed, and methods for stabilising excavations must be approved by RailCorp prior to commencement of excavation works. This will ensure there is no impact on the adjacent rail lines during excavation works.

## 7.4 Discharge of Water

Dewatering of excavation areas is likely to be required during the remediation works. The known contamination impacts to site groundwater are likely to preclude any excavation pit water being discharged directly to stormwater.

The options for the disposal of excavation pit water include:

- onsite treatment (if required) and discharge to sewer, requiring a permit and approval from Sydney Water utilising their Trade Waste option; or
- collection and off-site disposal by a liquid waste contractor for treatment/disposal to an appropriate waste treatment/processing facility.

Discharging to sewer under Sydney Water approval needs to comply with Acceptance Standards which often requires waste streams to undergo some preliminary treatment (pre-treatment) before discharging to the sewer. The equipment used to pretreat the wastewater may also require a permit.

All excavation pit water must be analysed for suspended solid concentrations, pH and any contaminants of concern identified during previous contamination site investigation.

An experienced environmental consultant should be engaged to undertake treatment, monitoring and sampling of any discharge from the Site.

### 7.4.1 Connection of Water Service

For a permanent water connection to service the Site, approval must be sought through Sydney Water by applying for a Section 73 Compliance Certificate.

## 7.5 Removal of Trees

No special consideration from Council is required to remove trees from the Site. Approval to conduct such works will be covered under the Part 3A approvals process.

## 7.6 Operation of a Treatment Facility

According to the POEO Act, 1997, a license is required to be issued by the NSW EPA for contaminated soil treatment works for on-site or off-site treatment that:

- handle more than 1,000m$^3$ per year of contaminated soil not originating from the site on which the works are located, or
- handle contaminated soil originating exclusively from the site on which the works are located and:
    1. incinerate more than 1,000m$^3$ per year of contaminated soil; or
    2. treat otherwise than by incineration and store more than 30,000m$^3$ of contaminated soil; or
    3. disturb more than an aggregate area of 3 hectares of contaminated soil.

For the purposes of soil treatment, scheduled activities using a mobile plant require a license to be issued by the NSW EPA, and is determined as the carrying on of any activity referred to above by mobile plant. Also, mobile waste processing is determined as being the treatment or processing of hazardous waste, industrial waste or Group A[7] waste (or any combination of those types of waste) by mobile plant and that is carried on for business or commercial purposes.

## 7.7 Waste Classification, Immobilisation and Disposal

According to the City of Sydney Contaminated Land Development Control Plan (DCP), 2004, hazardous and/or intractable wastes arising from the remediation work shall be removed and disposed of in accordance with the requirements of the NSW EPA and WorkCover Authority, together with the relevant legislation, namely:

- New South Wales Occupational Health and Safety Act 2000;

[7] *Group A waste are liquid waste types as defined in NSW EPA Environmental Guidelines: Assessment, Classification & Management of Liquid and Non-Liquid Wastes, 1999.*

- Occupational Health and Safety Regulation 2001;
- Contaminated Land Management Act and Regulations; and
- Environmentally Hazardous Chemicals Act 1985 and Regulations.

Classification of wastes must be conducted in accordance with the NSW EPA (1999) Environmental Guidelines (and revisions). Waste classification must be undertaken by an experienced environmental consultant.

The NSW DEC provide general approvals of immobilisation for specific contaminants of concern. Two general approvals can be applied to the waste materials at the Site. These are:

- Ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials (Approval # 1999/05); and
- Coal tar contaminated soil from former gasworks sites, which has been treated (Approval # 2005/14).

The disposal of contaminated soil shall have regard to the provision of both the POEO Act and Regulations, relevant immobilisation approvals (provided by the NSW EPA) and any relevant EPA guidelines such as the NSW EPA Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes (1999).

An experienced environmental consultant should be engaged to undertake monitoring, sampling and waste classification of all waste materials being disposed from the Site. Also, the environmental consultant is required to implement the specific requirements of the general approvals for immobilisation.

## 7.8 Rail Industry Safety Inductions (RISI)

The gasworks site is considered to be part of the "rail corridor", however because it is not operational and is separated from the rail tracks by continuous fencelines, RailCorp may consider issuing a waiver to remediation personnel so that they do not require RISI training. It should be noted however, that any work within the "operational" areas of the rail corridor, such as the Illawarra Line tracks to the south, or the stabling yard to the north, will require stringent access agreements and OH&S requirements.

## 7.9 Confined Spaces

The existence of toxic volatile substances in the Site soils and the requirement to extend excavations into deep soil layers to remove source material, may give rise to the need for specific worker training for confined space entry. This may also include training in specific OH&S hazardous work zones, including supplied air activities.

# 8 Remediation Management

This section provides an overview of the requirements for the management of the Site during the remedial works. It also provides the mechanisms to limit or control the remedial constraints identified in Table 5.1.

## 8.1 Health and Safety

The legislative obligations relating to OH&S management on the Site will entail:

- the remediation work will be classified as "High risk construction work" under Clause 209 of the OH&S Regulations;
- the remediation contractor will need to be appointed as the "Principal Contractor"; and
- the Principal Contractor is required to fulfil various requirements under the OH&S Regulations, including the production of site specific OH&S documentation, as per Clause 226 of the Regulations.

The Remediation Contractor will be required to produce the following OH&S documentation:

- A Project Safety Management Plan (PSMP) to describe the specific safety resources, consultation arrangements, risk management processes, responsibilities, procedures and practices for the project. The PSMP is also to include the following documents;
  - Site-Specific Safety Management Plans (SSMP) to identify the hazards and risk control measures and the proposed scope of work;
  - Work plans relating to specific hazardous activities, including but not limited to the removal of asbestos materials, excavation and shoring works, and hazardous waste handling and/or treatment; and
  - Safe Work Method Statements (SWMS) for particular construction-related activities.

The SSMP will be required to document the health and safety requirements and protection procedures to minimise the potential for exposure and injuries to site personnel. The SSMP will be used to convey important information to all site personnel including:

- Project specific objectives and performance measures;
- Project contacts, personnel responsibilities and details;
- Conduct standards;
- Incident/near miss reports and procedures;
- Hazards and hazard controls;
- Project specific SWMS;
- Project specific contaminants and exposure scenarios;

- Project specific Personal Protective Equipment (PPE) – based on appraisal of specific work tasks;
- Decontamination procedures;
- Safety training and site inductions; and
- Emergency response details.

Importantly, any new personnel arriving to the Site, including subcontractors and visitors, will be inducted into the Site with the information provided in the SSMP. A register of personnel and compliance should be included in the SSMP.

The H&S hazards would include, but not limited to, the following broad categories:

- Excavation activities;
- Hazardous chemicals and contaminated substances;
- Confined spaces;
- Vehicle operation and movement;
- Manual handling and lifting;
- Heat stress and sunburn;
- Noise, dust and odour;
- Slips, trips and falls;
- Emergencies and unexpected finds; and
- Biological hazards – snakes, spiders, blood-borne pathogens.

### 8.1.1 Soil Vapour

Exposure standards for the occupational workplace published by the WorkCover Authority of NSW (WorkCover) are considered the most relevant vapour criteria to be adopted for the remediation of the Site. These criteria provide protection to onsite workers against compounds at concentrations that produce adverse effects on health, safety or well being.

Table 8.1 provides the criteria for the volatile contaminants at the Site.

**Table 8.1 – Vapour Criteria**

| | TWA | | STEL | |
|---|---|---|---|---|
| | ppm | $mg/m^3$ | ppm | $mg/m^3$ |
| Benzene | 1 | 16 | - | - |
| Ethylbenzene | 100 | 434 | 125 | 543 |
| Toluene | 50 | 191 | 150 | 574 |
| Xylenes (total) | 80 | 350 | 150 | 655 |
| Naphthalene | 10 | 52 | 15 | 79 |
| Phenol | 1 | 4 | - | - |
| Cresol | 5 | 22 | - | - |

*Notes: TWA - Time Weighted Average; STEL - Short Term Exposure Limit*
*Cresol - Includes the isomers 2, 3 & 4 methlyphenol*

## 8.2 Community Consultation

A Community Liaison Plan (CLP) will be required to document the procedures to manage the community relations during the remedial works. Specifically the CLP should address the sensitivity of the Burren Street residential premises adjoining the western boundary of the Site, but should also consider the greater Macdonaldtown/Erskineville neighbourhood.

The main objectives of the CLP will be to:

- Document the ways the community are provided information on the remediation work and facilitate avenues for feedback;
- To manage complaint issues and ultimately minimise community concern over the remediation;
- Provide key project contacts and identify key stakeholders.

The remedial activities that may impact the community will include noise, dust, odours and vibrations. These activities and their potential impacts are required to be documented in a project specific Environmental Management Plan (EMP), as outlined in **Section 8.8**. The greater community of Macdonaldtown/Erskineville may also be affected by other activities such as heavy vehicle movement through transport routes. These activities should also be documented in a project specific Traffic Management Plan (TMP), as outlined in **Section 8.5**.

## 8.3 Site Establishment

The requirements for site establishment include access points, security, site facilities, utilities, site work hours, heavy vehicle movements, which would similarly apply to possible off site treatment areas.

### 8.3.1 Site Access

Construction work conducted on the northern adjoining Stabling Yards required the construction of an entry gate off Erskineville Road. This point is shown on **Figure 5**. It is proposed that this would also be the most appropriate entry for access to the Site. Entrance/exit to this point is right turn in and left turn out onto Erskineville Road to ensure all heavy vehicles utilise the Swanson Street arterial road.

At the completion of the construction work on the Stabling Yard, the entry point was to be reinstated to its former condition (i.e. paved footpath), in accordance with the conditions of approval for the stabling yard construction (under Part 5 EP&A Act). RailCorp is currently in the process of lodging a Development Application with the City of Sydney Council (under Part 4 EP&A Act) in order to maintain this roadway as a permanent access point to the rail corridor, which would also facilitate access for the gasworks remediation project.

From this entry gate, access to the Site follows an access road that runs parallel to the rail corridor. The most appropriate site entry point is from the eastern corner, where a turning circle should be maintained to enable large vehicle access/egress to the access road. These areas are shown on **Figure 5**.

Site entry from this point is likely to be one way given the available space and the likely sizes of transport vehicles.

### 8.3.2 Site Security

Security of the Site should include chain wire mesh fencing around the perimeter of the Site boundary and a security guard at the Swanson Street Entry gate. The security guard should man the entry gate through the period of site operating hours for the duration of the project. For non-operational hours, gates should be locked. The need for after hours security may also need to be considered.

### 8.3.3 Site Facilities

#### *Sheds*

It is envisaged that the location for site sheds (including offices, amenities and personnel decontamination units) would be in the Northeast area of the Site along the northern boundary. This area is not constrained by the need for deep excavations, nor are there any trees within this area. However, it may be necessary to assess other possible locations, including the Western Lot area.

Consideration should be given to excavate contamination impacts in the selected area prior to establishing site sheds. This would include excavation of Retaining Wall and ash/coke surface fill materials, and stockpiling onsite. Consideration should be given to install temporary facilities to enable these preliminary works to occur.

#### *Decontamination*

A wheel-wash and rumble bar should be installed inside the Site adjacent to the Site entry point (eastern end). This area should be a designated decontamination zone for vehicles and may also require a high pressure wash spray.

#### *Water Treatment*

A small scale water treatment unit will be required to treat wastewater from the vehicle decontamination unit and water from dewatering activities from excavated zones. The location of this unit should be adjacent to the decontamination area along the southeast site boundary.

Water treatment is expected to be greater at the beginning of earthworks as shallow perched water discharges into open excavations. The quantity of water stored in the perched aquifer is likely to be limited and discontinuous and is expected to discharge rapidly upon commencement of excavations. Discharge will reduce to seepage once the perched water has discharged completely. Seepage rates are expected to be within the range of 1 – 5L per minute from deeper excavations.

As discussed in **Section 7.4**, wastewater may be collected and disposed off site by a licensed facilitator or a Trade Waste Licence may be obtained that enables treated wastewater to be discharged into the sewer network. Residues from water treatment, including activated granulated carbon, should be disposed off site at a waste landfill facility. In this regard, a general approval of immobilisation provided by the NSW DECC (#1999/04) can apply to activated granulated carbon wastes for off site disposal.

### 8.3.4 Decommissioning Existing Groundwater Wells

The majority of existing groundwater monitoring wells on the Site will be destroyed during remediation works. Therefore prior to undertaking any excavation work, all wells should be decommissioned and deregistered (if already registered).

The procedures for decommissioning wells are provided in the Land and Water Biodiversity Committee *Minimum Construction Requirements for Water Bores in Australia*, 2003.

Deregistration of wells can be conducted through the DNR.

### 8.3.5 Utilities

Important to the remedial works is the installation of critical services considering there are no available services existing on the Site. These would include water, electricity and communications. These should be installed in accordance with appropriate WorkCover standards for construction sites and by appropriately certified tradesmen.

There may be a need to install a permanent service for water during the remediation and post remediation to facilitate maintenance of site vegetation. Approval should be sought through Sydney Water as outlined in **Section 7.4.1**.

### 8.3.6 Hours of Operation

In general, the hours of operation at the Site during remediation works are likely to be limited to:

- Monday to Friday – 7am to 6pm; and
- Saturday – 8am to 1pm.

It is unlikely that work will be permitted outside these hours or on Sundays or Public Holidays, with the exception of those works given special permission by the regulatory authority for work that requires special delivery times or is requested by the Police department or other authority or emergency work. These exceptions should be documented in the approval conditions for the remedial works. It is possible that working hours may change depending on the outcome of community liaison and/or development approval conditions.

### 8.3.7 Alternative Treatment Site

The area required to treat impacted soils by implementing the preferred options for treatment and disposal, is estimated to be approximately 3,000m$^2$ to 5,000m$^2$. The space required would not only accommodate a stabilisation or thermal desorption treatment unit, but would also need space for:

- stockpiling excavated material;
- pre-treatment facilities for material to be treated;
- stockpiling treated material (for curing purposes);
- stockpiling classified materials (for off site disposal, re-use or additional treatment); and
- construction of a containment building/tent to control and treat vapour emissions.

Given the necessary space required to treat soils, the available space on the Site is unlikely to accommodate an onsite treatment facility considering:

- The extent of the required excavation to remove impacted soils is approximately 3,500m$^2$;
- The requirement to remove source material at depth would require over-excavation to accommodate benches to prevent collapse as well as ramps for excavation equipment and other vehicle access/egress;
- The majority of the entire site surface would require removal of ash/coke fill material;
- The requirement to protect the existing Southern Gasholder from structural damage; and
- The remaining available space would have to accommodate all remedial works infrastructure including stockpiling areas, truck routes, parking, site sheds, a truck wash, a decontamination unit and a water treatment unit.

Additionally, the sensitive nature of the neighbouring residents adjoining the western boundary is likely to preclude any treatment facility from operating onsite.

Considering the above points, it is considered appropriate to utilise an alternative treatment site to treat impacted soils prior to landfill disposal. The establishment of an alternative site for treatment would require all necessary approvals, licences, management, controls and services as presented in this section and previous sections of this RAP. This RAP has been prepared under the assumption that the remediation strategy includes the use of an alternate treatment site for treating soils excavated from the Site.

## 8.4 Heritage

A qualified heritage consultant should have the responsibility of monitoring excavation works during remediation to ensure that impacts to heritage items are mitigated or minimised. The remediation work shall consider those recommendations provided in the report prepared by Heritage Concepts, November 2006. This report provides a number of recommendations that shall be undertaken, which include:

1. Retention and conservation of the Southern Gasholder and its existing fabric;
2. Undertaking a program of archaeological monitoring during the remediation program;
3. Offering the Connection Shed documents to the Powerhouse Museum;
4. All workers and contractors are subject to a Heritage Induction to be conducted by the heritage consultant prior to the commencement of any remediation works; and
5. An interpretation of all retained gasworks elements should be incorporated into the final redevelopment design of the Site, also to include appropriate signage and historical importance.

Other recommendations provided in the Heritage Concept (2006) report should be considered, however retention/protection of some items does not address the level of contamination in the soils and therefore does not address the unacceptable health risks posed by the contamination to human health and the

environment. Therefore the benefit of removing some of these structures outweighs their historical value.

In consideration of these recommendations and the levels of contamination at the Site, it is expected that the following items will be retained at the Site:

- The Southern Gasholder.

It is expected that the following items will be removed as a result of significant contamination:

- Remaining brick annulus of the Northern Gasholder;
- Connection Shed;
- Remaining brick layers and foundation footings of the Retort floor;
- Remains of the Retaining Wall;
- Tar Wells; and
- Condensate Pit.

## 8.5 Traffic

The Director Generals requirements under Part 3A approvals process will be made in consultation with the RTA and it is likely that they will require the consideration of traffic issues. Therefore the following measures should be undertaken during the remediation work:

- a Traffic Management Plan (TMP) should be developed to clearly identify route corridors to be used when accessing the Site. This would incorporate measures to minimise the use of local streets and would be approved by the RTA and City of Sydney Council;
- scheduling of deliveries to times outside of the peak commuter hours;
- transportation of any 'over-sized' or 'over-mass' equipment will be done at appropriate times (outside peak hours) with appropriate signage and escorts in accordance with RTA regulations (refer to **Section 8.5.1**);
- incident response procedures to cover vehicle breakdowns, accidents and load spillage for haulage vehicles. All heavy vehicle drivers will be made aware of TMP requirements and incident response procedures;
- staging would allow for all plant and equipment to remain onsite until no longer required whenever possible. Plant and equipment would not continuously be removed and brought back to the Site;
- traffic control is to be provided at the intersection of the temporary construction access and Erskineville Road;
- pedestrian control measures to be provided at the site entrance to warn of entering vehicles and minimise the possibility of vehicle pedestrian conflict;
- all staff would be given a detailed induction into the operation of the Site and the requirements under the TMP.

The TMP should be developed considering Council and RTA requirements for the movement of heavy vehicle traffic. The RTA website provides designated heavy vehicle routes for B Double vehicles.

### 8.5.1 Oversize Vehicles

Floating heavy machinery to and from the Site will be limited to the hours outside of peak traffic times. Floating of heavy machinery must not be done between the following times:

- Sunrise - 7am and 9am;
- Sunset - 4pm and 6pm.

Further details on road travel can be found in the "*Operators Guide to Oversize and Overmass Vehicle Movements*", Roads and Traffic Authority, 2002.

### 8.5.2 Construction Works Impacting Transport Routes

Consideration should be given to any planned major roadworks or infrastructure upgrades that may impact preferred transport routes. In this regard, contact should be made with the City of Sydney Council, the RTA and RailCorp to identify these works.

It is known that upgrade works are planned for the Newtown Station Bridge between April 2008 and June 2008.

## 8.6 Excavation Works

### 8.6.1 Vegetation

The City of Sydney Council has in place an Urban Tree Management Policy that provides a tool for tree management in the Council area. This document should be considered when determining the establishment or preservation of vegetation on the Site. In particular, the document provides guidance for future site use for:

- Tree protection;
- Tree planting and selection;
- Tree asset management;
- Tree replacement and removal; and
- Community consultation and involvement.

### 8.6.2 Excavation Restrictions

The extent to which excavations can be continued will be restricted by the following features on the Site:

Heritage and Potential Heritage Items – this includes the Southern Gasholder and Condensate Pit, the Retort brick paving floor and any other unknown that may be uncovered during excavation work. Previous archaeological assessments provide guidance to protecting these items and a protocol for monitoring and documenting items of potential heritage significance during the remediation project. Further information is provided in **Section 8.4**.

Live Services – this includes the aboveground concrete trench that runs parallel to the western boundary and the underground services that continue from the concrete trench and run through the Western Lot area. Other services are the sewer line that runs along the western boundary (refer to **Section 7.3**) and the Sydney Water Mains line that transects the southern portion of the Site. The mains are located in an underground tunnel over 20 metres below the ground surface and therefore may not need to be considered for the remediation work.

Site Boundary – the extent to which excavations can abut the site boundary will be governed by the vertical extent of contamination requiring excavation. The stability of the ground and above ground structures must be considered when excavating close to the western site boundary and northern boundary (refer to excavation depths presented on **Figure 4**). Appropriate batters should be formed to minimise instability in these areas, or ground stability works should be completed, including piling or shoring. Note that rail tracks are present to the south (Illawarra rail line) and to the north (stabling yard) of the gasworks site. These structures pose significant constraints on excavation works. Any movement of the tracks poses a serious derailment risk. As such, a geotechnical assessment must be performed, and methods for stabilising excavations must be approved by RailCorp prior to commencement of excavation works. In addition, continuous monitors will need to be installed on the tracks, and an emergency response plan must be developed and implemented if any track movement is identified.

Trees – There are a number of well established and mature trees present on the Site, including a stand that was positioned to provide screening coverage along the western and northern site boundary. Where trees may be retained to continue and even improve the visual impact to adjoining land users, excavation of localised soils should be minimised to maintain the root system. An evaluation should be made that considers the benefits of retaining particular tress against the degree of contamination in localised areas.

Lithology – The Site lithology consists of stiff and highly plastic red/grey podzolic soil underlain by Ashfield Shales. Previous investigations indicate that tar material has migrated deep into these materials up to depths of at least 8m below the ground surface. The vertical extent of excavation may be limited by the capability of the excavation machinery, where removing stiff clay and hard shales may become problematic and specialised equipment may be necessary. The source control approach outlined in **Section 5.6** should provide guidance to the limitation of removing tar impacted materials at depth.

### 8.6.3 Remediation Equipment and Machinery

The machinery required to undertake the preferred remediation approach is likely to include:

- Piling and/or shoring machinery to stabilise excavated areas particularly in areas of deep excavations around the Southern Gasholder, the Western site boundary and the northern site boundary.
- Excavators with the capacity to excavate potentially hard/stiff ground at depth, and possibly requiring a long arm reach.

- Machinery to manage excavated material and facilitate stockpiling, including bulldozers, front-end loaders, excavators, bobcats, etc.
- Haulage trucks to transport excavated material from the Site, likely to be B-Double trucks for easier manoeuvring in limited spaces.

### 8.6.4 Remediation Staging and Works Program

Staging of the remedial works should consider the limited space onsite and protection of the Southern Gasholder structure. A likely staging format would include the following:

- Obtainment of relevant licenses and approvals for the remediation works, including any related to the use of an alternate soil treatment site;
- Site establishment and preparation of remediation site – including security, access, site sheds, decontamination, services, setting up environmental safeguards, decommissioning existing groundwater wells, groundwater sampling of retained wells (refer to **Section 10.3.3**), stripping/shredding site vegetation, erecting odour tent and protecting live services;
- Establishment of alternative treatment site – considering all requirements as above;
- Geotechnical investigation;
- Underpinning/piling works at remediation site;
- Removal of contaminated material including (refer to **Figure 4**):
    1. Remove contents in Tar Wells;
    2. Remove contents in Nth Gasholder;
    3. Excavate surface ash/coke fill (pink & orange areas only, as shown on **Figure 4**) with consideration to archaeological monitoring, oversize materials and pipework;
    4. Excavate tar source area around Nth Gasholder and Tar Wells (pink area) to benching level (i.e. 3-4m) with consideration to archaeological monitoring, oversize materials, pipework and dewatering;
    5. Begin benching excavation at 3-4m depth within tar impacted soils (orange area) with considerations to archaeological monitoring, oversize materials, pipework and dewatering;
    6. Complete excavations indicated above in stage 4 to nominated depth (i.e. at least 8m). Validate & backfill completed excavations;
    7. Continue benching excavations indicated above in stage 5;
    8. Excavate deep tar impacts at BHE/BHF (pink area) with consideration to archaeological monitoring, oversize materials, pipework and dewatering. Validate & backfill completed excavations;
    9. Complete excavations indicated in stage 5 to limits of orange area.Validate & backfill completed excavations indicated above in stage 11;

10. Excavate contamination hotspots (MW13s, MW04s & BH14, shown as green areas) with consideration to archaeological monitoring, oversize materials, pipework and clean overburden. Validate & backfill completed excavations;
11. Excavate contamination hotspot (TP16, shown in green area) with consideration to archaeological monitoring, oversize materials, pipework and clean overburden. Validate & backfill completed excavations;
12. Remove impacted material (to the practicable extent) from the Retaining Wall;
13. Validate and backfill all existing surfaces to site level;

- Continual water treatment, stockpiling, loading and haulage of material off site.

### 8.6.5 Disused Former Gasworks Services

Previous investigations have shown that former gasworks services include tar pipes and cast iron pipes. The tar pipes are potentially laden with residual tar, which should be removed from the pipes to separate these wastes from metal pipe wastes. Options for this process would be ancillary to the primary remediation works. However, consideration should be given to chemical extraction or high pressure washing to separate these materials.

It is unknown if existing cast iron pipes contain tar or other residual contaminants. Regardless, cast iron pipes free of tar (or other materials) should be considered for recycling.

### 8.6.6 Stabilising Open Excavations

A non-percussive piling technique should be applied where piling is required to stabilise and protect the Southern Gasholder structure and around areas requiring deep excavations. A geotechnical investigation should be undertaken prior to any remedial work to determine the requirements in this regard.

The requirements for protecting any live services should consider the information provided in **Section 7.3**. The requirement for protecting structures adjoining the Site, including live rail lines, are provided in **Section 7.3.3.**

### 8.6.7 In-ground Concrete Structures

A previous archaeological assessment (Heritage Concepts, November 2006) indicated that the concrete slabs existing on the northern site boundary (embankment) do not have historical significance.

It may be beneficial to retain these structures in place, considering the stability of the northern boundary embankment. Any associated contamination impacts in the localised areas would have to be evaluated during the remediation work to re-assess the benefits of retaining these structures.

There will be a requirement to validate any fill material left insitu if these structures are to remain.

### 8.6.8 Marker Layers

Marker layers should be used to define areas that contain residual contamination that may be exposed during future construction/maintenance on the Site. The marker layer provides a warning mechanism if contamination is to be exposed. These areas should be documented in the EMP.

The use of marker layers can be applied to lateral faces of excavations. However, they should only be applied at depths that may be exposed in the future, which may be limited to 1.5m depth. In that regard, it is expected that markers layers may not be installed in the primary source zones other than around the Southern Gasholder.

Marker layer material should be resistant to volatile organics chemicals. In this regard, marker layer material made from High Density Polyethylene (HDPE) should be used given it is an inert polymer highly resistant to chemical degradation. This material would be suitable to withstand exposure to BTEX chemicals.

### 8.6.9 Survey Requirements

Formed excavation will require surveying to determine quantities of material removed and inturn backfill requirements. A survey of all retained structures, site features of importance and finished levels should be undertake once all excavation/backfill works have been completed.

Survey diagrams will also facilitate engineering/design drawings for future site layout and infrastructure.

Newly installed wells will also require surveying to facilitate the MNA approach detailed in **Section 10.3.3.**

## 8.7 Site Reinstatement

The material used for backfilling will need to meet the criteria outlined in **Section 9.3.** This may also extend to the beneficial re-use of some onsite materials, as outlined in **Section 9.4.**

The requirements for backfilling and compaction must follow all appropriate Australian Standard and Construction Codes of Practice. In particular, the RailCorp Infrastructure Engineering Standards – Geotechnical Guides, that includes:

- TMC 411 – Earthworks Manual, September 2006;
- SPC 411 – Specification Earthwork Materials, October 2006; and
- ESC 410 - Earthworks and Formation, September 2006.

These standards are provided in **Appendix E**.

At the time of preparing this RAP, a landscape design was being prepared by others for the Site. The details of this plan should be considered during the remedial works, particularly in regard to vegetation, fencing and drainage/stormwater.

## 8.8 Environmental Management

An Environmental Management Plan (EMP) for the proposed remediation works should be prepared that identifies environmental hazards and risks involved with the remediation and the control measures required to mitigate the risks. The EMP should

be prepared in accordance with NSW EPA Model EMP: *Environmental Management Plan for Landscaping Works* (2002), which can be applied to remediation sites.

The environmental risks that require management include:

- Soil and water;
- Air (dust, odour, vapours);
- Noise and vibration; and
- Visual Aspect.

The EMP should include the following information and control plans:

- Soil and Water Management Plan – This plan should include erosion and sediment controls, stockpiling and contamination controls.
- Air Quality Management Plan – This plan should include dust, odour and vapour controls.
- Noise and Vibration Management Plan – This should include details of noise and vibration standards to be met, noise and vibration monitoring requirements and noise and vibration control measures to be implemented.
- Traffic Management Plan – This should include details on site access/exit, preferred transport routes, special conditions to site entry/exit, transport materials and community impacts.
- Waste Management Plan - This plan will outline waste management procedures, including waste recycling and reuse measures and waste storage and disposal measures. The waste management plan will be developed to minimise the generation of waste and maximise reuse, recovery and recycling of waste products.
- Monitoring and Auditing – The monitoring methods, locations, frequency, criteria, reporting and responsibilities will be detailed in this section of the EMP.

### 8.8.1 Management of Soil and Water

The soil and water management plan should be based on the NSW EPA (1997) guidelines "Managing Urban Stormwater: Treatment Techniques" and the NSW Department of Housing (1998) guidelines "Managing Urban Stormwater Soils and Construction". The aims of the soil and water management plan will be to minimise the potential for erosion, minimise the risk of contamination from construction equipment and to avoid contamination migrating from the Site.

The soil and water management plan should address the following issues:

- erosion and sediment control measures;
- contamination control measures (e.g. measures to manage existing contamination and potential for remediation machinery spillages, etc);
- the methods for handling and storage of impacted soil or water to minimise potential exposure to the materials or migration offsite;
- monitoring requirements (testing procedures, frequency of sampling, etc);

- specific methods of on-site reuse and disposal of soil and wastewater generated during construction;
- reference to the Occupational Health and Safety Plan for procedures to minimise the risk of exposure of construction employees to potential contaminants;
- diversion of clean stormwater runoff around construction sites and areas (where possible);
- use of crushed rock or similar material on construction site and parking; and
- bunding of temporary fuel and chemical storage areas in accordance with DEC requirements.

***Erosion and Sedimentation Control***

The general measures for management of erosion and sedimentation are as follows:

- Sediment and erosion control measures will be installed prior to any remedial activities and will be maintained in an effective condition until earthworks have been completed and the Site has been remediated. The soil and water management plan will identify the areas nominated for erosion and sediment control, work sites, general access and parking requirements;
- The area of soil exposure will be minimised as much as possible at any time. Land disturbance will occur for the shortest possible time. Access to the site will be controlled, and vehicles and machinery will be kept to well-defined areas within the Site. Soil disturbance will be undertaken in stages and areas to minimise impacts and to have more manageable catchments;
- Run-off generated outside specific remedial sites will be diverted around these locations;
- Water runoff generated within the site will be directed to the excavation areas. This water will be pumped out with collected groundwater for treatment as outlined in **Section 8.3.3**;
- Straw bales or other silt barriers will extend a sufficient distance to prevent water escaping around the side of the trap and will be of double thickness in areas likely to receive a higher runoff;
- Truck tyres and equipment tyres will be inspected and cleaned. **Section 8.3.3** provides further detail to the decontamination required;
- Disturbed areas will have a barrier system installed and other excavated areas backfilled as soon as possible. Proposed landscaping will be undertaken as soon as practicable after the main remedial works have been completed; and
- A monitoring program will be implemented to ensure that the soil and water management plan is successful. This may be in the form of a site audit checklist. The monitoring program will assist in the early identification of potential problems in the areas affected by the remedial procedures.

***Stockpile Control***

Impacted material will be stockpiled in a designated area prior to loading and transporting off site. Any materials that are not impacted and require temporary

storage will be stockpiled separately from stockpiles of impacted materials. It may be necessary to cover these stockpiles (i.e. HDPE sheeting) in some circumstances to control dust and odours. The size of stockpiles should be minimised as much as practicable prior to transporting off site (or other fate). Straw bales or silt fences will be erected around soil stockpiles, and diversion drains will be constructed if necessary, to prevent the migration of soil particles.

### 8.8.2 Management of Air Quality

The NSW DEC currently adopts the air quality goals set out in the Action for Air Report (1998) and Action for Air Report Update (2002) which form the NSW Government's 25-year Air Quality Management Plan. This plan was devised in conjunction with the National Environment Protection Council's (NEPC) National Environmental Protection Measure (NEPM) for air quality, the Ambient Air Quality Measures (1998) and Variations (2003). The DEC standards generally adopt those set out by the NEPC in the Ambient Air Quality Measures (NEPC, 1998) report.

Construction activities typically generate air emissions as a result of vehicles travelling along unsealed roads, the stockpiling of large amounts of materials, and exposure of soils. In addition, the combustion of fuels to power construction machinery also produces air emissions.

#### *Odour and Vapour Control*

Odour management is a key concern for the EMP objectives, especially given the proximity of some remediation activities in highly impacted areas to the adjacent Burren Street residences. Some of the contaminated material exposed during excavation work is expected to generate strong odours and potential vapour hazards, based on the elevated concentrations of BTEX compounds and naphthalene, particularly in the vicinity of source tar materials. The use of a specialised odour tent should be used as a primary control method to manage these emissions. The specific features of the odour tent are that it should:

- be large enough to accommodate the required excavation machinery;
- be large enough to accommodate stockpiled material;
- cover the footprint of work zones or the entire tar impacted area (see orange and pink shaded zones on **Figure 4**);
- comprise a fan-forced vapour treatment system installed in accordance with current standards.

Material being transported from the Site is also expected to generate significant odour and vapour hazards. Specialised haulage trucks may be required to transport this material. The special features of the trucks may include a trailer section that can minimise vapour emission during transport.

In addition, the following actions should also be undertaken:

- odour monitoring will be performed along the site boundaries, particularly the western boundary adjacent to the residential properties.
- weekly and random site surveillance inspections are to be undertaken by specific personnel that visit the site for this purpose alone. The inspections

should include observations of nuisance level odours, and recorded in an on-site activities log to trace conditions at the Site;

- plastic sheeting (VLDPE or PVC) should be used to cover excavated surfaces that may be exposed for long periods;
- appropriate odour suppressants (e.g. Anotec or AirRepair) should be sprayed over the offending soils; and
- a phone number will be made available for local residents to contact the on-site superintendent to advise if dust and/or odour nuisance occurs (refer to **Section 8.2**).

***Dust Control***

The remedial actions shall be performed in such a way as to minimise the production of fugitive emissions emanating from the site. The following dust and fugitive emission control procedures will be strictly adhered to:

- water sprays will be used across the Site to suppress dust. Water spray equipment will be available on-site for use from the first mobilisation to the Site until the remedial works have reached practical completion;
- all loads transported from the Site will be securely covered with a tarpaulin;
- speed limits will be imposed for vehicles on-site, including the access road from Erskineville Road;
- green mesh will be installed on the site boundary fencing to lower wind velocity entering the Site, therefore reducing dust generation;
- monitoring of dust emissions during excavations will be undertaken to check for the presence of potential airborne contaminants from the waste material, particularly during remediation of materials containing asbestos (refer to **Section 7.2**);
- response monitoring of reported incidences relating to nuisance dust emissions from the Site;
- all materials processing equipment will have dust attenuation measures that make the equipment suitable for use in industrial/commercial areas and which comply with regulatory requirements; and
- there will be no burning of any material on-site.

### 8.8.3 Management of Noise and Vibration

The DEC's Environmental Noise Control Manual (ENCM) provides guidelines for assessing the noise impact from construction sites. The most appropriate criteria to be applied to noise from construction vehicles are found in the DEC's Environmental Criteria for Road Traffic Noise.

Construction activities with the potential to cause vibration can be assessed with respect to the following criteria:

- Damage Criteria - German Standard DIN 4150 Part 3 1999 and British Standard BS 7385 Part 2 1993; and

- Human Comfort Criteria – Australian Standard 2670 Part 2 1990 and British Standard BS 6472 1992.

Property condition surveys should be undertaken for those properties where there may be a risk of cosmetic damage as a result of construction works. Property condition surveys should be undertaken on buildings/structures/roads within 50m radius from the edge of the "designated works' and any heritage listed buildings and other sensitive structures within 150m of the edge of the "designated works'. This should also include an assessment of the adjacent rail tracks.

The remedial action will be performed in such a way as to minimise unnecessary noise and vibration. Regulatory limits for noise and vibration will be strictly adhered by applying the following controls:

- Construction Hours - works should be mainly carried out within standard construction hours of 7am until 6pm Monday to Friday and 8am until 1pm on Saturday. It is possible that working hours may change depending on the outcome of community liaison and/or development approval conditions.
- Deliveries - will be carried out generally within standard construction hours (delivery of oversized loads may be required to occur outside of standard working hours). Loading and unloading will be carried out at the greatest possible distance to sensitive receivers.
- Quietest Suitable Equipment - Plant and equipment will be selected to minimise noise emission, whilst maintaining efficiency of function. Mufflers and all noise control equipment will be maintained in good order. Trucks will not use exhaust brakes on site wherever possible.
- Truck Noise (off site) - Trucks will not queue up outside residential areas prior to the 7am start time. All regular trucks are to have mufflers and other noise control equipment in good working order. Trucking routes will use main roads where feasible.
- Site Layout and Site Access - Where possible, plant will be orientated to direct noise away from sensitive receivers. Site sheds, materials and stockpiles will be used to increase acoustic shielding where feasible. Site access roads will be located as far as possible from noise sensitive areas.
- Noise Monitoring - During construction, noise monitoring at nearest affected residences will be carried out at least on a weekly basis.
- Temporary Hoarding – A contingency measure to control excessive noise should consider the installation of temporary hoarding (refer to Table 8.1).
- Vibration Monitoring and Management - Vibration monitoring will be carried out where vibration intensive activities (e.g. vibratory compaction, piling works and excavation) are required to be carried out within the established buffer zones, or where there is considered to be a risk that levels may exceed the relevant structural damage criteria. This will include carrying out vibration measurements at the commencement of these specific work tasks, limiting the duration of the vibration works and scheduling times of the work to minimise disruption to receivers.

- Community Liaison - A program of community liaison and complaint response will be implemented. Site induction training will include a noise awareness component.

### 8.8.4 Management of Visual Aspect

The receptors to visual aspects include the residents of the Burren Street properties along the western boundary and the rail passengers travelling through the adjoining rail corridor on the southeast boundary.

The visual impact is based on the expected size of the excavation required to remove the contaminated soils and the increase in construction activity.

Construction of an odour tent to control odour emissions should also be utilized to manage the visual impact that the excavation presents to the local residents or train passengers.

Maximum retention of vegetation along site boundaries should be considered to provide screening of the remediation site.

## 8.9 General Contingency Plan

The conditions encountered during remedial works can be uncertain. A set of typical issues and proposed corrective actions associated with a remediation program is provided in Table 8-1.

**Table 8-1 Remedial Works Contingency Planning**

| Potential Issue | Proposed Corrective Action |
|---|---|
| Identification of a suitable treatment site | Reassess preferred remedial option (or combination of options) for onsite treatment. Those requirements provided in Section 8.3.7 should be used as a guide to accommodate onsite treatment or identify alternate treatment sites. |
| Under estimation of material volumes | Assess the need to identify a larger alternate treatment site or a secondary site (i.e. two off site treatment areas). Assess the need to undertake supplementary sampling or discriminatory classification sampling to lower uncertainty of volume estimates. Discuss and explore additional funding mechanism if required. |
| Unexpected finding of free tar impacts in the vicinity of the Southern Gasholder | Explore the opportunity to dismantle the Southern Gasholder structure and remediate impacts below the ground surface, then reassemble the structure on the Site post-remediation. Assess the need to review groundwater remediation strategies and additional strategies for soils (i.e. insitu techniques) considering heritage status of the gasholder. |
| Soil treatment option is ineffective. | Consider and assess, from trials, the additional treatment and funding required. Consider disposal of treated material with higher contamination content (i.e. as Industrial or Hazardous wastes). |
| Unmanageable mud in excavation zone | Improve drainage collection system; add geotextile/gravel in problem areas; strip off mud/slurry materials. |
| Excessive stormwater | Minimise active contaminated work area; improve stormwater diversion. |
| Excessive dust | Use water sprays; stop dust-generating activity until better dust control can be achieved or apply interim capping systems. |
| Excessively wet materials | Stockpile and dewater on site or add absorbents. |
| Excessive noise | Noise barrier (hoarding) installation. Augment muffler systems on excavation machinery or haulage trucks. |
| Excessive vibration | Reassess vehicle movement routes and speeds. Static roll backfilled areas requiring compaction. |
| Ineffective odour controls | Alternative control method will be assessed and applied. Controls should include masking agents (Anotec, AirRepair), chemical additives (Biosolve) or containment materials (foam, HDPE covers). |
| Equipment failures | Maintain spare equipment or parts; keep rental options available or shut down affected operations until repairs are made. |

# 9 Site Validation

This section presents the procedures and protocol to validate the site remediation. Prior to any site validation work being conducted at the remediation site, a Sampling Plan should be developed to document the data quality objectives (DQOs), sampling program, sampling methods, analytical suites and other field procedures.

## 9.1 Excavated Areas

### 9.1.1 Sampling Pattern for Excavation Surfaces

A systematic sampling pattern should be employed to validate any exposed surface after excavation. Samples will be collected based on:

- an evenly spaced grid of 8.5m.

This sampling pattern provides a sample density that is based on the 95% probability of detecting a circular contamination hotspot of 10m in diameter. This approach will be followed for all excavation floor areas.

Wall surfaces of an excavation will be sampled every 10 lineal metres and at vertical depths corresponding to the depth based criteria outlined in **Section 4**. Sampling of wall surfaces will be collected between each of the following depth intervals:

- 0.0m to 1.5m;
- 1.5m to 2.5m;
- 2.5m to 4.0m;
- 4.0m to 8.0m; and
- Every 2.0m below 8.0m depth.

Consideration should be given to material types to ensure that samples representative of each fill/soil type are collected during validation.

## 9.2 Waste Classification

### 9.2.1 Untreated Material

Untreated material will be stockpiled according to the material type and sampled for waste classification for off site disposal. Stockpiled untreated material will be sampled at the following frequency:

- one (1) sample every 100m$^3$ or part there of for each material type.

### 9.2.2 Treated Material

Treated material will be stockpiled according to the material type and sampled for waste classification for off site disposal. Stockpiled treated material will be sampled at the following frequency:

- 1 per 25m$^3$ for batches less than 1,000m$^3$ (up to 40 primary samples); and
- 1 per 50 m$^3$ for batches over 1,000 m$^3$ (at least 20 samples).

### 9.2.3 Liquid Wastes

Liquid wastes should be sampled to obtain representative concentrations of chemicals in the waste and subsequently given a waste classification prior to removal from the Site.

## 9.3 Imported Material

All material imported to the Site should be Virgin Natural Excavated Material (VENM). The determination of VENM follows the definition provided in NSW EPA, 1999, which defines a VENM material that is:

- excavated from areas that are not contaminated, as a result of industrial, commercial, mining or agricultural activities, with manufactured chemicals and that does not contain sulphidic ores or soils;
- supplied from a known and trusted VENM source, such as a quarry; and
- not mixed with, or comprises, anthropogenic components, e.g. concrete timber, building rubble, hazardous building materials.

Samples will be collected from imported materials at the following sampling frequency to verify the VENM status:

- 1 (one) sample every 100m$^3$ for imported volumes up to 1,000m$^3$, with a minimum number of 5 (five) samples collected per source site; and
- 1 (one) sample every 250m$^3$ for imported volumes greater than to 1,000m$^3$, with a minimum number of 5 (five) samples collected per source site.

### 9.3.1 Backfilling

The backfilling of formed excavation will be conducted in a manner that follows the procedures outlined in **Section 8.7**. Validation of backfilling procedures will be achieved by ensuring that the requirements of those procedures are fully satisfied. This includes documentation that certifies:

- Australian Standards methods were followed (were required);
- Appropriate materials were used for backfilling;
- Compaction standards were achieved (i.e. density tests indicate that required densities were achieved); and
- Appropriate gradients were achieved.

## 9.4 Beneficial Re-Use of Excavated Material

Material that is excavated and transported off the Site (i.e. for treatment) should not be imported back onto the Site, given the implications of importing potential waste materials.

Material that is suitable for beneficial re-use will need to satisfy the following criteria:

- must originate and remain on the Site;
- does not show visual impacts of tar;

- neutral leach (SPLP) analysis data meets the adopted criteria in Table 9.1, to indicate potential concentrations at the site boundary for contaminants of concern in groundwater;
- meets either the generic or risk-based criteria for soils defined in Table 4.1 at those specified depths; and
- meets the geotechnical requirements for compaction.

The neutral leach (SPLP) data is required to meet the criteria in the following table. The majority of criteria are taken from ANZECC 2000, with the exception of those referenced in the table. Each criterion has been corrected to reflect the contaminant concentration at the site boundary based on a Dilution Attenuation Factor (DAF) of 20.

**Table 9.1 – Neutral Leach Criteria for Beneficial Re-Use (all values in µg/L)**

| Analyte | Criterion Value |
|---|---|
| As (total) | 480[1] |
| Cd | 4 |
| Cr (VI) | 20 |
| Cu | 28 |
| Hg (inorganic) | 1.2 |
| Ni | 220 |
| Pb | 68 |
| Zn | 160 |
| Benzene | 19,000 |
| Toluene | 6,000 (ANZECC 1992) |
| Ethylbenzene | 2,800 (ANZECC 1992) |
| o-xylene | 7,000 |
| p-xylene | 4,000 |
| Benzo(a)pyrene | 1 (Dutch 2000) |
| Naphthalene | 320 |
| TPH ($C_{10}$-$C_{36}$) | 12,000 (Dutch 2000) |
| Phenol | 6,400 |
| Cyanide (total or free) | 140 |

*Table Notes:*
*(1) – ANZECC 2000 criterion for As (III) used.*

For future use of the Site for rail-related activities, the physical properties of materials being considered for beneficial re-use must meet the geotechnical requirements specific for rail land, as outlined in **Section 8.7**.

An assessment of beneficial re-use must also consider aesthetic impacts of the material. For a commercial/industrial land use setting this only extends to malodorous materials as outlined in **Section 4.6**.

Materials being assessed for beneficial re-use will be stockpiled according to their visual appearance and sampled at the following frequency:

- one (1) sample every 25m$^3$ or part there of for each different material type.

## 9.5 Analysis of Validation Data

The methodology used for comparison of soil data to criteria is based on the methods referred to in the NSW EPA *Sampling Design Guidelines* (1995) and NEPC (1999) NEPM, which are:

- comparison of the 95% upper confidence limit of the arithmetic mean concentration (95% UCL values) of each contaminant to the nominated site criterion;
- No individual sample result should have a concentration that exceeds 250% of the criterion;
- A normal distribution will only be used if the coefficient of variance is not greater than 1.2; and
- The standard deviation of a sample population should not exceed 50% of the nominated criteria.

Statistical analysis must only be performed on similar materials of same the lithology.

## 9.6 Quality Assurance and Quality Control Program

### 9.6.1 Field Data Samples

Field data quality samples should be collected as part of the QA/QC program. Field data quality samples that should be collected include:

- Field Duplicates/Intra-Laboratory Duplicates at a frequency of 1/20 primary samples;
- Split Duplicates/Inter-Laboratory Duplicates at a frequency of 1/20 primary samples;
- Equipment Rinsate Blanks (not for disposable items) at a frequency of 1/piece of equipment/sampling day;
- Trip Blanks at a frequency of 1/sample batch; and
- Spiked Trip Blanks at a frequency of 1/sample batch (were volatile analysis is requested only).

The combination of Field duplicates and Split duplicates corresponds to a field QA/QC program that consist 10% of primary samples.

### 9.6.2 Laboratory Data Samples

The analytical laboratories undertaking the chemical analysis of samples must be accredited by the National Association of Testing Authorities (NATA) for each analytical method.

The following is a summary of the laboratory quality control samples that will be analysed by the selected laboratory and reported with the chemical analysis results:

- Method Blanks;

- Laboratory Duplicates;
- Laboratory Control Samples;
- Matrix Spikes; and
- Surrogate Spikes.

### 9.6.3 Data Quality Assessment

An assessment of data quality and the validity of the QA/QC program should be undertaken based on an evaluation of the Data Quality Indicators (DQIs). This assessment should be based on a nominated set of PARCC parameters (i.e. precision, accuracy, representativeness, completeness and comparability).

The DQI parameters will be required to be defined within a Sampling Plan to be developed for the remediation and validation works. Achievement of the project DQOs will be required to be assessed against the DQIs for both field and laboratory procedures.

## 9.7 Waste Tracking

A materials tracking system should be implemented to control and track the movement of materials on and off the Site. This system should control each of the different material handling phases that occur during the project including excavation, stockpiling, processing (screening and crushing), re-use, off site treatment and off-site disposal.

The system will track all site materials from "cradle-to-grave" and will provide detailed and accurate information about the location and quantity of all materials both on and off-site.

Waste tracking data shall be reconciled with documentation provided by waste transporters and waste receivers.

## 9.8 Validation Report

The validation report will be prepared in accordance with NSW EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*, and to meet requirements of the NSW DEC (2006) *Guidelines for the NSW Site Auditor Scheme*. The validation report will include the following:

- Details on the implementation of the RAP;
- Verification of regulatory compliance;
- A clear statement on whether the Site is considered suitable for its intended land use and whether it is considered to present an unacceptable risk to human health and the environment;
- Details of the long term EMP; and
- Any limitations, assumptions and uncertainties relevant to the conclusions of the report.

# 10 Long-Term Management

The preferred remedial strategy will involve an ongoing monitoring and management commitment for the Site. An EMP should be developed after the completion of the remediation to account for potential ongoing risks to future Site users from residual contamination, management of the Southern Gasholder heritage structure and management of groundwater contamination.

## 10.1 Site Users

The EMP will document the potential exposure risks posed by post-remediation residual contamination, and provide detailed procedures for undertaking works where risks may be encountered (i.e. an exposure pathway is completed). An example is providing specific procedures for undertaking subsurface excavations. A permit and sign off protocol will enable those responsible for implementing the EMP to ensure all requirements of the EMP have been met for particular work tasks.

The EMP will include details on the locations of contamination marker layers (if installed) and information on maintaining Site security.

The EMP should also provide information that details specific limitations and controls on-Site activities. Of particular importance is prohibiting the construction of basements on the Site, prohibiting the use of groundwater and controlling extracted groundwater (i.e. from dewatered trenches) from discharging from the Site.

## 10.2 Protecting Heritage Items

The EMP will provide information specific to the limitations on redevelopment potential in the vicinity of the Southern Gasholder, based on the heritage value of this structure and the requirement to protect its stability and fabric. The limitation should also extend to the western site boundary embankment, where aesthetic impacts (noise, visual) to neighbouring residents may need to be minimized.

The EMP should detail necessary requirements to maintain the Southern Gasholder and the embankment area, particularly in regard to:

- landscaping and aesthetic considerations;
- signage to notify site users of the heritage value;
- maintaining a 'buffer zone' around the structure to minimise potential damage; and
- prohibition of the use of heavy machinery and undertaking excavations in the buffer zone.

It is understood that a landscape design plan will be prepared prior to Site remediation, which should address some of the requirements above.

## 10.3 Groundwater Management

A groundwater management plan (GMP) will form part of the EMP to address risks from ongoing groundwater contamination. The GMP should detail the ongoing monitoring required to assess whether the Site remedial action (i.e. source removal to the extent practicable) is achieving the management goals for groundwater. Further,

the GMP is to provide an approach that enables cessation of groundwater monitoring based on evaluation of results over a certain period of time following commencement of monitoring. The following sections provide an overview of the proposed groundwater monitoring requirements.

### 10.3.1 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) will form part of the remedial strategy for the Site, and provides the basis for assessing the success of the Site remediation goals relating to groundwater protection by source removal. This approach will be implemented to monitor the concentration of residual compounds (primarily PAH, and BTEX) remaining in the groundwater beneath Site following remediation.

Limited data obtained by CH2M HILL (2000) indicated there was the potential for natural attenuation of hydrocarbon compounds in both the shallow groundwater and the deep shale groundwater, based on reported concentrations of natural attenuation parameters, sulfate, nitrate, dissolved oxygen, ferrous iron and methane.

A summary of previous data is presented in the following table.

**Table 10.1 – Summary of Natural Attenuation Parameters Data**

| | Sulfate | Nitrate | Dissolved Oxygen | Ferrous Iron | Methane |
|---|---|---|---|---|---|
| **Shallow Groundwater** | | | | | |
| **Mean (CH2M HILL, 2000)** | 151 | 0.476 | 2.03 | 30.8 | 943.3 |
| **Mean (CH2M HILL, 2001)** | - | - | 3.7 | - | - |
| **Mean (SKM, 2006)** | - | - | 7.43 | - | - |
| **Deep Shale Groundwater** | | | | | |
| **Mean (CH2M HILL, 2000)** | 613.3 | 0.012 | 2.8 | 18.7 | 50.67 |
| **Mean (CH2M HILL, 2001)** | - | - | 2.35 | - | - |
| **Mean (SKM, 2006)** | - | - | 8.14 | - | - |

*All values in mg/L*
*(-) not tested.*

The natural attenuation processes that are likely to be occurring at the former gasworks Site would include processes such as biodegradation, dispersion, sorption and volatilization. Biodegradation mechanisms may occur under both aerobic and anaerobic conditions including respiration (oxygen reduction), denitrification, iron (ferric) reduction, sulfagenesis, and methanogenisis.

Dispersion of the contaminants may be considered low given the low permeability and adsorptive affect of the clay and shale lithology. However, given the age of the Site operations (i.e. over 100 years) and the prominent fracturing of the weathered shale, dispersion has occurred from the source zones, particularly for contaminants with high to moderate solubility. This mechanism may be the result of preferential groundwater pathway flow through shale fracture. Dispersion is evident given the plume in the deep shale extends up to 125m, for light fraction hydrocarbons, and 160m, for middle to heavy fraction hydrocarbons, from the Site.

MNA is considered a feasible and appropriate strategy for managing groundwater contamination given that:

- MNA would complement the primary remedial strategy of tar removal to the extent practicable;
- active remediation of groundwater impacts would be highly impractical and cost ineffective given the local hydrogeological conditions;
- the extent of the contamination plume in both the shallow and deep groundwater systems has been defined;
- there is no beneficial use of groundwater likely beneath the Site or downgradient areas in RailCorp land;
- the Site has been adequately characterised to determine the level of contamination, the lateral and vertical extent of soil contamination, source zone areas, the lithological profile, the hydrogeological regime, the extent of groundwater impacts and permeability of the profile; and
- existing data indicates a potential for natural attenuation to occur under both aerobic and anaerobic conditions, particularly the presence of methane suggesting active attenuation occurring.

### 10.3.2 Management Goals for Groundwater

As discussed in **Section 4.3**, the management of groundwater contamination will form part of the remediation approach to the Site.

An MNA program will be the basis to management of groundwater and will include monitoring the groundwater quality and evaluating the resulting data.

Evidence of the success of soil remediation will be directly linked to the MNA program, which is based on the following three lines of evidence:

- a reduction in the extent of the contamination plume;
- a reduction in contaminant concentrations in the plume; and
- indications of naturally occurring degradation based on geochemical parameters.

A system of metrics will be used that effectively enable an evaluation of the success of soil remediation and the progress of natural attenuation.

In that regard, by using existing groundwater data and collecting additional groundwater data during and post remediation, an evaluation on the progress of MNA will essentially look at:

- plume stability – to demonstrate whether the contamination plume has reached equilibrium (i.e. attenuation rate equals groundwater velocity) or is shrinking, or adversely, if the plume is expanding;
- statistical analysis – to determine contaminant concentration trends over time and degradation rates and degradation products;
- baseline conditions – to establish a bench mark to compare the progress of MNA (to demonstrate MNA is working), including an evaluation against

background conditions (to determine potential up gradient impacts migrating onto the Site) and a comparison against generic GILs (to determine level of potential risk posed by residual impacts). Baseline conditions can also be used to determine degradation products and rates of production.

The disturbance of the ground during excavation of tar sources may potentially generate an increase in leaching of some contaminants, and therefore increases in concentrations of contaminants in the groundwater may result for a short time during and subsequently after remediation. However, this scenario is unknown and is unlikely to affect the required outcomes of MNA in the long term.

### 10.3.3 MNA Program Design

The MNA program will use a network of new nested monitoring well locations on Site, as well as a network of existing monitoring wells off Site. Each new nested well location will comprise a shallow well that is screened through the perched groundwater system (between 1 to 4 mbgl), and a deep well that is screened through the saturated zone of the shale bedrock system (between 12 and 15 mbgl). The potential for ongoing source materials to exist in and around the Southern Gasholder should be taken into consideration when positioning well screens, particularly the base of the gasholder, where tar sources may have accumulated.

Each new monitoring well installed will need to be surveyed to Australian Height Datum by a professional surveyor.

#### *Well Location and Rationale*

The nested monitoring well locations should be installed at eight (8) new locations, as indicated on **Figure 6**. These new locations will facilitate monitoring at strategic positions on the down gradient site boundary, down gradient of source areas (gasholders and tar wells) and up gradient of the source areas. It is not expected that the groundwater gradient will be altered subsequent to Site remediation.

The location of these monitoring new wells will enable data collected during the MNA program to be assessed as one data set or separately to monitor:

1. residual tar impacts in remediated areas (i.e. Tar Wells and Northern Gasholder); and
2. potential tar material below the Southern Gasholder.

This approach will enable the MNA program to be assessed separately for each of these two areas over time, if for example, monitoring around the Southern Gasholder shows ongoing impacts, but the remediated areas of the Northern Gasholder and the tar wells indicate evidence of natural attenuation occurring. It may be appropriate to only continue monitoring the Southern Gasholder and the network of wells off Site in this instance.

The network of monitoring wells existing down gradient and off Site should continue to also be used as part of the monitoring program. These locations include MW38d, MW39s/MW39d, MW40s/MW40d and MW41d.

#### *Timeframe*

The MNA program will consist of two phases of monitoring. The first phase (monthly event) will include frequent data collection to establish baseline conditions,

contaminant presence/occurrence and establish statistical analysis and rates. The second phase (year 2 – biannual event) will include assessment of existing and new data to confirm the stability of the plume. If required, and with input from the NSW DECC, a third stage may be conducted to further assesses the plume stability. The staged approach will enable an end point to be selected for the MNA program and effectively an end to the site remediation process.

### *Sampling and Methodology*

The analytical suite should be based on the contaminants of concern and parameters to enable assessment of natural attenuation. The expected analytical suite is provided in Table 10.2.

The purging and sampling of groundwater should be undertaken using a low-flow bladder technique. Where dewatering of the wells is encountered, then the use of bailers should be considered.

Field measurements will be undertaken during each monitoring event to measure the hydrogeological characteristics and footprint of the contamination plume. The expected field measurements to be collected are provided in Table 10.2.

A summary of the program design is provided in the table below.

**Table 10.2 – MNA Program Design**

| Phase | Scope Item | Number of Wells | Monitoring Period | Sampling Event | Purging/Sampling Method | Analytical Suite | Field Parameters and Measurements |
|---|---|---|---|---|---|---|---|
| One | Existing Wells (off site) | 6 | Pre- remediation | Once | Low-Flow bladder | • Metals[1]<br>• TPH<br>• BTEX<br>• PAH<br>• Phenols<br>• Ferrous Iron<br>• Sulfate<br>• Nitrate<br>• Methane | • Standing Water level<br>• Quality parameters[2]<br>• Hydraulic conductivity |
| | | | During remediation | Monthly | | | |
| | | | 12 months post remediation | Monthly | | | |
| | New Wells (on site) | 16 | 12 months post remediation | Monthly | | | |
| Two | All wells | 22 | Post Remediation | Biannual | | | |

*(1) Arsenic (total), cadmium, chromium (total), copper, lead, mercury, nickel and zinc.*

*(2) Redox potential, Electrical conductivity, temperature, pH, dissolved oxygen and physical observation.*

# 11 Conclusion

Based on the results and conclusions of the previous investigation programs, CH2M HILL considers that it is practical and feasible to remediate the Site to a condition that is considered acceptable for the proposed commercial/industrial land use and will not present an unacceptable risk to human health or the environment.

The combinations of remedial approaches documented in **Section 5.4** are seen as the preferred remedial options for the Site to address the ongoing health and ecological risks. Prior to remediation occurring, there is a requirement to obtaining relevant licences and approvals for the remediation and alternative treatment areas.

The preferred option includes a combination of:

- Installation of Site Security Fencing;
- Collection of liquid wastes/sludges and disposal at a liquid waste facility;
- Excavation, organic stabilisation treatment (at an alternative treatment site) and disposal of soil waste at a landfill facility under the NSW DECC General Approval for Immobilisation for coal tar materials – Approval #2005/14 (refer to **Section 3.1.5**);
- Excavation, thermal desorption treatment (at an alternate treatment site) and disposal of soil waste at a landfill facility;
- Excavation and disposal of soil waste at a landfill facility under the NSW DECC General Approval for Immobilisation for ash materials – Approval #1999/05 (refer to **Section 3.1.5**);
- Excavation and disposal of asbestos impacted demolition waste at a landfill facility;
- Excavation and disposal of untreated fill/soil waste at a landfill facility;
- Beneficial Reuse and Recycle (including segregation of demolition waste) of suitable materials where appropriate;
- Insitu (passive) chemical oxidation of residual source materials at depth subsequent to excavation and disposal of above materials; and
- Long term Environmental Management Plan (EMP) including a Groundwater Management Plan (GMP) with a Monitored Natural Attenuation (MNA) approach.

Following the completion of the remedial works a Validation Report will be prepared in general accordance with the requirements of the *NSW EPA Guidelines for Consultants Reporting on Contaminated Sites* (1998).

The requirement to prepare an EMP and continue ongoing monitoring of groundwater is paramount to assessing the success of site remediation.

# 12 References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# Figures

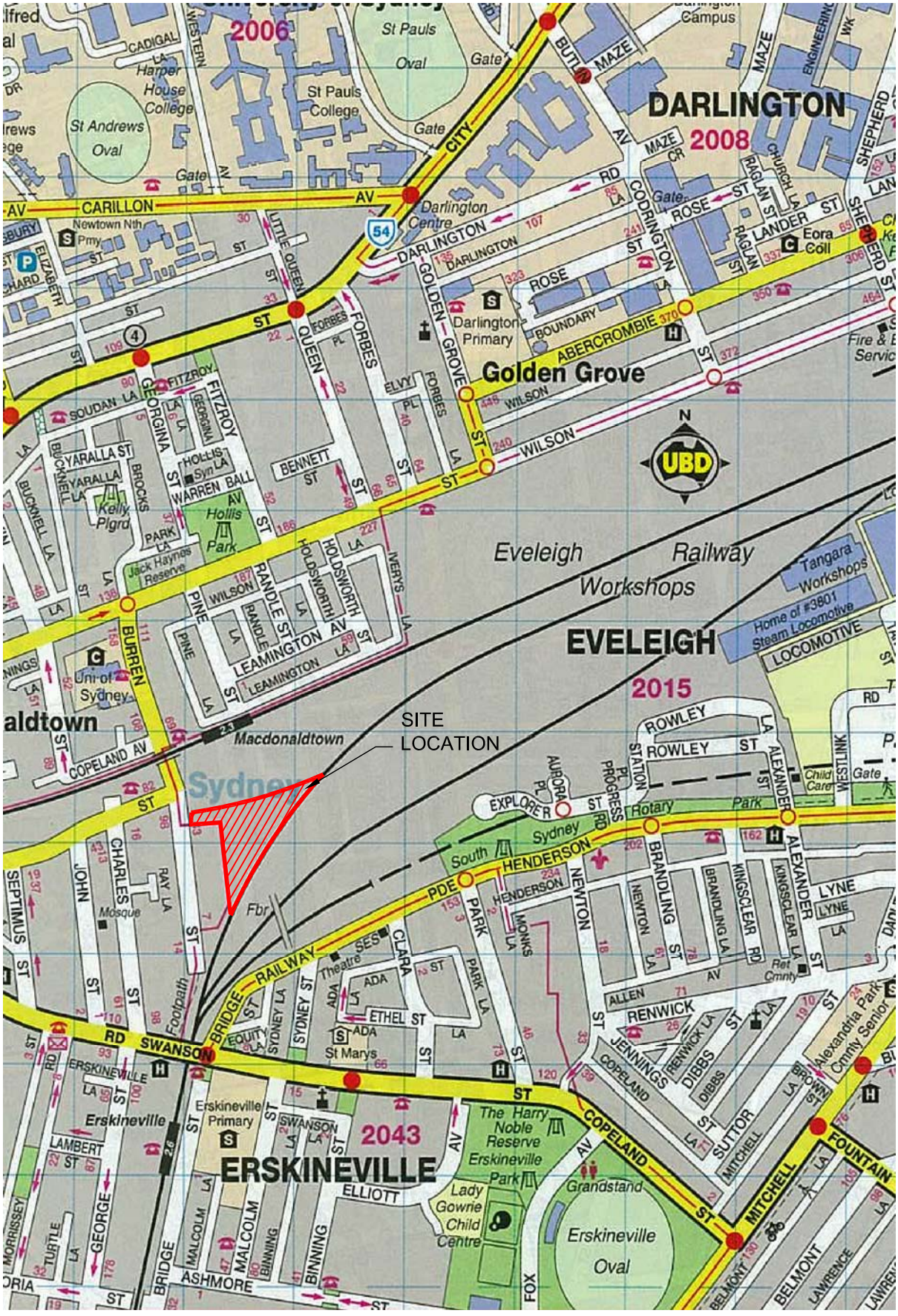


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**Figure 1**
**Site Location**

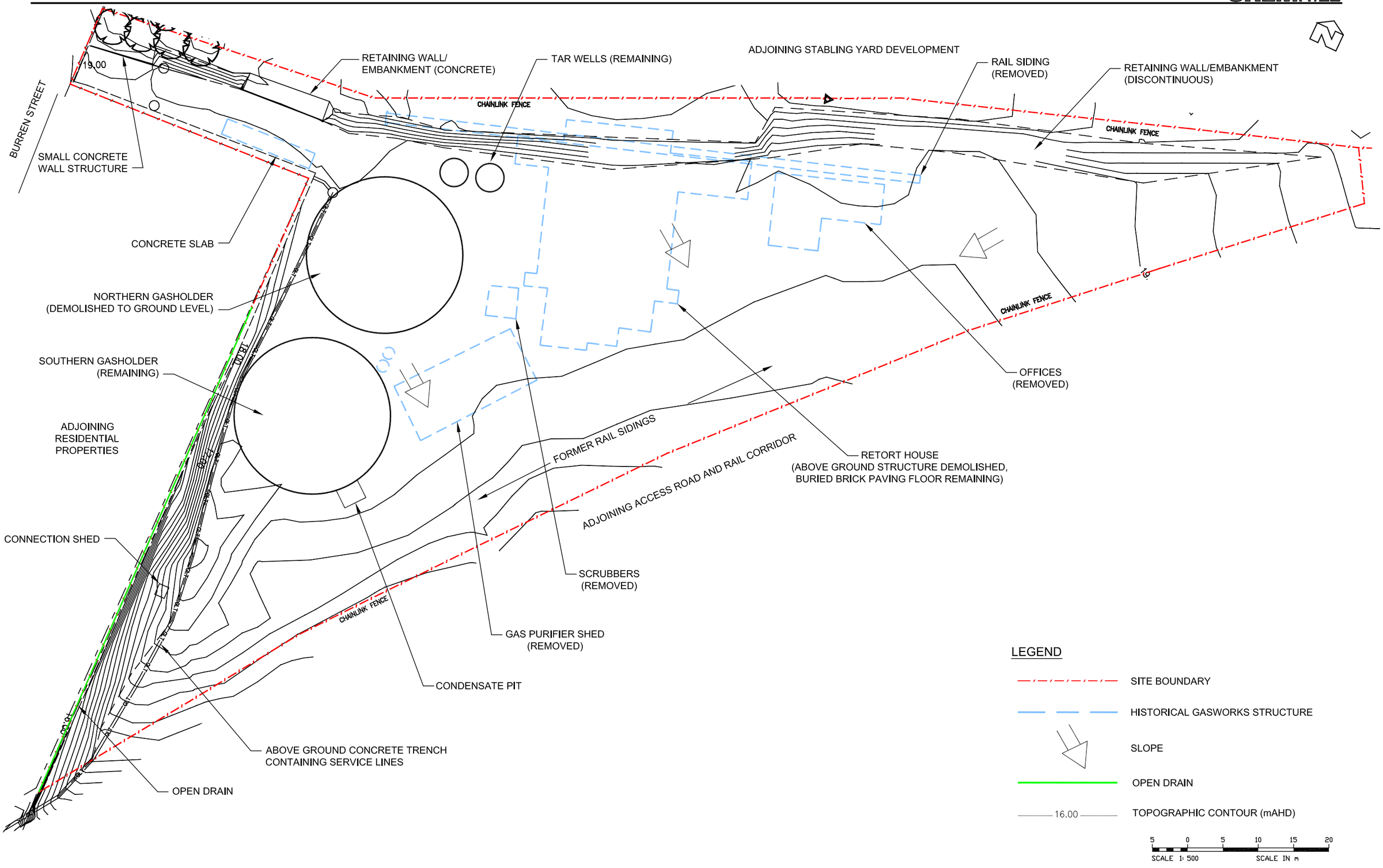
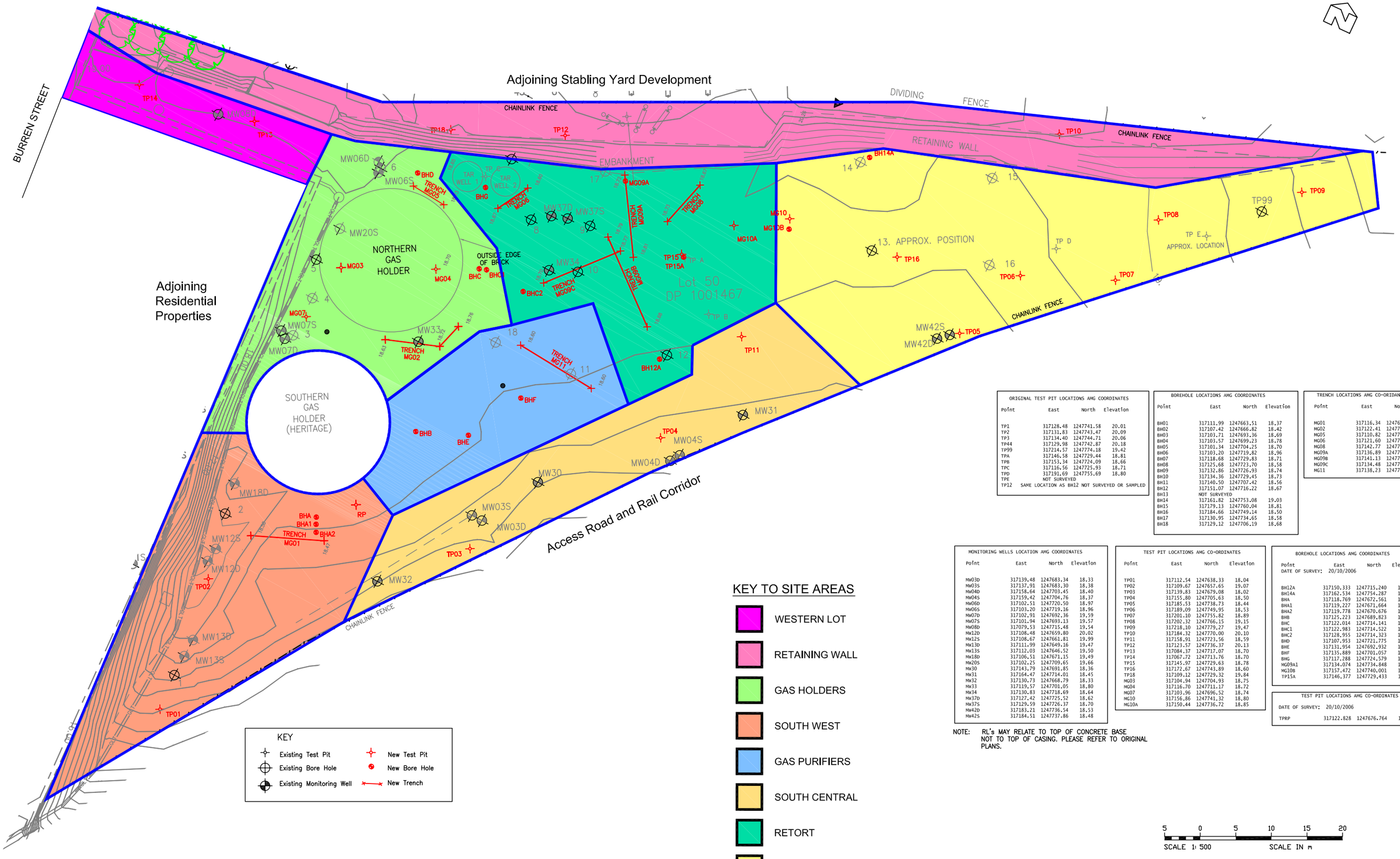



**Figure 2**
**Historic & Current Site Layout**




ORIGINAL TEST PIT LOCATIONS AMG COORDINATES

| Point | East | North | Elevation |
|---|---|---|---|
| TP1 | 317128.48 | 1247741.58 | 20.01 |
| TP2 | 317131.83 | 1247743.47 | 20.09 |
| TP3 | 317134.40 | 1247744.71 | 20.06 |
| TP44 | 317129.98 | 1247742.87 | 20.18 |
| TP99 | 317214.57 | 1247774.18 | 19.42 |
| TPA | 317146.58 | 1247729.44 | 18.81 |
| TPB | 317153.34 | 1247724.09 | 18.66 |
| TPC | 317116.56 | 1247725.93 | 18.71 |
| TPD | 317191.69 | 1247755.69 | 18.80 |
| TPE | NOT SURVEYED | | |
| TP12 | SAME LOCATION AS BH12 NOT SURVEYED OR SAMPLED | | |

BOREHOLE LOCATIONS AMG COORDINATES

| Point | East | North | Elevation |
|---|---|---|---|
| BH01 | 317111.99 | 1247663.51 | 18.37 |
| BH02 | 317107.42 | 1247666.82 | 18.42 |
| BH03 | 317103.71 | 1247693.36 | 18.69 |
| BH04 | 317103.57 | 1247699.23 | 18.78 |
| BH05 | 317101.34 | 1247704.25 | 18.70 |
| BH06 | 317103.20 | 1247719.82 | 18.96 |
| BH07 | 317118.68 | 1247729.83 | 18.71 |
| BH08 | 317125.68 | 1247723.70 | 18.58 |
| BH09 | 317132.86 | 1247726.93 | 18.74 |
| BH10 | 317134.36 | 1247729.45 | 18.73 |
| BH11 | 317140.50 | 1247707.42 | 18.56 |
| BH12 | 317151.07 | 1247716.22 | 18.67 |
| BH13 | NOT SURVEYED | | |
| BH14 | 317161.82 | 1247753.08 | 19.03 |
| BH15 | 317179.13 | 1247760.04 | 18.81 |
| BH16 | 317184.66 | 1247749.14 | 18.50 |
| BH17 | 317130.95 | 1247734.65 | 18.58 |
| BH18 | 317129.12 | 1247706.19 | 18.68 |

TRENCH LOCATIONS AMG CO-ORIDANTES

| Point | East | North |
|---|---|---|
| MG01 | 317116.34 | 1247667.86 |
| MG02 | 317122.41 | 1247701.92 |
| MG05 | 317110.82 | 1247719.75 |
| MG06 | 317121.60 | 1247725.15 |
| MG08 | 317142.77 | 1247736.07 |
| MG09A | 317136.89 | 1247730.85 |
| MG09B | 317141.13 | 1247722.61 |
| MG09C | 317134.48 | 1247721.27 |
| MG11 | 317138.23 | 1247707.26 |

MONITORING WELLS LOCATION AMG COORDINATES

| Point | East | North | Elevation |
|---|---|---|---|
| MW03D | 317139.48 | 1247683.34 | 18.33 |
| MW03S | 317137.91 | 1247683.30 | 18.38 |
| MW04D | 317158.64 | 1247703.45 | 18.40 |
| MW04S | 317159.42 | 1247704.76 | 18.37 |
| MW06D | 317102.51 | 1247720.50 | 18.97 |
| MW06S | 317103.20 | 1247719.16 | 18.96 |
| MW07D | 317102.91 | 1247692.36 | 19.59 |
| MW07S | 317101.94 | 1247693.13 | 19.57 |
| MW08D | 317079.53 | 1247715.48 | 19.54 |
| MW12D | 317108.48 | 1247659.80 | 20.02 |
| MW12S | 317108.67 | 1247661.81 | 19.99 |
| MW13D | 317111.99 | 1247649.16 | 19.47 |
| MW13S | 317112.03 | 1247646.52 | 19.50 |
| MW18D | 317106.51 | 1247671.15 | 19.49 |
| MW20S | 317102.25 | 1247709.65 | 19.66 |
| MW30 | 317143.79 | 1247691.85 | 18.36 |
| MW31 | 317164.47 | 1247714.01 | 18.45 |
| MW32 | 317130.73 | 1247668.79 | 18.33 |
| MW33 | 317119.57 | 1247701.05 | 18.80 |
| MW34 | 317130.83 | 1247718.69 | 18.64 |
| MW37D | 317127.42 | 1247725.52 | 18.62 |
| MW37S | 317129.59 | 1247726.37 | 18.70 |
| MW42D | 317183.21 | 1247736.54 | 18.53 |
| MW42S | 317184.51 | 1247737.86 | 18.48 |

TEST PIT LOCATIONS AMG CO-ORDINATES

| Point | East | North | Elevation |
|---|---|---|---|
| TP01 | 317112.54 | 1247638.33 | 18.04 |
| TP02 | 317109.67 | 1247657.65 | 19.07 |
| TP03 | 317139.83 | 1247679.08 | 18.02 |
| TP04 | 317155.80 | 1247705.63 | 18.50 |
| TP05 | 317185.53 | 1247738.73 | 18.44 |
| TP06 | 317189.09 | 1247749.95 | 18.53 |
| TP07 | 317201.10 | 1247755.82 | 18.89 |
| TP08 | 317202.32 | 1247766.15 | 19.15 |
| TP09 | 317218.10 | 1247779.27 | 19.47 |
| TP10 | 317184.32 | 1247770.00 | 20.10 |
| TP11 | 317158.91 | 1247723.56 | 18.59 |
| TP12 | 317123.57 | 1247736.37 | 20.13 |
| TP13 | 317084.37 | 1247717.07 | 18.70 |
| TP14 | 317067.72 | 1247713.76 | 18.70 |
| TP15 | 317145.97 | 1247729.63 | 18.78 |
| TP16 | 317172.67 | 1247743.89 | 18.60 |
| TP18 | 317109.12 | 1247729.32 | 19.84 |
| MG03 | 317104.94 | 1247704.93 | 18.75 |
| MG04 | 317116.70 | 1247711.17 | 18.72 |
| MG07 | 317103.96 | 1247696.52 | 18.74 |
| MG10 | 317156.86 | 1247741.32 | 18.80 |
| MG10A | 317150.44 | 1247736.72 | 18.85 |

BOREHOLE LOCATIONS AMG COORDINATES

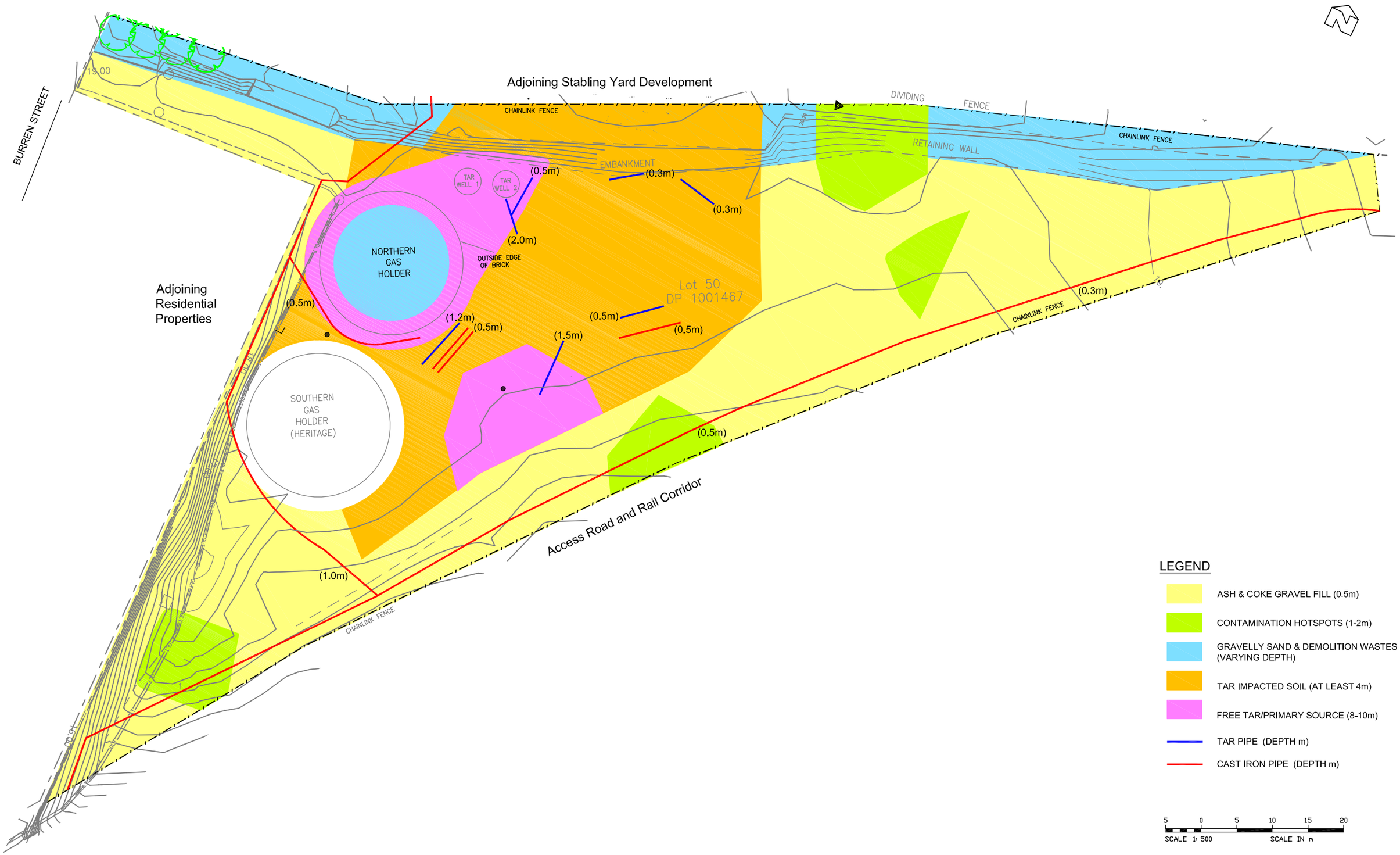
| Point | East | North | Elevation |
|---|---|---|---|
| DATE OF SURVEY: | 20/10/2006 | | |
| BH12A | 317150.333 | 1247715.240 | 18.63 |
| BH14A | 317162.534 | 1247754.287 | 18.89 |
| BHA | 317118.769 | 1247672.561 | 18.46 |
| BHA1 | 317119.227 | 1247671.664 | 18.41 |
| BHA2 | 317119.778 | 1247670.676 | 18.48 |
| BHB | 317125.223 | 1247689.823 | 18.49 |
| BHC | 317122.014 | 1247714.141 | 18.78 |
| BHC1 | 317122.083 | 1247714.522 | 18.75 |
| BHC2 | 317128.955 | 1247714.323 | 18.66 |
| BHD | 317107.953 | 1247721.775 | 18.86 |
| BHE | 317131.954 | 1247692.932 | 18.50 |
| BHF | 317135.889 | 1247701.057 | 18.56 |
| BHG | 317117.288 | 1247724.579 | 18.61 |
| MG09A1 | 317134.074 | 1247734.848 | 18.44 |
| MG10B | 317157.472 | 1247740.001 | 18.82 |
| TP15A | 317146.377 | 1247729.433 | 18.80 |

TEST PIT LOCATIONS AMG CO-ORDINATES

| | | | |
|---|---|---|---|
| DATE OF SURVEY: | 20/10/2006 | | |
| TPRP | 317122.828 | 1247676.764 | 18.37 |

NOTE: RL's MAY RELATE TO TOP OF CONCRETE BASE NOT TO TOP OF CASING. PLEASE REFER TO ORIGINAL PLANS.

**Figure 3**
**Site Areas and Previous Sampling Locations**




LEGEND

- ASH & COKE GRAVEL FILL (0.5m)
- CONTAMINATION HOTSPOTS (1-2m)
- GRAVELLY SAND & DEMOLITION WASTES (VARYING DEPTH)
- TAR IMPACTED SOIL (AT LEAST 4m)
- FREE TAR/PRIMARY SOURCE (8-10m)
- TAR PIPE (DEPTH m)
- CAST IRON PIPE (DEPTH m)

5 0 5 10 15 20
SCALE 1: 500 SCALE IN m

**Figure 4**
**Remediation Areas**
**& Excavation Depth Estimates**




**Figure 5**
**Site Access and Traffic Routes**




**Figure 6**
**Groundwater Monitoring Well Locations for MNA Program**

# Tables

**Table 1 - Summary of All Data for Fill & Silty Clay Material - Macdonaldtown Gasworks Site**

| Sample Location | Easting (AMG) | Northing (AMG) | Elevation (mAHD) | Soil Profile | | Sample Depth (m) | | Contaminants of Concern - Concentrations in mg/kg | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | BaP | Total PAH | TPH (C6-C9) | TPH (C10-C14) | TPH (C15-C28) | TPH (C29-C36) | Total C10-C36 | Benzene | Toluene | Ethylbenzene | Total Xylenes | Metals | Cyanide (Total) | VOCs | Total Phenols | OCPs | OPPs | Asbestos | PCBs |
| Commercial / Industrial Landuse Guidelines (NEHF F / NSW EPA 1994 Service Station Guidelines) | | | | | | | | 5 | 100 | 65 | - | - | - | 1000 | 1 | 130 | 50 | 25 | Various | 2500 | See BTEX | 42500 (phenol) | 50 (heptaclor)<br>50 (aldrin+dieldrin)<br>50 (chlordane)<br>1000 (DDT+DDE+DDD) | | | 50 |
| **Gasholder** | | | | | | | | | | | | | | | | | | | | | | | | |
| BH03 | 317103.713 | 1247693.358 | 18.690 | Gravelly fil | | 0-0.1 | 0-0.1 | **27** | **294.8** | nd | 120 | 3300 | 1600 | **5020** | nd | nd | nd | nd | < guidelines | - | - | 18.4 | - | - | - | - |
| | | | | Red clay & decomposed shale | | 0.1-1.5 | 1.0-1.1 | nd | nd | nd | nd | 300 | 260 | 560 | nd | nd | nd | nd | < guidelines | nd | - | - | - | - | - | - |
| BH04 | 317103.564 | 1247699.228 | 18.780 | Gravelly fill | | 0-0.1 | 0-0.1 | nd | nd | - | - | - | - | - | - | - | - | - | < guidelines | - | - | - | - | - | - | - |
| | | | | Clay, gravel and shale fi | | 0.1-0.55 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Coal slag fill & coarse sanc | | 0.55-0.8 | 0.7-0.8 | **140** | **1697** | nd | 1000 | 9700 | 1400 | **12100** | nd | nd | nd | nd | < guidelines | - | - | 419 | - | - | - | - |
| | | | | Clay, coal pieces, gravel, rock | | 0.8-1.5 | 0.8-0.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Grey silty clay | | 1.5-2.5 | 1.5-1.6 | nd | nd | - | - | - | - | - | nd | nd | nd | nd | < guidelines | - | - | - | - | - | - | - |
| BH05 | 317101.342 | 1247704.245 | 18.7 | Refusal on Gas Holder at 0.0m | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH06 | 317103.196 | 1247719.155 | 18.960 | Bitumen | | 0-0.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Coke fill, minor sanc | | 0.1-0.3 | 0.2-0.3 | **190** | **2374** | 11 | 2600 | 15000 | 2400 | **20000** | nd | nd | nd | 3 | < guidelines | 0.7 | - | 65 | - | - | - | - |
| | | | | Red clay fill & weathered shal | | 0.3-1.0 | 0.3-0.4 | **30** | **137.3** | nd | 70 | 580 | 260 | 910 | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |
| | | | | Grey silty clay | | 1.0-2.2 | 1.0-1.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Grey silty clay | | | 2.0-2.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW06S | 317103.196 | 1247719.155 | 18.960 | Bitumen | | 0-0.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Coke and sand fill | | 0.1-0.4 | 0.2-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Coke and sand fill | | | 0.3-0.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red clay and weathered shale | | 0.4-1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay fill | | 1.0-2.2 | 1-1.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay fill | | | 2-2.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW06D | 317102.514 | 1247720.496 | 18.970 | Coke and sand fill | | 0-0.3 | 0.2-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Clay and weathered shale | | 0.3-1.1 | 0.3-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay | | 1.0-2.2 | 1-1.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay | | | 2-2.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW07S | 317101.940 | 1247693.130 | 19.575 | Bitumen | | 0-0.05 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy clay fill | | 0.05-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red plastic clay | | 0.3-4.0 | 0.8-1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW07D | 317102.910 | 1247692.360 | 19.590 | Clay fill with HC odour | | 0-4.0 | 1.4-1.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | - | - | - | - |
| MW20S | 317102.250 | 1247709.650 | 19.660 | Sandy clay fill | | 0-4.0 | 0.05-0.3 | **6.1** | 68.9 | nd | | 398 | | 398 | nd | nd | nd | nd | <guidelines | - | nd | nd | - | - | - | - |
| MW33 | 332293.5328 | 6247699.5870 | 18.797 | Silty sandy clay fill | | 0-0.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | | | 0.1-0.6 | 0.5-0.95 | | | | | | | | | | | | | | | | | | | |
| | | | | Sandy silty clay fill, HC odour | | | | - | - | - | - | **2124 (C16-C35 Aromatics) & 217 (Aliphatics)** | | | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | Silty clay, HC odou | | 0.6-1.5 | 0.5-0.95 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MG02 | 317122.410 | 1247701.920 | 18.680 | Black ash, coke gravels, clinker fill, high odou | | 0-0.3 | 0 | nd | **142.0** | **72** | 290 | nd | nd | 290 | **4.2** | 5.8 | 22.1 | **29.6** | - | - | - | - | 1.3 | - | - | - | - |
| | | | | Red/grey mottled moderately plastic clay | | 0.3-1.0 | 0.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Dark brown low plasticity silty clay fill, black ooze, tar high odo | | 1.5-1.9 | 1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Dark brown low plasticity silty clay fill, black ooze, tar high odo | | | 1.8 | **178** | **5301.9** | **189** | 10300 | 21400 | 4440 | **36140** | **3** | 4.4 | 30.2 | **165.8** | <guidelines | 23.3 | - | 6.7 | nd | nd | - | nd |
| MG03 | 317104.9400 | 1247704.9300 | 18.750 | Gravelly sandy silt fill with ballast, bricks, scrap metal, sandstone bloci | | 0-1.0 | 0.1 | **10.4** | **114.8** | nd | 100 | 1800 | 850 | **2750** | nd | nd | nd | nd | <guidelines | - | - | nd | nd | nd | nd | nd |
| MG04 | 317116.7000 | 1247711.1700 | 18.720 | Gravelly sand fill with black and brown brick fragments | | 0-1.5 | 0.5 | **6** | 61.3 | nd | nd | 1340 | 470 | **1810** | nd | nd | nd | nd | **Pb=2140** | - | - | - | - | - | - | - |
| | | | | Fibro cement sheet fragment | | | 1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | detected (fragment) | - |
| | | | | Gravelly sand fill with black and brown brick fragments | | | 1.5 | 1.3 | 15.30 | nd | nd | 240 | nd | 240 | nd | nd | nd | nd | <guidelines | - | - | - | nd | nd | detected | nd |
| MG05 | 317110.820 | 1247701.920 | 18.730 | Bitumen, ash gravels and crushed roc | | 0-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Brown low plasticity silty clay fill with fine grave | | 0.3-1.3 | 0.5 | - | - | nd | 280 | 10800 | 2260 | **13340** | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - | - |
| | | | | Brown low plasticity silty clay fill with fine gravels | | | 1.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MG07 | 317103.960 | 1247696.520 | 18.740 | Gravelly ash fill and ballast | | 0-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/grey mottled moderate plasticity clay fill with minor bricks | | 0.3-1.0 | 1.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | - | - | - | - |
| BHC | 317122.0140 | 1247714.1410 | 18.7800 | Gravelly clay, wet, black staining, high odour | | 2.4-4.4 | 3.6 | | | | | | | | | | | | | | | | | | | |
| **Total Samples Analysed** | - | - | - | - | | - | - | 15 | 15 | 14 | - | - | - | 15 | 16 | 16 | 16 | 16 | 15 | 3 | 1 | 10 | 3 | 3 | 3 | 3 |
| **Detects above criteria** | - | - | - | - | | - | - | 8 | 7 | 2 | - | - | - | 8 | 2 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Hotspots** | - | - | - | - | | - | - | 5 | 4 | 1 | - | - | - | 6 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Retort** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BH07 | 317118.681 | 1247729.832 | 18.710 | Coke fill, minor sanc | | 0-0.8 | 0-0.1 | **200** | **2078** | nd | 1300 | 11000 | 2100 | **14400** | nd | nd | nd | nd | < guidelines | - | - | 50 | nd | - | - | - |
| | | | | Clay, shale and rock fil | | 0.8-1.0 | - | - | - | - | - | - | - | - | - | - | - | - | < guidelines | - | - | - | - | - | - | - |
| | | | | Clay, oil, tar, HC odou | | 1.0-2.0 | 1.4-1.5 | **26** | **1144.8** | - | - | - | - | - | nd | nd | 8 | **32** | < guidelines | 98 | some detections | nd | - | - | - | nd |
| BH08 | 317125.080 | 1247723.696 | 18.580 | Gravelly fill | | 0-0.5 | 0-0.1 | 4.6 | 53.3 | - | - | - | - | - | - | - | - | - | < guidelines | - | - | - | - | - | - | - |
| | | | | Coke and sand fill | | 0.5-1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay and coal slag | | 1.0-1.5 | 1.0-1.1 | **7** | 99.3 | nd | 120 | 740 | 120 | 980 | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |
| | | | | Grey silty clay | | 1.5-2.5 | 1.6-1.7 | **5.4** | 82 | - | - | - | - | - | nd | nd | nd | nd | < guidelines | - | - | - | - | - | - | nd |
| | | | | Grey silty clay | | | 2.3-2.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH09 | 317132.858 | 1247726.929 | 18.740 | Sand and brick fill | | 0-0.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Refusal on brick at 0.2 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH10 | 317134.360 | 1247720.447 | 18.730 | Ballast & slag fill | | 0-0.3 | 0-0.1 | **11** | **112** | - | - | - | - | - | - | - | - | - | < guidelines | - | - | nd | - | - | - | - |
| | | | | Ballast & slag fill | | | 0.3 | 2.8 | 28 | nd | 30 | 300 | 140 | 470 | nd | nd | nd | nd | < guidelines | - | - | - | - | - | - | - |
| | | | | Refusal at 0.3 on concrete slab | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH17 | 317130.945 | 1247734.645 | 18.58 | Refusal on foundations at 0.0m | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH12 | 317151.071 | 1247716.220 | 18.670 | Gravelly fill | | 0-0.1 | 0-0.1 | **5.8** | 49.3 | - | - | - | - | - | - | - | - | - | <guidelines | 3.4 | - | - | - | - | - | - |
| | | | | Coarse sand | | 0.1-2.0 | 0.9-1.0 | nd | nd | - | - | - | - | - | - | - | - | - | <guidelines | 3.4 | nd | - | - | - | - | - |
| | | | | Coarse sand | | | 1.3-1.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Clay, shale and coke fill | | 2.0-2.5 | 2.0-2.1 | nd | 0.6 | - | - | - | - | - | nd | nd | nd | nd | - | 3 | - | - | - | - | - | - |
| | | | | Clay and coke fill (odourous) | | 2.5-3.1 | 2.6-2.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP12 | (Same location as BH12) Not surveyed or sampled | | | Ash and coal | | 0-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sand with minor odour | | 0.3-3.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Wet sand with odou | | 3.0-4.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TPA | 317146.580 | 1247729.442 | 18.81 | Sand and gravel fil | | 0-1.5 | 1.6 | **8.4** | **536.9** | **100** | 1600 | 1400 | 200 | **3200** | **1.6** | 15 | 7 | **65** | <guidelines | 5.6 | - | nd | - | - | - | - |
| | | | | Tar migrating from brick seams | | 1.5-2.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Refusal on concrete or brick at 2m | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TPB | 317153.335 | 1247724.094 | 18.66 | Sand and slag fill | | 0-1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Refusal on pipes and concrete at 1n | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TPC | 317116.562 | 1247725.926 | 18.71 | Bricks, tar, HC odours | | 0-1.6 | 1 | **8.4** | **750.6** | - | - | - | - | - | nd | 5 | 9 | **48** | <guidelines | 34 | - | nd | - | - | - | - |
| | | | | Refusal on bricks at 1.6m | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW34 | 332304.4362 | 6247717.4350 | 18.639 | Gravelly sandy clay | | 0-0.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy clay | | 0.2-0.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay, HC odour | | 0.4-1.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay, oil sheen, odour | | 1.2-1.5 | 1.4 | - | - | - | - | **92 (C16-C35 Aromatics) & nd (Aliphatics)** | | | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| MW37S | 332303.0680 | 6247725.0410 | 18.696 | Ballast | | 0-0.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Ash fill | | 0.2-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay fill | | 0.3-2.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay fill with tar | | 2.0-4.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW37D | 332300.9170 | 6247724.1940 | 18.615 | Silty sandy gravel fill | | 0-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Slag and brick fill | | 0.3-1.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay fill, odours | | 0.3-1.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay fill | | 1.3-2.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MG06 | 317121.6000 | 1247725.1500 | 18.950 | Brown low plasticity silty clay fill with visible tar and oil, HC odours | | 0-1.2 | 1.0 | 2 | **135.00** | 18 | 660 | 610 | nd | **1270** | 0.2 | 0.8 | 3 | 9.5 | <guidelines | 2.7 | - | - | - | - | - | - |
| MG08 | 317142.7700 | 1247736.0700 | 18.700 | Loose sandy ash and ballast fill with coarse gravels | | 0-0.3 | 0.3 | - | - | - | - | - | - | - | - | - | - | - | <guidelines | - | - | - | - | - | - | - |
| | | | | Red/grey moderately plastic gravelly clay fill, HC odours, tar seepa | | 0.3-1.6 | 1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/grey moderately plastic gravelly clay fill with HC odours, tar seepa | | | 1.5 | **444** | **15237.60** | 51 | 99100 | 310000 | 26000 | **435100** | 0.2 | 0.5 | 3.6 | 10.6 | <guidelines | - | - | 39 | nd | nd | - | nd |
| | | | | Brown/green, plastic silty clay fill with high odours and visible tar in pon | | 1.6-2.5 | 2.1 | **6.9** | **321.20** | **97** | 740 | 1620 | 430 | **2790** | 0.3 | 0.4 | 12.3 | 6 | - | - | - | - | - | - | - |
| MG09A1 | | | | Sandy clay, free ta | | 0.7 | 0.7 | **8.2** | **416.6** | 39 | 850 | 2110 | 560 | **3520** | **1.7** | 6.6 | 2.4 | 21 | | 23.6 | | 2 | | | | |
| MG09B | 317141.1300 | 1247722.6100 | 18.735 | Sandy gravel fill/Concrete slal | | 0-0.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Ash and clay fil | | 0.2-0.5 | 0.3 | - | - | 12 | 790 | 13800 | 6110 | **20700** | 0.5 | 1.1 | 0.3 | 4 | <guidelines | - | - | - | - | - | - | - |
| | | | | Gravelly clay fill | | 0.5-1.6 | 0.6 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | nd | nd | - | nd |
| | | | | Fibro cement sheet fragmen | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | detected (fragment) | - |
| | | Not surveyed | | Service pipe | | - | PIPE | **595** | **26805.30** | **3770** | 402000 | 654000 | 124000 | **1180000** | **576** | **1210** | **156** | **1516** | <guidelines | - | - | 9872.4 | nd | nd | - | nd |
| MG09C | 317134.4800 | 1247721.2700 | 18.735 | Sandy gravel fill/Concrete slab | | 0-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Ash gravels and sand fill | | 0.3-0.8 | 0.3 | **5** | 50.00 | nd | nd | 630 | 520 | **1150** | nd | nd | nd | nd | <guidelines | nd | - | - | - | - | - | - |
| | | | | Red/grey moderately plastic gravelly clay fill with visible pockets of tar | | 0.7-1.8 | 1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Brown/green silty clay fill over weathered shale, high HC odours | | 1.8-3.8 | 1.9 | 2.1 | 73.60 | 18 | 300 | 360 | nd | 660 | nd | 0.4 | 0.5 | 0.6 | <guidelines | nd | - | - | - | - | - | - |
| MG10A | 317150.4400 | 1247736.7200 | 18.850 | Sandy gravel fill and ballas | | 0-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Black ash and coke gravel fi | | 0.3-0.8 | 0.7 | **339** | **4758.20** | nd | 9650 | 200000 | 25300 | **234950** | nd | nd | nd | nd | <guidelines | 27.1 | - | 76.5 | nd | nd | nd | - |
| TP15 | 317145.9700 | 1247729.6300 | 18.780 | Gravelly sand fill, overlying brickwork layer | | 0-0.3 | 0.3 | 2.2 | 19.80 | nd | nd | 230 | 150 | 380 | nd | nd | nd | nd | - | 1.1 | - | - | - | - | - | - |
| | | | | Ash and gravel fill with free tar in brickwork footin | | 0.3-1.8 | 1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tar Well #2 | | Not surveyed | | Coal Tar and gravels from tar well # | | - | Well Contents | **164** | **25558** | **6690** | 56700 | 35800 | 6200 | **98700** | **814** | **1680** | **254** | **3170** | <guidelines | 67.1 | - | 3384.2 | - | - | - | - |
| **Total Samples Analysed** | - | - | - | - | | - | - | 22 | 22 | 14 | - | - | - | 15 | 19 | 19 | 19 | 19 | 19 | 12 | 2 | 10 | 5 | 4 | 2 | 5 |
| **Detects above criteria** | - | - | - | - | | - | - | 13 | 10 | 2 | - | - | - | 9 | 2 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **Hotspots** | - | - | - | - | | - | - | 6 | 10 | 0 | - | - | - | 7 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 1 - Summary of All Data for Fill & Silty Clay Material - Macdonaldtown Gasworks Site**

| Sample Location | Easting (AMG) | Northing (AMG) | Elevation (mAHD) | Soil Profile | | Sample Depth (m) | Contaminants of Concern - Concentrations in mg/kg | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BaP | Total PAH | TPH (C6-C9) | TPH (C10-C14) | TPH (C15-C28) | TPH (C29-C36) | Total C10-C36 | Benzene | Toluene | Ethylbenzene | Total Xylenes | Metals | Cyanide (Total) | VOCs | Total Phenols | OCPs | OPPs | Asbestos | PCBs |
| Commercial / Industrial Landuse Guidelines (NEHF F / NSW EPA 1994 Service Station Guidelines) | | | | | | | 5 | 100 | 65 | - | - | - | 1000 | 1 | 130 | 50 | 25 | Various | 2500 | See BTEX | 42500 (phenol) | 50 (heptaclor)<br>50 (aldrin+dieldrin)<br>50 (chlordane)<br>1000 (DDT+DDE+DDD) | | | 50 |
| **Gas Purifier** | | | | | | | | | | | | | | | | | | | | | | | | |
| BH11 | 317140.501 | 1247707.420 | 18.560 | Gravelly fill | | 0-0.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Coarse sand | | 0.1-1.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Clay and coke fill | | 1.1-2.3 | 1.2-1.3 | - | - | - | - | - | - | - | - | - | - | < guidelines | nd | - | - | - | - | - |
| BH18 | 317129.119 | 1247706.185 | 18.680 | Gravelly fil | | 0-0.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Ash, coke and slag fil | | 0.2-0.4 | 0.2-0.3 | **220** | **3953** | nd | 3400 | 26000 | 9000 | **38400** | nd | nd | nd | nd | <guidelines | 8.8 | - | 97 | - | - | - | - |
| | | | | Clay and rock fill | | 0.4-1.0 | 0.4-0.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Moist clay with strong odou | | 1.0-1.5 | 1.0-1.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Fill with oil, tar, strong odou | | 1.5-1.9 | 1.7-1.8 | **28** | **2160.8** | - | - | - | - | - | **7** | 11 | **80** | **210** | <guidelines | - | - | nd | - | - | - | - |
| | | | | Silty clay (odour, | | 1.9-2.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MG11 | 317138.230 | 1247707.260 | 18.600 | Dark grey very gravelly sand fill with ash, coke and balla | | 0-0.2 | 0.2 | **42** | **696.60** | nd | 290 | 4720 | 1200 | **6210** | nd | nd | nd | nd | <guidelines | nd | - | - | - | - | - | - |
| | | | | Orange and red firm clay fil | | 0.5-1.7 | 1.5 | - | - | - | - | - | - | - | - | - | - | - | - | 2.5 | - | - | - | - | - | - |
| | | | | Yellow/orange medium sand fill with black staining and s | | 1.7-3.2 | 2.0 | **48.8** | **728.80** | 10 | 330 | 5760 | 1660 | **7750** | nd | nd | nd | nd | <guidelines | 3.5 | - | 1.1 | nd | nd | - | nd |
| BHE | 317131.9540 | 1247692.9320 | 18.5000 | Reworked clay, low/med plast, firm | | 1.6 | 1.6 | | | | | | | | | | | | | | | | | |
| | | | | Reworked clay, low/med plast, firm | | 2.2 | 2.2 | nd | 24.6 (naphthalene | **155** | 170 | 190 | nd | 360 | 0.4 | 0.4 | 16.1 | 17 | | n | | nd | | | | |
| BHF | 317135.8890 | 1247701.0570 | 18.5600 | Reworked clay, low/med plast, firm, ash gravels | | 1 | 1.0 | **6.4** | 89.5 | nd | 90 | 740 | 320 | **1150** | nd | nd | nd | nd | | 5.3 | | nd | | | | |
| **Total Samples Analysed** | - | - | - | - | | - | - | 6 | 6 | 5 | - | - | - | 5 | 6 | 6 | 6 | 6 | 5 | 7 | 0 | 5 | 1 | 1 | 0 | 1 |
| **Detects above criteria** | - | - | - | - | | - | - | 5 | 4 | 1 | - | - | - | 4 | 1 | 0 | 1 | 1 | 0 | 0 | - | 0 | 0 | 0 | - | 0 |
| **Hotspots** | - | - | - | - | | - | - | 4 | 4 | 0 | - | - | - | 3 | 1 | 0 | 0 | 1 | 0 | 0 | - | 0 | 0 | 0 | - | 0 |
| **Northeast** | | | | | | | | | | | | | | | | | | | | | | | | |
| BH13 | | Not surveyed | | Gravelly fil | | 0-0.1 | 0-0.1 | 4.6 | 39.2 | - | - | - | - | - | - | - | - | - | <guidelines | - | - | - | - | - | - | - |
| | | | | Coke and sand fil | | 0.1-0.7 | 0.2-0.3 | **39** | **413.2** | 24 | 400 | 3400 | 3300 | **7100** | **1.6** | 5 | nd | 9 | <guidelines | - | - | nd | - | - | - | - |
| | | | | Red clay and weathered shale | | 0.7-1.0 | 0.9-1.0 | nd | 0.6 | - | - | - | - | - | nd | nd | nd | nd | | - | nd | - | - | - | - | - |
| | | | | Silty clay | | 1.0-1.5 | 1.2-1.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH14 | 317161.824 | 1247753.075 | 19.030 | Gravelly fill | | 0-0.1 | - | **5** | 32.8 | - | - | - | - | - | - | - | - | - | <guidelines | - | - | - | - | - | - | nd |
| | | | | Sand and coke fill | | 0.1-0.7 | 0.2-0.3 | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | <guidelines | nd | - | - | - | - | - | - |
| | | | | Red clay and weathered shale | | 0.7-1.5 | 0.9-1.0 | nd | 3.8 | - | - | - | - | - | **4.6** | nd | 26 | **48** | <guidelines | - | - | - | - | - | - | - |
| BH14A | 317162.5340 | 1247754.2870 | 18.890 | Silty clay, strong hydrocarbon odou | | 1.1-1.5 | 1.4 | nd | 0.7 (naphthalene | 9 | nd | nd | nd | nd | 0.4 | nd | nd | 0.6 | | | | nd | | | | |
| BH15 | 317179.131 | 1247760.045 | 18.810 | Gravelly fil | | 0-0.1 | 0-0.1 | **16** | 88.7 | - | - | - | - | - | - | - | - | - | <guidelines | - | - | - | - | - | - | - |
| | | | | Sand and coke fil | | 0.1-0.8 | 0.2-0.3 | **58** | **377.8** | nd | 90 | 2800 | 1500 | **4390** | nd | nd | nd | nd | <guidelines | nd | - | nd | - | - | - | - |
| | | | | Red clay & weathered shale | | 0.8-1.0 | 0.9-1.0 | 2.4 | 14.8 | - | - | - | - | - | nd | nd | nd | nd | | - | - | - | - | - | - | - |
| | | | | Clay and coke fill | | 1.0-2.0 | 1.4-1.5 | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| | | | | Clay and coke fill | | | 1.9-2.0 | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| BH16 | 317184.659 | 1247749.137 | 18.500 | Gravelly fill | | 0-0.1 | 0-0.1 | **11** | 80.6 | - | - | - | - | - | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - | - |
| | | | | Sand and rock fill | | 0.1-1.5 | 0.9-1.0 | nd | nd | - | - | - | - | - | nd | nd | nd | nd | <guidelines | nd | - | - | - | - | - | - |
| | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| TPD | 317191.694 | 1247755.693 | 18.8 | Ash fill | | 0-0.3 | 0.2 | **6.2** | 68.7 | - | - | - | - | - | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - | - |
| | | | | Sands | | 0.3-1.6 | 0.6 | nd | nd | - | - | - | - | - | nd | nd | nd | nd | <guidelines | nd | - | - | - | - | - | - |
| TPE | | Not surveyed | | Ash fill | | 0-0.5 | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| TP99 | 317214.570 | 1247774.179 | 19.420 | Ash and coke fill | | 0-0.5 | 0-0.1 | nd | nd | - | - | - | - | - | nd | nd | nd | nd | <guidelines | | - | - | - | - | - | - |
| | | | | Ash and coke fill | | | 0.2-0.3 | 1.2 | 11.8 | - | - | - | - | - | nd | nd | nd | nd | <guidelines | - | nd | - | nd | - | - | nd |
| MW42S | 332357.7440 | 6247737.6530 | 18.484 | Sandy silt | | 0-0.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clayey gravel fill | | 0.2-0.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy fill | | 0.5-1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silt / sand / clay fill | | 1.5-1.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW42D | 332356.4770 | 6247736.3090 | 18.529 | Sandy silt | | 0-0.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clayey gravel fill | | 0.2-0.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy fill | | 0.5-1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Clayey sand fill | | 1.5-2.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MG10 | 317156.8600 | 1247741.3200 | 18.800 | Black ash and ballast fill with sandy material, HC odours | | 0-0.4 | 0.2 | 1.8 | 24.70 | nd | nd | 1390 | 500 | **1890** | nd | nd | nd | nd | <guidelines | 8 | - | nd | nd | nd | nd | nd |
| | | | | Red/grey mottled highly plastic clay | | 0.5-0.6 | 0.6 | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| MG10B | 317157.4720 | 1247740.0010 | 18.820 | Reworked clay, low/med plast, firn | | 1.1-2.0 | 1.8 | 1.6 | 38.40 | nd | nd | nd | nd | nd | nd | nd | nd | nd | | | | nd | | | | |
| TP05 | 317185.5300 | 1247738.7300 | 18.440 | Gravelly sand and ash, clinker and coke fill, odou | | 0-0.3 | 0.25 | **158** | **4300.90** | - | - | - | - | - | - | - | - | - | | - | - | 8.1 | - | - | nd | - |
| | | | | Light brown low plasticity sandy clay fill | | 0.3-0.5 | 0.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | nd | chlordane 0.14 | nd | - | nd |
| | | | | Yellow medium sand | | 0.5-1.2 | 1.0 | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| | | | | Dark brown clayey sil | | 1.2-1.9 | 1.5 | nd | 4.50 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - | - |
| TP06 | 317189.0900 | 1247749.9500 | 18.530 | Gravelly sand fill with ash, clinker and coke, dark staining and odo | | 0-0.3 | 0.25 | **55** | **690.20** | - | - | - | - | - | - | - | - | - | | - | - | 20.5 | - | - | nd | - |
| | | | | Light brown/orange gravelly non plastic sandy clay fill with some clinker | | 0.3-0.5 | 0.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | | nd | - | - | - | - | - | - |
| | | | | Sandy clayey gravel of sandstone and clinker fil, black stains | | 0.5-1.4 | 1.0 | 0.7 | 6.00 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | nd | nd | nd | - | nd |
| | | | | Dark grey/brown clayey silt with slight stain in top 0.2m of stratum | | 1.4-2.3 | 1.5 | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| TP07 | 317201.1000 | 1247755.8200 | 18.890 | Degraded concrete slab | | 0-0.2 | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| | | | | Black dark/grey gravelly sand fill of predomi-ntly ash, coke and clinker | | 0.2-0.5 | 0.25 | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | nd | - |
| | | | | Gravelly clayey sand fill with brick fragments, sandstone and shale gravels | | 0.5-0.9 | 0.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | - | - | - | - | - |
| | | | | Grey/ red mottled sandy gravelly clay fill with sandstone and shale gravels | | 0.9-1.3 | 1.0 | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| | | | | Soft clayey silt | | 1.3-1.7 | 1.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | | - | - | - | - | - | - | - |
| TP08 | 317202.3200 | 1247766.1500 | 19.150 | Black gravelly fine to coarse sand fill of ash clinker and coke with odour | | 0-0.4 | 0.25 | **8.2** | 78.40 | - | - | - | - | - | - | - | - | - | | - | - | nd | - | - | nd | - |
| | | | | Light brown very sandy cobbley gravel of sandstone fill with slight odour | | 0.4-0.6 | 0.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | nd | nd | nd | - | nd |
| | | | | Grey with red mottles sandy gravelly (sandstone) clay fill | | 0.9-1.4 | 1.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | nd | - | - | - | - |
| | | | | Soft clayey silt | | 1.4-1.6 | 1.5 | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| TP09 | 317218.1000 | 1247779.2700 | 19.470 | Gravelly sand fill of ash clinker and coke, with odour | | 0-0.4 | 0.25 | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | nd | - |
| | | | | Gravelly cobbly sand (crushed sandstone) fill, black staining top 0.1m | | 0.4-0.6 | 0.5 | **5.4** | 68.00 | nd | nd | 290 | 180 | 470 | nd | nd | nd | nd | | - | - | - | - | - | - | - |
| | | | | Grey with orange/red mottles gravelly (shale) sandy clay | | 0.6-1.9 | 1.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | nd | - | - | - | - |
| | | | | Grey with orange/red mottles gravelly (shale) sandy clay | | | 1.5 | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| TP16 | 317172.6700 | 1247743.8900 | 18.600 | Gravelly (sandstone) cobbly sand fill of fine to coarse sandstor | | 0.2-0.6 | 0.3 | **6.9** | 55.20 | 13 | 60 | 760 | 460 | **1280** | **1.2** | 2.8 | 0.3 | 5.6 | <guidelines | - | - | - | - | - | - | - |
| | | | | As above but black stain and ta | | 0.6-1.5 | 1.0 | **39.4** | **425.10** | **166** | 320 | 5120 | 2200 | **7640** | **3.1** | 3.7 | 6.4 | **61.2** | <guidelines | nd | - | 0.6 | nd | nd | - | nd |
| **Total Samples Analysed** | - | - | - | - | | - | - | 33 | 33 | 18 | - | - | - | 18 | 26 | 26 | 26 | 26 | 23 | 12 | 2 | 14 | 6 | 5 | 6 | 7 |
| **Detects above criteria** | - | - | - | - | | - | - | 12 | 5 | 1 | - | - | - | 5 | 5 | 4 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Hotspots** | - | - | - | - | | - | - | 6 | 5 | 1 | - | - | - | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **South Central** | | | | | | | | | | | | | | | | | | | | | | | | |
| MW03S | 317137.911 | 1247683.304 | 18.380 | Sand and gravel fill | | 0-0.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Gravelly clay fill | | 0.5-2.0 | 1-1.1 | 1.4 | 10.9 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - | - |
| | | | | Sandy clay fill | | 2-2.5 | 2-2.1 | 0.5 | 2.7 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - | - |
| | | | | Silty clay | | 2.5-3.5 | 3-3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW03D | 317139.485 | 1247683.339 | 18.330 | Sand and gravel fill | | 0-0.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Gravelly clay fill | | 0.5-2.0 | 1-1.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy clay fill | | 2-2.5 | 2-2.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay | | 2.5-5.0 | 3-3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay | | | 4-4.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW04S | 317159.418 | 1247704.764 | 18.400 | Sand and gravel fill | | 0-0.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy clay fill | | 0.6-2.0 | 1-1.1 | nd | 1.3 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - | - |
| | | | | Silty clay fill | | 2-2.5 | 2-2.1 | nd | 3.6 | nd | nd | nd | nd | nd | **4** | nd | nd | nd | <guidelines | - | - | - | - | - | - | - |
| | | | | Sandy clay fill | | 2.5-3.5 | 3-3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW04D | 317158.641 | 1247703.451 | 18.370 | Sand and gravel fill | | 0-0.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy clay fill | | 0.6-2.0 | 1-1.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay fill | | 2-2.5 | 2-2.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy clay fill | | 2.5-5.5 | 3-3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW30 | 332317.9292 | 6247690.8620 | 18.363 | Topsoil | | 0-0.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty sandy clay fill, HC odour | | 0.1-0.9 | 0-0.45 | - | - | - | - | 113 (C16-C35 Aromatics) & 154 (Aliphatics) | | | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | Plastic clay possible odour | | 0.9-1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW31 | 332338.1760 | 6247713.4180 | 18.446 | Topsoil | | 0-0.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty sandy clay fill | | 0.1-0.9 | 0.5-0.95 | - | - | - | - | 50 (C16-C35 Aromatics) & 65 (Aliphatics) | | | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | Gravelly sandy clay fill, odour | | 0.9-1.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay | | 1.4-1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW32 | 332305.3280 | 6247667.5440 | 18.331 | Clay and gravel, topsoil | | 0-0.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay fill | | 0.1-0.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandstone fill | | 0.3-0.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy silty clay fill | | 0.6-1.5 | 1.2 | - | - | - | - | nd (C16-C35 Aromatics) & nd (Aliphatics) | | | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| TP03 | 317139.830 | 1247679.080 | 18.020 | Gravelly sand fill, ash and crushed sandstone with ballast, clinker, odour | | 0-0.3 | 0.25 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | nd | - |
| | | | | Gravelly (sandstone) clay with ballast and coke | | 0.3-1.5 | 0.5 | nd | 1.20 | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | Gravelly (sandstone) clay with ballast and coke | | | 1.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | nd | nd | - | nd |
| | | | | Dark grey non plastic clayey silt fill with strong HC-like odour | | 1.5-2.8 | 1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Dark grey non plastic clayey silt fill with strong HC-like odour | | | 2.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| TP04 | 317155.800 | 1247705.630 | 18.500 | Gravelly sand fill with coke, clinker, sandstone gravel and ash | | 0-0.5 | 0.25 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | nd | - |
| | | | | Orange/ light brown/ red mottled low plasticity gravelly (shale) clay | | 0.5-0.7 | 0.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | As above but with black odourous staining | | 0.7-0.8 | 0.7 | nd | 1.30 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | nd | nd | - | - |
| TP11 | 317158.910 | 1247723.560 | 18.590 | Brown/ black gravelly sand fill predomi-ntly ash and coke | | 0-0.3 | 0.2 | **6.2** | 62.80 | nd | nd | 850 | 510 | **1360** | nd | nd | nd | nd | <guidelines | - | - | - | - | - | nd | - |
| | | | | Yellow/orange very clayey sand with layer of dense coke gravel 0.2-0.3m | | 0.3-1.0 | 1.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | nd | nd | nd | - | nd |
| **Total Samples Analysed** | - | - | - | - | | - | - | 11 | 11 | 11 | - | - | - | 14 | 14 | 14 | 14 | 14 | 8 | 1 | 0 | 2 | 3 | 3 | 3 | 2 |
| **Detects above criteria** | - | - | - | - | | - | - | 1 | 0 | 0 | - | - | - | 1 | 1 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 |
| **Hotspots** | - | - | - | - | | - | - | 0 | 0 | 0 | - | - | - | 0 | 1 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 |

**Table 1 - Summary of All Data for Fill & Silty Clay Material - Macdonaldtown Gasworks Site**

| Sample Location | Easting (AMG) | Northing (AMG) | Elevation (mAHD) | Soil Profile | | Sample Depth (m) | Contaminants of Concern - Concentrations in mg/kg | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BaP | Total PAH | TPH (C6-C9) | TPH (C10-C14) | TPH (C15-C28) | TPH (C29-C36) | Total C10-C36 | Benzene | Toluene | Ethylbenzene | Total Xylenes | Metals | Cyanide (Total) | VOCs | Total Phenols | OCPs | OPPs | Asbestos | PCBs |
| Commercial / Industrial Landuse Guidelines (NEHF F / NSW EPA 1994 Service Station Guidelines) | | | | | | | 5 | 100 | 65 | - | - | - | 1000 | 1 | 130 | 50 | 25 | Various | 2500 | See BTEX | 42500 (phenol) | 50 (heptaclor)<br>50 (aldrin+dieldrin)<br>50 (chlordane)<br>1000 (DDT+DDE+DDD) | | | 50 |
| **Southwest** | | | | | | | | | | | | | | | | | | | | | | | | |
| BH01 | 317111.994 | 1247643.511 | 18.370 | Gravelly fill | | 0-0.1 | 0-0.1 | 3 | 21.3 | nd | 20 | 340 | 160 | 520 | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| | | | | Fine sand / rock fill | | 0.1-2.9 | 0.9-1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay | | 2.9-3.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay & coke fill (odourous) | | 3.2-3.5 | 3.3-3.4 | 0.9 | 31.6 | - | - | - | - | - | nd | nd | nd | nd | < guidelines | - | naphthalene = 2 | - | - | - | - | - |
| | | | | Silty clay | | 3.5-4.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH02 | 317107.419 | 1247666.818 | 18.420 | Red clay & decomposed shale | | 0-1.5 | 0-0.1 | **14** | **141.8** | - | - | - | - | - | - | - | - | - | < guidelines | - | - | nd | - | - | - | - |
| | | | | Red clay & decomposed shale | | | 0.2-0.3 | **35** | **203.4** | - | - | - | - | - | - | - | - | - | < guidelines | - | - | nd | nd | - | - | - |
| | | | | Red clay & weathered shale | | 1.5-2.1 | 2.0-2.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay, rock fragments, HC odour | | 2.1-3.0 | 2.5-2.6 | nd | 0.9 | 12 | 50 | nd | nd | 50 | nd | nd | nd | 5 | < guidelines | nd | - | - | - | - | - | - |
| | | | | Plastic clay and gravel (odourous) | | 3.0-3.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Silty clay (odourous) | | 3.3-4.0 | 3.3-3.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| VP01_01 | | | | - | | - | Surface | **5.9** | 93.5 | nd | nd | 420 | 550 | 995 | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| VP01_02 | | | | - | | - | Surface | **10** | **137.7** | nd | nd | 790 | 870 | **1685** | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| VP01_03 | | | | - | | - | Surface | **7.1** | **104.3** | nd | nd | 870 | 1100 | **1995** | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| VP01_04 | | | | - | | - | Surface | **15** | **219.4** | nd | nd | 830 | 1200 | **2055** | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| VP01_05 | | | | - | | - | Surface | 3.2 | 45.4 | nd | nd | 710 | 990 | **1725** | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| VP01_06 | Not surveyed - VP01 & VP02 located 15m directly south of remaining gasholder | | | - | | - | Surface | 10 | **134.1** | nd | nd | 1600 | 1500 | **3125** | nd | nd | nd | nd | **Pb=2140** | - | - | - | nd | - | - | - |
| VP02_01 | | | | - | | - | Surface | 2.5 | 44.8 | nd | nd | 520 | 700 | **1245** | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| VP02_02 | | | | - | | - | Surface | **12** | **258.3** | nd | nd | 1500 | 1100 | **2625** | nd | nd | nd | nd | **Pb=1510** | - | - | - | nd | - | - | - |
| VP02_03 | | | | - | | - | Surface | 3.3 | 68.9 | nd | nd | 420 | 490 | 935 | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| VP02_04 | | | | - | | - | Surface | **12** | **236.6** | nd | nd | 1300 | 1200 | **2525** | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| VP02_05 | | | | - | | - | Surface | 3.5 | 62.9 | nd | nd | 550 | 570 | **1145** | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| VP02_06 | | | | - | | - | Surface | 1.8 | 22.9 | nd | nd | 440 | 450 | 875 | nd | nd | nd | nd | < guidelines | - | - | - | nd | - | - | - |
| MW12S | 317108.660 | 1247661.840 | 19.990 | Sandy clay fill | | 0-3.0 | 0.8-1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW12D | 317108.480 | 1247659.800 | 20.020 | Sandy clay fill | | 0-1.4 | 1.4-1.5 | **7.7** | 68.2 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | nd | nd | - | - | - | - |
| | | | | Red plastic clay | | 1.4-10.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW13S | 317112.030 | 1247646.520 | 19.500 | Sandy clay and gravel fi | | 0-4.2 | 0.9-1.0 | **34.9** | **346** | nd | | 6444 | | **6444** | nd | nd | nd | nd | <guidelines | - | nd | 5.9 | - | - | - | - |
| MW13D | 317112.010 | 1247649.090 | 19.470 | Sandy clay fill | | 0-1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy clay (friable) fill | | 1.0-4.4 | 1.4-1.5 | 1 | 8.3 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | nd | nd | - | - | - | - |
| MW18D | 317106.550 | 1247671.160 | 19.490 | Sandy clay fill | | 0-1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW18D | 317106.550 | 1247671.160 | 19.490 | Red plastic clay | | 1.0-10.0 | 1.4-1.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | - | - | - | - |
| MG01 | 317116.340 | 1247667.860 | 18.530 | Sandy gravel fill and coke | | 0-0.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | nd | - |
| | | | | Red/grey mottled moderate plasticity clay fill | | 0.1-0.2 | 0.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | detected (fragment) | - |
| | | | | Brown/ yellow gravelly silty clay fill | | 0.2-0.7 | 0.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Grey/brown moderately plastic clay fill, odours, black ash pockets | | 1.3-1.5 | 1.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MG01 | 317116.340 | 1247667.860 | 18.530 | Black and white shale with coke gravel fill, HC odour | | 1.5-2.0 | 1.8 | 0.6 | 12.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | nd | nd | nd | - | nd |
| | | | | Brown, low plasticity silty clay fill, minor HC odours | | 2.0-2.6 | 2.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Brown low plasticity silty clay | | 2.6-3.2 | 2.8 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | Brown low plasticity silty clay | | | 3.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP01 | 317112.540 | 1247638.330 | 18.040 | Light brown gravelly (sandstone and concrete) sand fill | | 0-0.3 | 0.25 | 3.5 | 38.20 | nd | nd | 250 | 220 | 470 | nd | nd | nd | nd | - | - | - | - | - | - | nd | - |
| | | | | Brown/grey/red clayey gravelly (sandst, shale, concrete) sand fill, grey ash | | 0.3-1.4 | 1.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | Yellow, medium grained sandy gravelly clay | | 1.4-2.2 | 1.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | nd | nd | - | nd |
| | | | | Yellow, medium grained sandy gravelly clay | | | 2.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Brown very gravelly (sandstone shale) clayey sand | | 2.2-3.5 | 3.0 | 0.7 | 5.90 | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| TP02 | 317109.670 | 1247657.650 | 19.070 | Grey/black gravelly sand fill, ash, clinker and coke | | | 0.25 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | nd | - |
| | | | | Grey/black gravelly sand fill, ash, clinker and coke | | 0.1-1.2 | 0.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Grey/black gravelly sand fill, ash, clinker and coke | | | 1.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | Brown/orange gravelly clayey sand fill with patches of red sandy clay (1.4m) | | 1.2-1.7 | 1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Brown/dark gravelly sand with sandstone and bricks, clinker and cobbles | | 1.7-2.8 | 2.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Brown/orange very sandy gravelly (coke) clay fill with clay pipe | | 2.8-3.9 | 3.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| RP | 317122.828 | 1247676.764 | 18.370 | Gravelly clay, low plast, minor ash and ballast gravels | | 0-0.7 | - | | | | | | | | | | | | | | | | | | | |
| | | | | Reworked clay, low/med plast, firm | | 0.7-1.2 | - | | | | | | | | | | | | | | | | | | | |
| RP | 317122.828 | 1247676.764 | 18.370 | Sandy clay fill - ceramic piping | | 1.2-2.0 | 2.0 | **12.8** | **118.20** | nd | 120 | 930 | 680 | **1730** | nd | nd | nd | nd | <guidelines | - | - | nd | nd | nd | - | nd |
| RP | | Not surveyed | | Coal tar materia | | - | PIPE | **491** | **20890** | **70** | 4590 | 15200 | 4870 | **24660** | **2** | 3.6 | 1.1 | **47** | <guidelines | - | - | 7.6 | nd | nd | - | nd |
| **Total Samples Analysed** | - | - | - | - | | - | - | 30 | 30 | 27 | - | - | - | 27 | 28 | 28 | 28 | 28 | 24 | 2 | 4 | 21 | 5 | 3 | 4 | 3 |
| **Detects above criteria** | - | - | - | - | | - | - | 12 | 10 | 1 | - | - | - | 11 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **Hotspots** | - | - | - | - | | - | - | 6 | 2 | 0 | - | - | - | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Retaining Wall** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TP44 | 317129.984 | 1247742.866 | 20.180 | Ash fill | | 0-0.3 | 0.2-0.3 | **150** | **2472.4** | - | - | - | - | - | **15** | 16 | nd | 10 | <guidelines | - | - | 74 | - | - | - | - |
| | | | | Clay and sandstone fragments | | 0.3-2.1 | 2.0-2.1 | nd | nd | - | - | - | - | - | nd | nd | nd | nd | <guidelines | - | - | nd | - | - | - | - |
| TP1 | 332302.67 | 6247740.31 | 20.01 | Sandy gravel and topso | | 0-0.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Gravel, ash, coke, coal fill, odou | | 0.1-0.4 | 0.1-0.3 | **67** | **898.1** | nd | 190 | 6200 | 3000 | **9390** | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - | - |
| | | | | Gravelly sand with fine ash, bricks | | 0.4-0.7 | 0.5-0.6 | 1.3 | 15.6 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - | - |
| | | | | Plastic clay | | 0.7-1.9 | 0.8-0.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP2 | 332304.83 | 6247743.68 | 20.09 | Sandy, ash, gravel, coal, coke, bricks | | 0-0.4 | 0-0.2 | - | - | - | - | - | - | - | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | Powdery grey ash fill | | 0.4-0.5 | 0.4-0.5 | - | - | - | - | - | - | - | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | Plastic clay | | 0.5-1.7 | 0.8-1.0 | - | - | - | - | - | - | - | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| | | | | | | | 1.3-1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP3 | 332307.71 | 6247745.13 | 20.06 | Sandy gravel fil | | 0-0.2 | 0-0.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Ash, coal, coke (black and white | | 0.2-0.4 | 0.2-0.3 | 1.4 | 14.3 | **150** | 130 | 760 | 210 | **1100** | **3.2** | 10 | 2.8 | **179** | <guidelines | - | - | - | - | - | - | - |
| | | | | Powdery grey ash fill | | 0.4-0.7 | 0.4-0.6 | 0.4 | 4.3 | nd | nd | nd | nd | nd | nd | 1.6 | nd | nd | <guidelines | - | - | - | - | - | - | - |
| | | | | Plastic clay | | 0.7-1.5 | 0.8-0.9 | - | - | - | - | - | - | - | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| TP10 | 317184.32 | 1247770 | 20.1 | Grey/black gravelly sand, ash, coke, coal, bricks, rail rivets and rail sleeper | | 0-0.8 | 0.25 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | nd | - |
| | | | | Grey/black gravelly sand, ash, coke, coal, bricks, rail rivets and rail sleeper | | | 0.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Yellow medium sand with concrete boulder and some mild grey staining | | 0.95-1.3 | 1.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | nd | nd | nd | - | nd |
| | | | | Orange with grey mottles gravelly (shale) clay | | 1.3-1.7 | 1.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Grey sandy gravel (shale) | | 1.7-2.3 | 2.0 | 1 | 14.50 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | 2.2 | - | - | - | - | - | - |
| | | | | Orange with grey mottles gravelly (shale) clay | | 2.3-3.2 | 3.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP12 | 317123.57 | 1247736.37 | 20.13 | Gravelly (ash, concrete, sandstone, brick) sand | | 0-0.6 | 0.25 | **9.6** | **116.40** | nd | 180 | 1420 | 720 | **2320** | nd | nd | nd | nd | <guidelines | - | - | nd | - | - | detected | - |
| | | | | Gravelly (ash, concrete, sandstone, brick) sand | | | 0.5 | 1 | 11.40 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | nd | nd | - | nd |
| | | | | brick,concrete boulders, fibro sheet fragments | | 0.6-1.7 | 1.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP18 | 317109.12 | 1247729.32 | 19.84 | Gravelly (ash, concrete, sandstone, brick) sand, fibro sheet fragments | | 0-1.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | nd | - |
| | | | | Gravelly (ash, concrete, sandstone, brick) sand, metals, rubber, leather, fibro | | 0-1.2 | 1.2 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | 3 | - | nd | nd | nd | - | nd |
| | | | | Brown slightly sandy clay | | 1.5-2.6 | 1.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Samples Analysed** | - | - | - | - | | - | - | 11 | 11 | 9 | - | - | - | 9 | 15 | 10 | 10 | 10 | 11 | 3 | 0 | 6 | 3 | 3 | 3 | 3 |
| **Detects above criteria** | - | - | - | - | | - | - | 3 | 3 | 1 | - | - | - | 3 | 2 | 0 | 0 | 1 | 0 | 0 | - | 0 | 0 | 0 | 1 | 0 |
| **Hotspots** | - | - | - | - | | - | - | 2 | 2 | 0 | - | - | - | 1 | 2 | 0 | 0 | 1 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 |
| **Western Lot** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MW08D | 317079.530 | 1247715.480 | 19.540 | Sandy clay fill | | 0-0.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| VP03_01 | | | | - | | - | Surface | nd | nd | nd | nd | 180 | 180 | 397.5 | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |
| VP03_02 | | | | - | | - | Surface | 2 | 23.3 | nd | nd | 210 | 200 | 447.5 | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |
| VP03_03 | Not surveyed - VP03 located in north western corner, adjacent to fenceline of 43 Burren St | | | - | | - | Surface | 1.6 | 19.6 | nd | nd | 340 | 230 | 607.5 | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |
| VP03_04 | | | | - | | - | Surface | nd | 8.7 | nd | nd | 140 | 140 | 317.5 | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |
| VP03_05 | | | | - | | - | Surface | 1.8 | 19.5 | nd | nd | 260 | 270 | 567.5 | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |
| VP03_06 | | | | - | | - | Surface | nd | nd | nd | nd | 50 | 50 | 137.5 | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |
| TP13 | 317084.37 | 1247717.07 | 18.7 | Very gravelly sand fill of ash, clinker, burnt shale, coke, co | | 0-0.3 | 0.25 | **45.5** | **512.00** | nd | 190 | 6010 | 2670 | **8870** | nd | nd | nd | nd | <guidelines | - | - | 6.7 | - | - | nd | - |
| | | | | Brown non plastic friable silty clay with shale grav | | 0.4-0.6 | 0.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP14 | 317067.72 | 1247713.76 | 18.7 | Dark gravelly sand, ash, visual staining (ash) blac | | 0-0.25 | 0.25 | **7.4** | 94.70 | nd | 50 | 2770 | 680 | **3500** | nd | nd | nd | nd | <guidelines | - | - | nd | - | - | nd | - |
| | | | | Brown/orange low plasticity silty gravelly (shale) clay fill | | 0.25-0.8 | 0.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - | - |
| **Total Samples Analysed** | - | - | - | - | | - | - | 9 | 9 | 9 | - | - | - | 9 | 9 | 9 | 9 | 9 | 8 | 0 | 0 | 8 | 0 | 0 | 2 | 0 |
| **Detects above criteria** | - | - | - | - | | - | - | 2 | 1 | 0 | - | - | - | 2 | 0 | 0 | 0 | 0 | 0 | - | - | 0 | - | - | 0 | - |
| **Hotspots** | - | - | - | - | | - | - | 1 | 1 | 0 | - | - | - | 2 | 0 | 0 | 0 | 0 | 0 | - | - | 0 | - | - | 0 | - |
| **Western Drain Sediments** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OD01 | Not surveyed - In drain behind gasholders | | | - | | - | Surface | **10** | **125.9** | nd | nd | 1500 | 1700 | **3200** | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |
| OD02 | Not surveyed - drain south of gasholders | | | - | | - | Surface | **8.2** | 91.6 | nd | 160 | 700 | 980 | **1840** | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |
| OD03 | Not surveyed - S extremity of drain | | | - | | - | Surface | 4.8 | 54.3 | nd | 400 | 1600 | 1400 | **3400** | nd | nd | nd | nd | < guidelines | - | - | nd | - | - | - | - |

**BOLD** Concentration exceeds Commercial/Industrial Guidelines

**BOLD** Hotspot of contamination (conc exceeds criteria by 250%)

**Table 2 - Summary of All Data for Natural Soil - Macdonaldtown Gasworks Site**

| Sample Location | Easting (AMG) | Northing (AMG) | Elevation (mAHD) | Soil Profile | Sample Depth (m) | | Contaminants of Concern - Concentrations in mg/kg | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BaP | Total PAH | TPH (C6-C9) | TPH (C10-C14) | TPH (C15-C28) | TPH (C29-C36) | Total C10-C36 | Benzene | Toluene | Ethylbenzene | Total Xylenes | Metals | Cyanide (Total) | VOCs | Total Phenols | OCPs | OPPs | PCBs |
| Commercial / Industrial Landuse Guidelines (NEHF F / NSW EPA 1994 Service Station Guidelines) | | | | | | | 5 | 100 | 65 | - | - | - | 1000 | 1 | 130 | 50 | 25 | Various | 2500 | See BTEX | 42500 (phenol) | 50 (heptaclor)<br>50 (aldrin+dieldrin)<br>50 (chlordane)<br>1000 (DDT+DDE+DDD) | | 50 |
| **Gasholders** | | | | | | | | | | | | | | | | | | | | | | |
| BH03 | 317103.713 | 1247693.358 | 18.690 | Grey plastic clay | 1.5-2.8 | 2.4-2.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/orange clay, weathered shale | | 2.9-3.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/orange clay, weathered shale | 2.8-4.0 | 3.9-4.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH04 | 317103.564 | 1247699.228 | 18.780 | Red plastic clay, weathered shale | 2.5-3.0 | 2.5-2.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH06 | 317103.196 | 1247719.155 | 18.960 | Red clay & weathered shale | 2.2-3.1 | 3.0-3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW06S | 317103.196 | 1247719.155 | 18.960 | Red clay and weathered shale | 2.2-3.5 | 3-3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW06D | 317102.514 | 1247720.496 | 18.970 | Red clay and weathered shale | 2.2-7.0 | 3.0-3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Shale | 7.0-15.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW07D | 317102.910 | 1247692.360 | 19.590 | Plastic clay becoming weathered shale | 4.0-11.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Shale | 11.0-12.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MG02 | 317122.410 | 1247701.920 | 18.680 | Red/ yellow mottled, med plastic clay becoming shale, HC odour | | 2.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/ yellow mottled, med plastic clay becoming shale, HC odour | | 2.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/ yellow mottled, med plastic clay becoming shale, HC odour | | 3.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/ yellow mottled, med plastic clay becoming shale, HC odour | | 3.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/ yellow mottled, med plastic clay becoming shale, HC odo | 2.0-4.7 | 4.7 | nd | 1.20 | 4 | nd | nd | nd | nd | 0.3 | nd | nd | nd | - | - | - | - | - | - | - |
| MG05 | 317110.820 | 1247701.920 | 18.730 | Red/grey mottled, stiff, very high HC odou | | 1.8 | 2.2 | **288.50** | **118** | 2100 | 940 | nd | **3040** | nd | 5.6 | 15 | **80.4** | <guidelines | - | - | nd | nd | nd | nd |
| | | | | Red/grey mottled, stiff, very high HC odour | | 3.4 | nd | 43.80 | - | - | - | - | - | - | - | - | - | - | - | - | nd | - | - | - |
| | | | | Red/grey mottled, stiff, very high HC odour | 1.3-5.0 | 5.0 | nd | 65.10 | **92** | 580 | 740 | nd | **1320** | nd | 7.3 | 3.9 | **35** | - | - | - | - | - | - | - |
| MG07 | 317103.960 | 1247696.520 | 18.740 | Red/yellow mottled, low plasticity sandy clay | 3.0-4.0 | 4.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | nd | nd | nd |
| BHA | 317118.7690 | 1247672.5610 | 18.4600 | Red/grey mottled weathered shale clay, dark stains, strong HC odour | 4.0-6.0 | 5.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| | | | | Weathered shale with red ironstone gravelly fracturing, dark stains, odours | | 7.0 | nd | nd | nd | nd | nd | nd | nd | 0.4 | nd | nd | nd | - | | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, dark stains, odours | 6.0-10.2 | 10.2 | nd | 3.5 (naphthalene) | nd | nd | nd | nd | nd | 0.3 | nd | nd | nd | - | | | nd | | | |
| BHA1 | 317119.2270 | 1247671.6640 | 18.4100 | Weathered shale with red ironstone gravelly fracturing, dark stains, odours | | 7.0 | nd | nd | nd | nd | nd | nd | nd | **1.6** | nd | nd | nd | - | | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, dark stains, odours | 6.0-10.2 | 10.2 | nd | nd | nd | nd | nd | nd | nd | **1.4** | **nd** | nd | nd | - | | | nd | | | |
| BHA2 | 317119.7780 | 1247670.6760 | 18.4800 | Weathered shale with red ironstone gravelly fracturing, dark stains, odours | | 7.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, dark stains, odours | 6.0-10.2 | 10.2 | nd | nd | nd | nd | nd | nd | nd | 0.9 | nd | nd | nd | - | | | nd | | | |
| BHB | 317125.2230 | 1247689.8230 | 18.4900 | Red/grey mottled weathered shale clay, high odour | 3.0-6.5 | 6.0 | nd | 5.9 (naphthalene) | 4 | nd | nd | nd | nd | **2** | nd | 0.5 | 0.9 | - | | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, odou | 6.5-9.6 | 9.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | | | nd | | | |
| BHC | 317122.0140 | 1247714.1410 | 18.7800 | Brick annulus, free tar, wet, very high odour | 5.5- 6.5 | 6.0 | **17.6** | **1906.4** | **559** | 5440 | 2610 | 710 | **8760** | **6.4** | 38.7 | 40.8 | **246.7** | - | | | 2.3 | | | |
| BHC1 | 317122.9830 | 1247714.5220 | 18.7500 | Weathered shale with red ironstone gravelly fracturing, dark stains, odou | 7.2-8.0 | 8.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | | | nd | | | |
| BHD | 317107.9530 | 1247721.7750 | 18.8600 | Red/grey mottled weathered shale clay, wet, HC odour, tar visit | 6.5-8 | 7.0 | nd | nd | 8 | nd | nd | nd | nd | **5.4** | 0.2 | 0.7 | 1.6 | - | | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, odou | 8.0-8.4 | 8.4 | nd | nd | 9 | nd | nd | nd | nd | **7.5** | 0.9 | nd | 0.8 | - | | | 11.4 | | | |
| **Total Samples Analysed** | | | | | | | 18 | 18 | 17 | - | - | - | 17 | 17 | 17 | 17 | 17 | 2 | 0 | 0 | 15 | 2 | 2 | 2 |
| **Detects above criteria** | | | | | | | 1 | 2 | 3 | - | - | - | 3 | 6 | 0 | 0 | 3 | 0 | - | - | 0 | 0 | 0 | 0 |
| **Hotspots** | | | | | | | 1 | 2 | 1 | - | - | - | 2 | 3 | 0 | 0 | 2 | 0 | - | - | 0 | 0 | 0 | 0 |
| **Retort** | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH07 | 317118.681 | 1247729.832 | 18.710 | Red clay, weather shale (odourous) | 2.0-3.0 | 2.9-3.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH08 | 317125.080 | 1247723.696 | 18.580 | Grey compacted clay / shale | 2.5-4.0 | 3.5-3.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW37D | 332300.9170 | 6247724.1940 | 18.615 | Plastic silty clay fill | 2.5-9.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Clay and shale | 9.0-12.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH12 | 317151.071 | 1247716.220 | 18.670 | Red clay and weathered shale | 3.1-4.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Plastic clay | 4-4.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Compacted clay (slight odour | 4.1-4.5 | 4.4-4.5 | **8.4** | **224.4** | 9 | 300 | 420 | nd | 720 | **1** | 3 | nd | 4 | - | nd | - | 34.2 | - | - | - |
| BH12A | 317150.333 | 1247715.24 | 18.63 | Clay red/grey mottled, med plast, stiff - visible tar in pon | 3.5-5 | 4.2 | **13.9** | **515.6** | **228** | 1190 | 3350 | 810 | **5350** | **20** | 53 | 8.3 | **94.9** | - | 4.6 | | 6.9 | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing | 5-9.2 | 6.0 | nd | nd | nd | nd | nd | nd | nd | 0.2 | nd | nd | nd | - | | | nd | | | |
| MG06 | 317121.6000 | 1247725.1500 | 18.950 | Red/green mottled low plasticity clay, high HC odour, tar in pores | | 2.0 | 0.8 | **101.50** | 41 | 620 | 980 | nd | **1600** | nd | 2.5 | 6.9 | 22.7 | <guidelines | - | - | nd | nd | nd | nd |
| | | | | Red/green mottled low plasticity clay, high HC odour | | 3.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/green mottled low plasticity clay, high HC odour | 2.0-4.7 | 4.7 | nd | 6.10 | 6 | nd | nd | nd | nd | nd | nd | 0.5 | 1.4 | <guidelines | 2.1 | - | - | - | - | - |
| MG08 | 317142.7700 | 1247736.0700 | 18.700 | Red/grey mottled highly plastic clay, visible tar in pores | 2.5-3.5 | 3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Grey/ white moderate plasticity weathered shale clay, faint HC odour | 3.5-4.0 | 4.0 | nd | 8.40 | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| MG09B | 317141.1300 | 1247722.6100 | 18.735 | Red/grey mottled moderate plasticity clay | 1.7-2.5 | 2.5 | nd | 0.70 | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| MG09C | 317134.4800 | 1247721.2700 | 18.735 | Brown/green low plasticity silty clay becoming shale, high HC odo | 1.9-3.8 | 3.8 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - |
| MG10A | 317150.4400 | 1247736.7200 | 18.850 | Red/grey highly plastic clay becoming weathered shale cl | | 2.8 | **6.3** | **206.90** | 56 | 760 | 3060 | 250 | **4070** | **1.1** | 1.9 | 6.3 | 18.9 | <guidelines | - | - | nd | nd | nd | nd |
| | | | | Red/grey highly plastic clay becoming weathered shale cl | 2.3-4.0 | 4.0 | nd | 0.70 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | - | - | - |
| TP15 | 317145.9700 | 1247729.6300 | 18.780 | Red/grey mottled moderate plasticity clay, tar in pon | | 2.8 | **10.8** | **426.20** | **107** | 450 | 1400 | 240 | **2090** | **1.8** | 10.9 | 17.5 | **56.2** | <guidelines | 1.9 | - | - | nd | nd | - |
| | | | | Red/grey mottled moderate plasticity clay to weathered shale, tar in poi | 2.5-4.1 | 4.1 | 0.5 | 18.10 | **65** | nd | nd | nd | nd | **2.7** | 10.6 | 4.9 | 24.8 | <guidelines | - | - | - | nd | nd | - |
| TP15A | 317146.377 | 1247729.433 | 18.8 | Weathered shale with red ironstone gravelly fracturing, free tar, odours | | 6.0 | nd | 0.8 (naphthalene) | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | nd | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing | 5.0-8.0 | 7.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | nd | | nd | | | |
| BHC2 | 317128.9550 | 1247714.3230 | 18.6600 | Weathered shale with red ironstone gravelly fracturing, dark stains, odours | | 6.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, odours | 4.8-8.0 | 8.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | | | nd | | | |
| BHG | 317117.2880 | 1247724.5790 | 18.6100 | Red/grey mottled moderate plasticity clay, tar in pores, high odours | 4.8-6.0 | 6.0 | 1 | 76.6 | 24 | 160 | 220 | nd | 380 | **2.4** | 4.1 | 1.3 | 8.7 | - | nd | | 7.4 | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, dark stains, odours | | 7.2 | nd | 12.3 | 8 | nd | nd | nd | nd | nd | nd | 0.4 | 1.6 | - | | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, odours | 6.0-8.1 | 8.1 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | | | nd | | | |
| MG09A1 | 317134.074 | 1247734.848 | 18.44 | Red/grey mottled weathered shale clay, slight odour | | 3.6 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | nd | | nd | | | |
| | | | | Red/grey mottled weathered shale clay, slight odour | 2.0-5.0 | 4.8 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | nd | | nd | | | |
| **Total Samples Analysed** | | | | | | | 21 | 21 | 21 | - | - | - | 21 | 21 | 21 | 21 | 21 | 7 | 9 | 0 | 15 | 4 | 4 | 2 |
| **Detects above criteria** | | | | | | | 4 | 5 | 3 | - | - | - | 4 | 6 | 0 | 0 | 2 | 0 | 0 | - | 0 | 0 | 0 | 0 |
| **Hotspots** | | | | | | | 1 | 2 | 1 | - | - | - | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Gas Purifier** | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH11 | 317140.501 | 1247707.420 | 18.560 | Grey clay | 2.3-2.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Stiff weathered clay | 2.8-3.9 | 3.0-3.1 | - | - | - | - | - | - | - | - | - | - | - | <guidelines | nd | - | - | - | - | - |
| BH18 | 317129.119 | 1247706.185 | 18.680 | Red clay and weathered shale (odour) | 2.5-4.0 | 2.9-3.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red clay and weathered shale (odour) | | 3.9-4.0 | nd | 1.8 | - | - | - | - | - | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - |
| MG11 | 317138.230 | 1247707.260 | 18.600 | Red/grey mottled very firm clay | 3.2-4.0 | 4.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | nd | - | - | - |
| BHE | 317131.9540 | 1247692.9320 | 18.5000 | Red/grey mottled weathered shale clay, slight odour | 2.5-5.0 | 3.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | 1.6 | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, odours | 5.0-8.4 | 8.4 | nd | 1.9 (naphthalene) | nd | nd | nd | nd | nd | 1.6 | 0.2 | nd | nd | - | nd | | nd | | | |
| BHF | 317135.8890 | 1247701.0570 | 18.5600 | Red/grey mottled weathered shale clay, slight odour | 2.4-5.5 | 3.6 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | nd | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, free tar, odours | | 7.0 | nd | 0.8 (naphthalene) | 7 | nd | nd | nd | nd | 0.8 | 0.4 | nd | 1 | - | nd | | nd | | | |
| | | | | Weathered shale with red ironstone gravelly fracturing, free tar, odours | 5.5-9.0 | 8.5 | 1.1 | **134.6** | 22 | 650 | 510 | 100 | **1260** | 0.8 | nd | 1.9 | 9.8 | - | nd | | nd | | | |
| **Total Samples Analysed** | | | | | | | 7 | 7 | 6 | - | - | - | 6 | 7 | 7 | 7 | 7 | 3 | 7 | 0 | 6 | 0 | 0 | 0 |
| **Detects above criteria** | | | | | | | 0 | 1 | 0 | - | - | - | 1 | 1 | 0 | 0 | 0 | 0 | 0 | - | 0 | - | - | - |
| **Hotspots** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | - | - | - |
| **Northeast** | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH13 | | Not surveyed | | Clay and weathered shale | 1.5-2.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Plastic clay | 2.0-3.9 | 3.0-3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH14 | 317161.824 | 1247753.075 | 19.030 | Red clay | 1.5-2.5 | 2.2-2.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Grey plastic clay | 2.5-3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Sandy silty clay, very odorous | 3.1-4.1 | 3.9-4.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | White clayey sand, crumbly | 4.1-5.1 | 4.9-5.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH14A | | | | | | 2.4 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | | | nd | | | |
| BH15 | 317179.131 | 1247760.045 | 18.810 | Plastic clay | 2.0-2.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | White clayey sand, crumbly | 2.5-4.2 | 4.1-4.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH16 | 317184.659 | 1247749.137 | 18.500 | Plastic clay and gravel | 1.5-2.2 | 2.0-2.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Plastic clay | 2.2-3.1 | 2.6-2.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Plastic clay | | 3.0-3.1 | nd | nd | - | - | - | - | - | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - |
| | | | | Weathered shale | 3.1-4.1 | 4.0-4.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP99 | 317214.570 | 1247774.179 | 19.420 | Clay | 0.5-2.1 | 2.0-2.1 | nd | nd | - | - | - | - | - | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - |
| MW42S | 332357.7440 | 6247737.6530 | 18.484 | Silty clay | 1.9-4.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW42D | 332356.4770 | 6247736.3090 | 18.529 | Sandy silty clay | 2.3-12.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MG10B | 317157.4720 | 1247740.0010 | 18.820 | Red/grey mottled weathered shale clay | | 3.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | | | | nd | | | |
| TP05 | 317185.5300 | 1247738.7300 | 18.440 | Red/brown firm clay | 1.9-2.0 | 2.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| TP06 | 317189.0900 | 1247749.9500 | 18.530 | Red/brown with grey mottles higly plastic clay | 2.3-2.7 | 2.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| TP07 | 317201.1000 | 1247755.8200 | 18.890 | Grey with red/brown mottles firm clay | 1.7-2.2 | 2.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| TP08 | 317202.3200 | 1247766.1500 | 19.150 | Grey with red mottles very firm clay | 1.9-2.0 | 2.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - |
| TP09 | 317218.1000 | 1247779.2700 | 19.470 | Grey with red mottles very firm clay | 2.4-2.6 | 2.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - |
| TP16 | 317172.6700 | 1247743.8900 | 18.600 | Red/grey mottled very firm clay | 1.5-3.8 | 3.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | nd | - | - | - |
| **Total Samples Analysed** | | | | | | | 10 | 10 | 8 | - | - | - | 8 | 10 | 10 | 10 | 10 | 5 | 1 | 0 | 3 | 0 | 0 | 0 |
| **Detects above criteria** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | - | - | - |
| **Hotspots** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | - | - | - |

**Table 2 - Summary of All Data for Natural Soil - Macdonaldtown Gasworks Site**

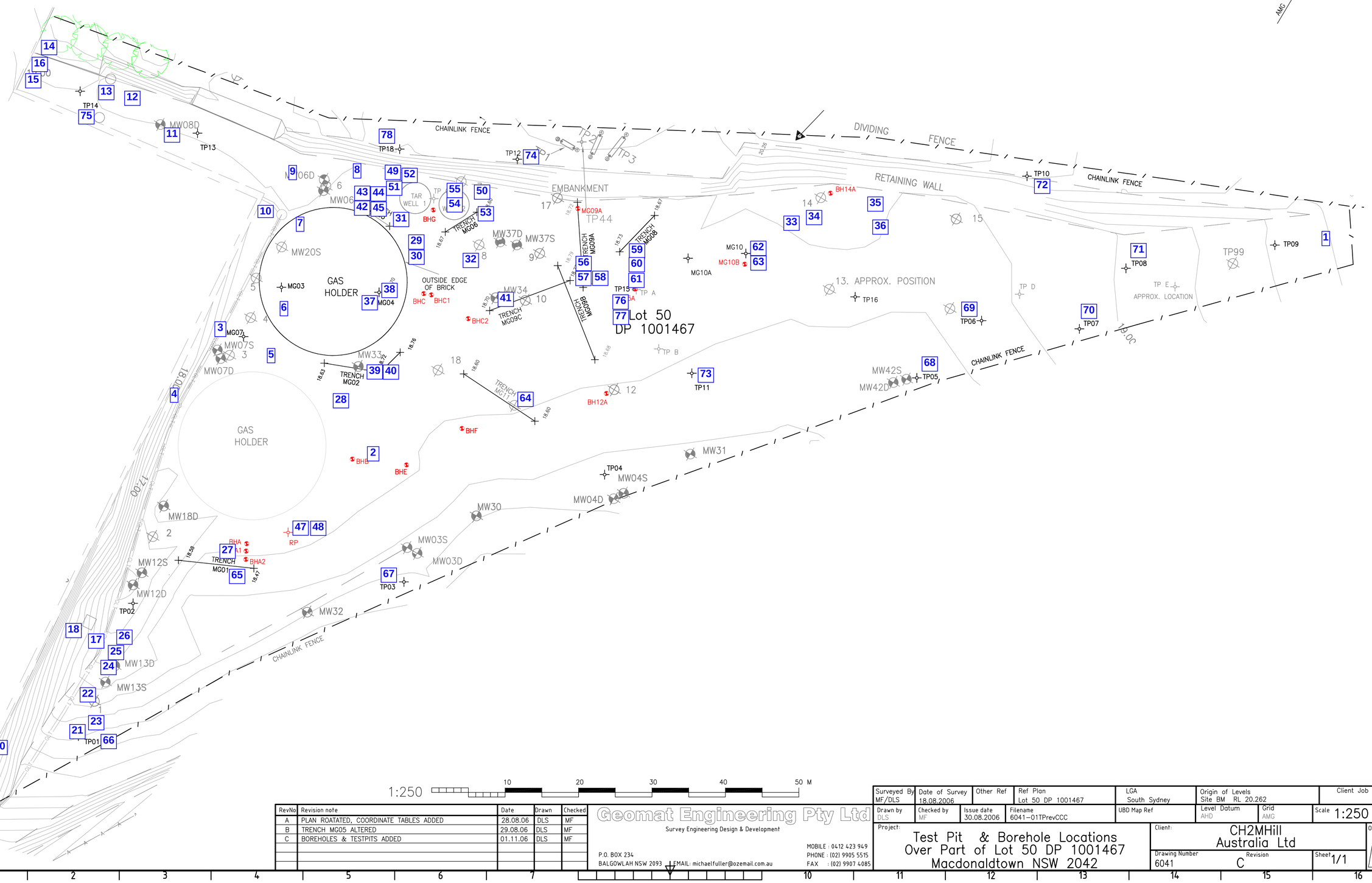
| Sample Location | Easting (AMG) | Northing (AMG) | Elevation (mAHD) | Soil Profile | Sample Depth (m) | | Contaminants of Concern - Concentrations in mg/kg | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BaP | Total PAH | TPH (C6-C9) | TPH (C10-C14) | TPH (C15-C28) | TPH (C29-C36) | Total C10-C36 | Benzene | Toluene | Ethylbenzene | Total Xylenes | Metals | Cyanide (Total) | VOCs | Total Phenols | OCPs | OPPs | PCBs |
| Commercial / Industrial Landuse Guidelines (NEHF F / NSW EPA 1994 Service Station Guidelines) | | | | | | | 5 | 100 | 65 | - | - | - | 1000 | 1 | 130 | 50 | 25 | Various | 2500 | See BTEX | 42500 (phenol) | 50 (heptaclor)<br>50 (aldrin+dieldrin)<br>50 (chlordane)<br>1000 (DDT+DDE+DDD) | | 50 |
| **South Central** | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW03D | 317139.485 | 1247683.339 | 18.330 | Siltstone | 5.0-11.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Shale | 11.0-13.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW04D | 317158.641 | 1247703.451 | 18.370 | Siltstone | 5.5-10.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Shale | 10-11.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP03 | 317139.830 | 1247679.080 | 18.020 | Red/brown with grey mottles plastic silty clay, strong HC odour | | 3.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/brown with grey mottles plastic silty clay, strong HC odour | 2.8-4.0 | 4.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| TP04 | 317155.800 | 1247705.630 | 18.500 | Wet soft clayey silt, slight odour | 2.0-2.9 | 2.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/ brown grey mottled slightly sandy clay, slight odour | 2.9-3.1 | 3.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| TP11 | 317158.910 | 1247723.560 | 18.590 | Grey with red mottles very firm clay | 3.2-4.0 | 3.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| **Total Samples Analysed** | | | | | | | 3 | 3 | 3 | - | - | - | 3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Detects above criteria** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - |
| **Hotspots** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - |
| **Southwest** | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH01 | 317111.994 | 1247643.511 | 18.370 | Red clay / weathered shale | 4.0-4.5 | 4.0-4.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BH02 | 317107.419 | 1247666.818 | 18.420 | Red clay, compacted, hard | 4.0-4.5 | 4.4-4.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| MW12S | 317108.660 | 1247661.840 | 19.990 | Red plastic clay | 3.0-5.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW12D | 317108.480 | 1247659.800 | 20.020 | Shale | 10.0-12.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW13S | 317112.030 | 1247646.520 | 19.500 | Red plastic clay | 4.2-5.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW13D | 317112.010 | 1247649.090 | 19.470 | Plastic clay | 4.4-10.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Shale | 10.0-12.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW18D | 317106.550 | 1247671.160 | 19.490 | Shale bedrock | 10.0-12.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MG01 | 317116.340 | 1247667.860 | 18.530 | Red/ grey mottled highly plastic clay becoming shale, feint HC odour | | 3.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Red/ grey mottled highly plastic clay becoming shale, feint HC odour | 3.3-5.0 | 5.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| TP02 | 317109.670 | 1247657.650 | 19.070 | Light grey with red mottles non-plastic firm clay | 3.9-4.3 | 4.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | | | Brown fine to coarse gravelly sand, coke and ash present, strong HC odour | | 4.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| | | | | Brown fine to coarse gravelly sand, coke and ash present, strong HC odour | 4.3-4.5 | 4.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | nd | nd | - |
| **Total Samples Analysed** | | | | | | | 4 | 4 | 4 | - | - | - | 4 | 4 | 4 | 4 | 4 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| **Detects above criteria** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | 0 | 0 | - |
| **Hotspots** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | 0 | 0 | - |
| **Retaining Wall** | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP10 | 317184.32 | 1247770 | 20.1 | Grey with red mottles very firm clay, shale gravels at top | 3.2-4.1 | 4.0 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - |
| TP18 | 317109.12 | 1247729.32 | 19.84 | Red/ grey mottled clay | | 3.2 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | - | - | - | - |
| | | | | Red/ grey mottled clay | 2.6-4.4 | 4.4 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | - | - | - | - |
| **Total Samples Analysed** | | | | | | | 3 | 3 | 3 | - | - | - | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| **Detects above criteria** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - |
| **Hotspots** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - |
| **Western Lot** | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MW08D | 317079.530 | 1247715.480 | 19.540 | Red clay becoming weathered shale | 0.4-11.0 | 1.4-1.5 | 0.7 | 5.6 | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | - | - | - |
| MW08D | 317079.530 | 1247715.480 | 19.540 | Shale | 11.0-12.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TP13 | 317084.37 | 1247717.07 | 18.7 | Orange/yellow red mottled non plastic silty clay | 0.6-1.3 | 1 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| | | | | Red/grey mottled very firm clay | 1.3-1.7 | 1.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | - | - | - | - | - | - | - |
| TP14 | 317067.72 | 1247713.76 | 18.7 | Orange/brown with red mottles slightly silty clay | 0.8-1.2 | 1 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | - | - | nd | - | - | - |
| | | | | Red/grey mottled slightly silty clay | 1.2-1.8 | 1.5 | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | <guidelines | nd | - | - | - | - | - |
| **Total Samples Analysed** | | | | | | | 5 | 5 | 5 | - | - | - | 5 | 5 | 5 | 5 | 5 | 3 | 1 | 0 | 2 | 0 | 0 | 0 |
| **Detects above criteria** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | - | - | - |
| **Hotspots** | | | | | | | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | - | - | - |

**BOLD** Concentration exceeds Commercial/Industrial Guidelines

**BOLD** Hotspots of contamination (conc exceeds criteria by 250%)

# Appendix A
# Site Photographic Record and Locations

# Macdonaldtown Gasworks - Photograph Locations




1:250 — 10 20 30 40 50 M

| RevNo | Revision note | Date | Drawn | Checked |
|---|---|---|---|---|
| A | PLAN ROATATED, COORDINATE TABLES ADDED | 28.08.06 | DLS | MF |
| B | TRENCH MG05 ALTERED | 29.08.06 | DLS | MF |
| C | BOREHOLES & TESTPITS ADDED | 01.11.06 | DLS | MF |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| | | | | | | |
|---|---|---|---|---|---|---|
| Surveyed By MF/DLS | Date of Survey 18.08.2006 | Other Ref | Ref Plan Lot 50 DP 1001467 | LGA South Sydney | Origin of Levels Site BM RL 20.262 | Client Job Number |
| Drawn by DLS | Checked by MF | Issue date 30.08.2006 | Filename 6041–01TPrevCCC | UBD Map Ref | Level Datum AHD / Grid AMG | Scale 1:250 |

Project: Test Pit & Borehole Locations Over Part of Lot 50 DP 1001467 Macdonaldtown NSW 2042

Client: CH2MHill Australia Ltd

Drawing Number 6041 — Revision C — Sheet 1/1 — Original Sz A1

**Photo 1** (Dec 06) – Overall view of the site, looking west

**Photo 2** (Dec 06) – The existing (southern) gasholder

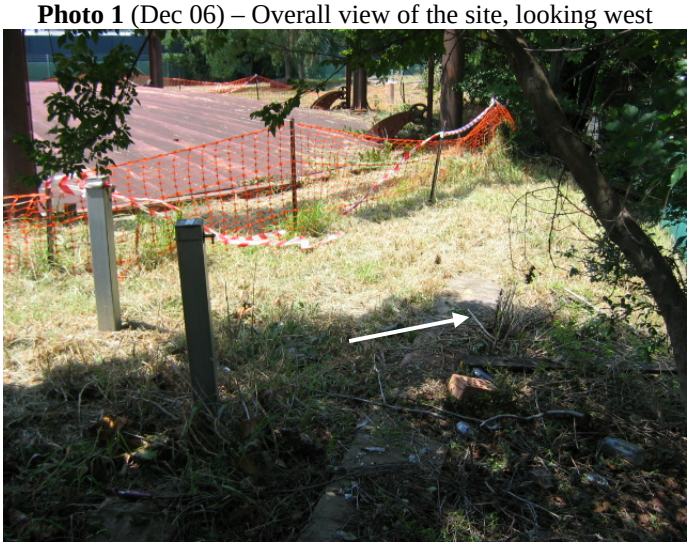

**Photo 3** (Dec 06) – Communications cables located within ground level concrete trough, behind gasholder annuli (2m from fence which adjoins Burren St properties)

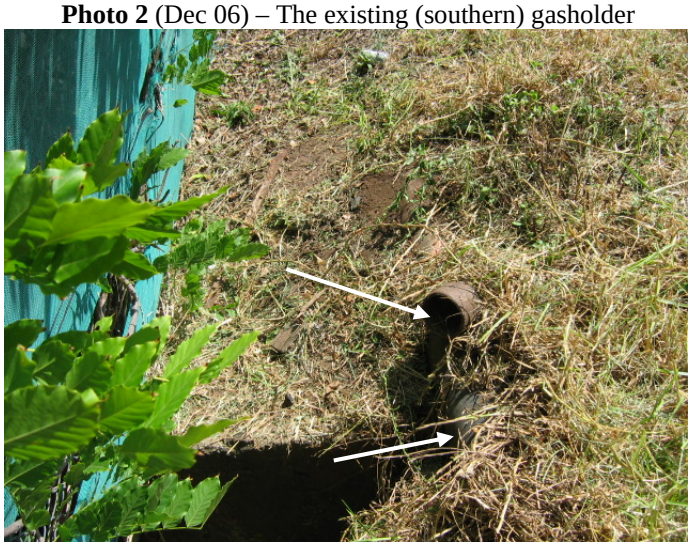

**Photo 4** (Dec 06) – Sydney Water sewer line located under embankment (1m from fence which adjoins Burren St properties). Disused gasworks pipework also buried in embankment

**Photo 5** (Dec 06) – Concrete structure appears to be buried between the two gasholder annuli

**Photo 6** (Dec 06) – Annulus of demolished gasholder remains in situ, to the north of the existing gasholder

**Photo 7** (Dec 06) – Cable pit (0.5m deep) which services communications cables, is located within 0.5m of the northern gasholder annulus (immediately behind 43 Burren St)

**Photo 8** (Dec 06) – Low brick wall and concrete / tiled structure in the north west site area

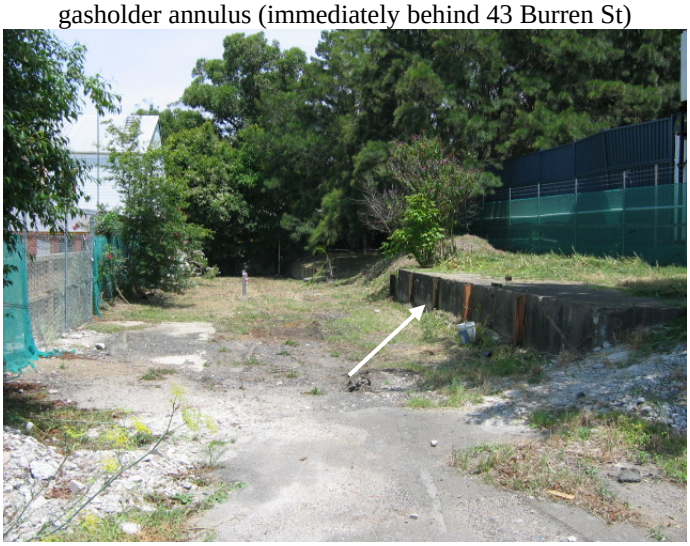

**Photo 9** (Dec 06) – Concrete structure in the north west site area

**Photo 10** (Dec 06) – Pipework fitting located next to concrete troughing behind 43 Burren St

**Photo 11** (Dec 06) – Cable pits servicing communications cables next to 43 Burren St (in north west site area)

**Photo 12** (Dec 06) – Buried concrete / brick structure in north west site area

**Photo 13** (Dec 06) – Concrete retaining wall (with steel rails)

**Photo 14** (Dec 06) – Additional level of brickwork on top of retaining wall area

**Photo 15** (Dec 06) – Note difference in levels in north west area. Site is level with Burren Street, however area on top of retaining wall (and Stabling Yard surface level) is ~1.5m higher

**Photo 16** (Dec 06) – Cable pit servicing communications cables in north west site area

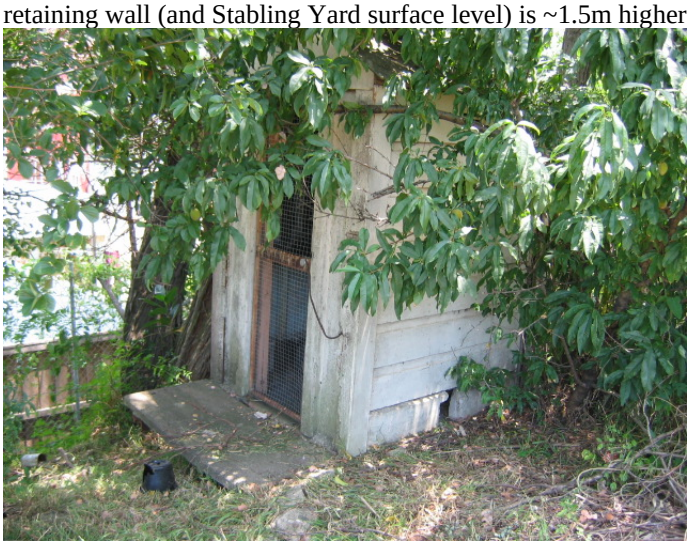

**Photo 17** (Dec 06) – Old electrical shed on embankment, south of the existing gasholder

**Photo 18** (Dec 06) – Old electrical shed on embankment, south of the existing gasholder

**Photo 19** (Dec 06) – Sydney Water sewer pit located in south west corner of site

**Photo 20** (Dec 06) – Open drain located between western fenceline, and rear of Burren St properties. Drain is in poor condition and overgrown, and lies approx 1m below embankment level

**Photo 21** (Dec 06) – Trees located to the south of the existing gasholder

**Photo 22** (Dec 06) – Trees located along top of embankment, in south western site area

**Photo 23** (Dec 06) – Tree located in south western corner of site

**Photo 24** (Dec 06) – Trees located across embankment, to the south of the existing gasholder

**Photo 25** (Dec 06) - Trees and weeds located across embankment, to the south of the existing gasholder

**Photo 26** (Dec 06) – Large tree located next to old electrical shed, south of existing gasholder

**Photo 27** (Dec 06) - Trees located to the south of the existing gasholder

**Photo 28** (Dec 06) – Trees located east of the existing gasholder

**Photo 29** (Dec 06) – The annulus of the northern gasholder, and trees located behind 37 – 43 Burren St

**Photo 30** (Dec 06) – Trees located behind 31-35 Burren St (double storey buildings)

**Photo 31** (Dec 06) – Trees located in north west site area

**Photo 32** (Dec 06) – Embankment and trees located along northern site boundary (adjacent to stabling yard)

**Photo 33** (Dec 06) – Some waste materials on site

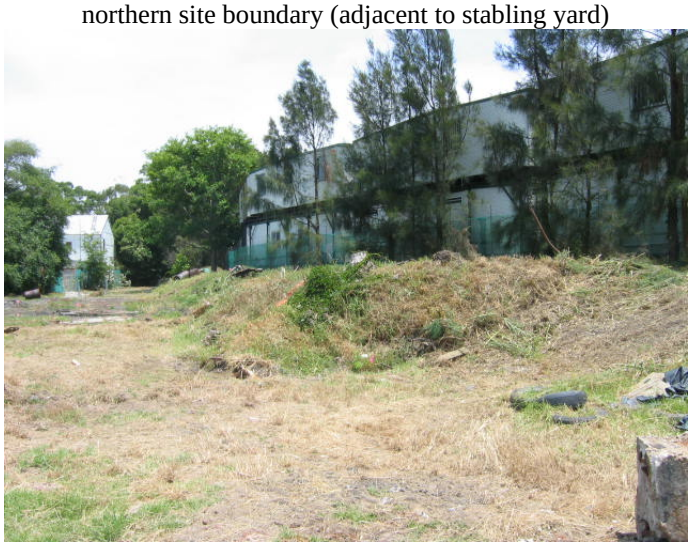

**Photo 34** (Dec 06) – Embankment and waste materials in northern site area (adjacent to stabling yard)

**Photo 35** (Dec 06) – Embankment along boundary of north eastern site area

**Photo 36** (Dec 06) – The eastern site area

**Photo 37** (Aug 06) – Demolition materials and significant perched water within northern gasholder annulus (MG04)

**Photo 38** (Aug 06) – Waste materials within testpit MG04, inside northern gasholder annuli

**Photo 39** (Aug 06) – Tar pipe and fill layers in testpit MG02, between the two gasholder annuli

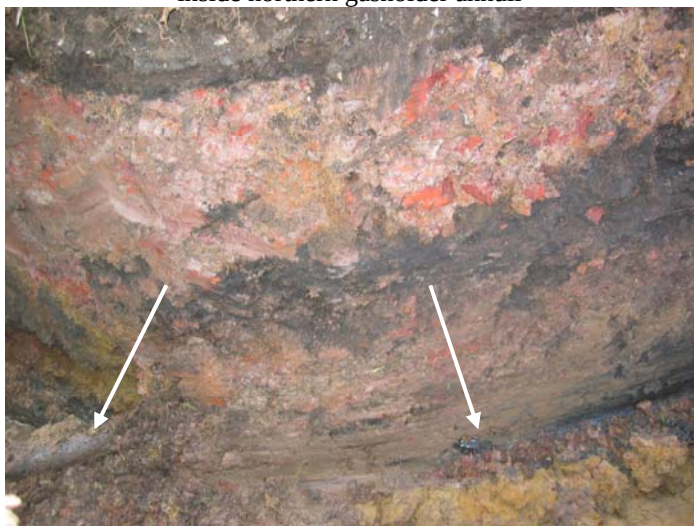

**Photo 40** (Aug 06) – Tar pipe, fill layers and tar seepage in testpit MG02, between the two gasholder annuli

**Photo 41** (Aug 06) – Material excavated from area adjacent to northern gasholder annulus

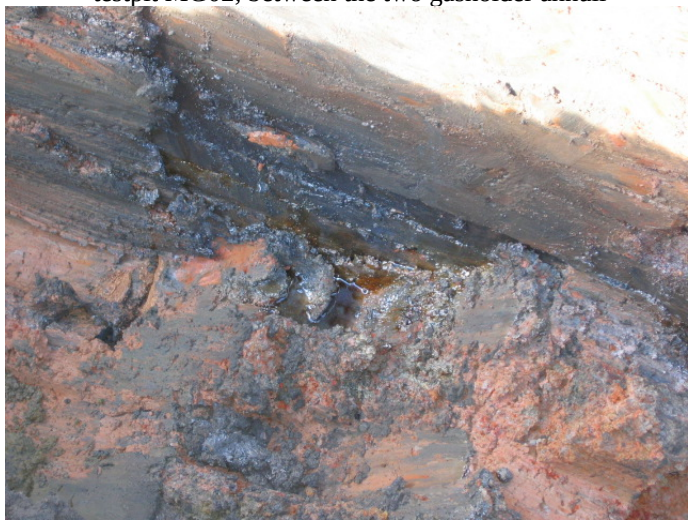

**Photo 42** (Aug 06) – Tarry / oily wastes on brickwork – outside of northern gasholder annulus (MG05)

**Photo 43** (Aug 06) – The outside of the northern gasholder annulus, exposed in testpit MG05

**Photo 44** (Aug 06) – Tar and oil seeping into testpit MG05, outside the northern gasholder

**Photo 45** (Aug 06) – Tar and oil seeping into testpit MG05, outside the northern gasholder

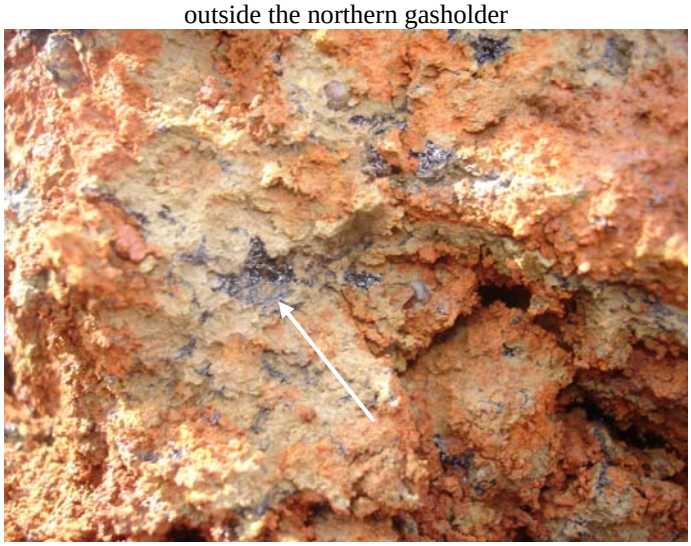

**Photo 46** (Aug 06) – Tar within soils pores in natural clay (exact location not documented)

**Photo 47** (Aug 06) – Pit located immediately to the south of the existing gasholder

**Photo 48** (Aug 06) – Pit located immediately to the south of the existing gasholder

**Photo 49** (Aug 06) – Two tar pits with concrete lids, in north west site area

**Photo 50** (Aug 06) – The location of testpit MG06, adjacent to the tar wells

**Photo 51** (Aug 06) – Brick structure adjacent to western tar well

**Photo 52** (Aug 06) – Water within the tar well (floating on top of tarry waste)

**Photo 53** (Aug 06) – Tar seeping through the brick wall of the tar pit (into testpit MG06)

**Photo 54** (Aug 06) – Tarry waste within the tar wells

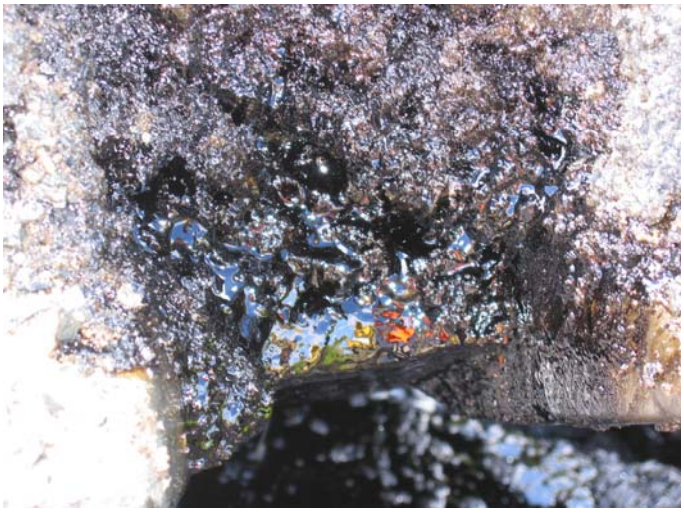

**Photo 55** (Aug 06) – Tarry waste within the tar wells

**Photo 56** (Aug 06) – Brickwork beneath former retort house

**Photo 57** (Aug 06) – Tar within pipework removed from testpit beneath former retort house

**Photo 58** (Aug 06) – Pipework removed from testpits beneath former retort house

**Photo 59** (Aug 06) – Tar within testpit MG08, beneath the former retort house

**Photo 60** (Aug 06) – Tarry soils within testpit MG08, beneath the former retort house

**Photo 61** (Aug 06) – Tar within soil pores in natural clay, from testpit MG08 beneath former retort house

**Photo 62** (Aug 06) – Fill profile in testpit MG10, beneath eastern edge of former retort house

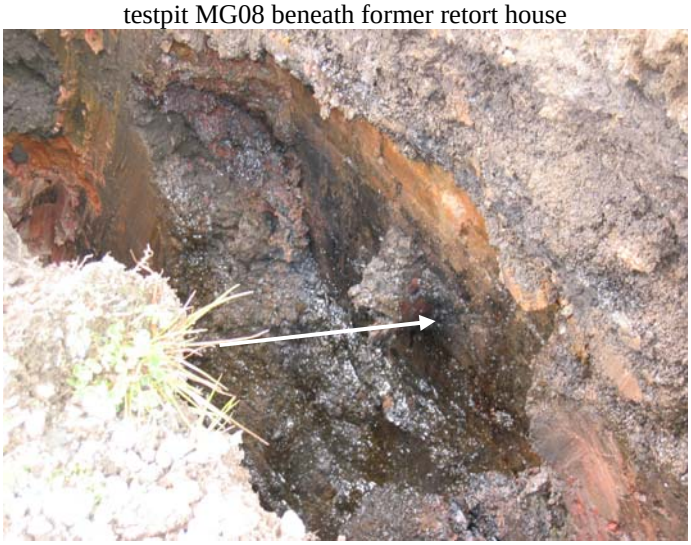

**Photo 63** (Aug 06) – Tarry materials and a buried brick structure within testpit MG10, beneath eastern edge of former retort house

**Photo 64** (Aug 06) – Fill profile in testpit MG11, near location of former purifiers

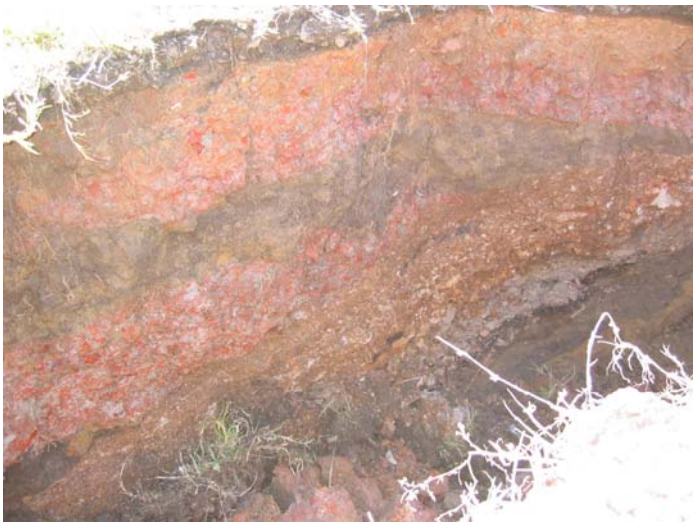

**Photo 65** (Aug 06) – Fill layers in testpit MG01, south of existing gasholder

**Photo 66** (Aug 06) – Fill profile in testpit TP01, in south western corner of site

**Photo 67** (Aug 06) – Fill profile in testpit TP03, along southern site boundary

**Photo 68** (Aug 06) – Fill profile in testpit TP05, along southern site boundary

**Photo 69** (Aug 06) – Fill profile in testpit TP06, in eastern site area

**Photo 70** (Aug 06) – Fill profile in testpit TP07, in south eastern site area, including an old buried rail line

**Photo 71** (Aug 06) – Fill profile in testpit TP08, in eastern site area

**Photo 72** (Aug 06) – Fill profile in testpit TP10, on northern site boundary, including two stepped retaining wall

**Photo 73** (Aug 06) – Fill profile in testpit TP11

**Photo 74** (Aug 06) – Retaining walls and fill in testpit TP12

**Photo 75** (Aug 06) – Fill profile at testpit TP14, in north western site area

**Photo 76** (Aug 06) – Brickwork and tars beneath the former retort house in testpit TP15

**Photo 77** (Aug 06) – Brickwork and tars beneath the former retort house in testpit TP15

**Photo 78** (Aug 06) – Fill profile including waste materials in testpit TP18 (on embankment between gasworks and stabling yard)

**Photo 79** (Historic Photo) – Buried pipework (located unknown)

**Photo 80** (Historic Photo) – Tarry materials (located unknown)

**Photo 81** (Historic Photo) – Buried pipework (located unknown)

**Photo 82** (Historic Photo) – Gasworks pipework (located unknown)

# Appendix B
# Development of Risk-Based Depth Criteria

# Approach to Developing Risk-Based Human Health Criteria

## *Protection of Future Site Users from Potential Vapour Inhalation*

The approach to developing site specific risk-based criteria is based on the Johnson and Ettinger (J&E) (1991) one-dimensional analytical model to determine theoretical values that would apply to soil at depth based on a potential to generate vapours at levels that would pose a risk to future site users.

Johnson and Ettinger (J&E) (1991) provides a screening-level model that incorporates both convective and diffusive mechanisms for estimating the transport of contaminant vapours emanating from either subsurface soils or groundwater into indoor spaces located directly above the source of contamination.

A users guide to the Johnson and Ettinger (J&E) (1991) model has been developed by the US EPA (2004).

## *Calculating Risk-Based Criteria*

To calculate risk-based criteria, the model is run using a populated spreadsheet that requires variable input based on site and soil conditions.

Specific contaminant compounds of concern at the Site were selected based on whether the compounds are considered to have sufficient volatility and toxicity to pose a risk to human health. Table 1 of the users guide lists 114 chemicals that may be found at hazardous waste sites and indicates whether the chemical is sufficiently toxic and volatile to result in a potentially unacceptable indoor inhalation risk.

The contaminants selected were based on the contaminants of concern at the Site, which included those identified in the table.

| | | |
|---|---|---|
| Benzene | o-xylene | Benzo(b)fluoranthene |
| Toluene | p-xylene | Chrysene |
| Ethylbenzene | Naphthalene | Fluorene |
| m-xylene | Acenaphthene | Pyrene |

The chemical properties of these compounds drive the calculations. The soil conditions are based on a set of variables for particular soil types. The soil type selected was based on the expectation that backfill material will consist of a sandy clay material. The following properties were used to populate each spreadsheet for individual compounds:

- Depth of floor base – 15cm (i.e. concrete slab on ground).
- Depth of risk based interval – 250cm, 400cm or 800cm (i.e. depth to which criteria apply).
- Soil temperature – 15°C.
- Soil type – Sandy Clay.
- Soil bulk density – 1.63g/cm$^3$ (model default).
- Soil porosity – 0.385 unitless (model default).
- Soil water-filled porosity – 0.197cm$^3$/cm$^3$ (model default).

The remainder of the variable inputs are model defaults. The results tab on the calculation spreadsheet provides a final indoor exposure soil concentration (in µg/kg). This value was used as the risk-based soil criteria value. The results spreadsheet for each compound is provided at the rear of this appendix.

DATA ENTRY SHEET

SL-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 71432 | | Benzene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| 1.07E+01 | 1.07E+02 | 1.07E+01 | 4.57E+05 | 1.07E+01 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| 1.68E+01 | 1.68E+02 | 1.68E+01 | 4.57E+05 | 1.68E+01 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [X]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 71432 | | Benzene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 400 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 4.39E+06 | 4.39E+06 | 5.10E+04 | NOC |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.
NOC = NOT OF CONCERN. The contaminant is a solid at the soil temperature and not of concern for this pathway.
MESSAGE: Risk/HQ or risk-based soil concentration is based on a route-to-route extrapolation.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 71432 | | Benzene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| 1.07E+01 | 1.07E+02 | 1.07E+01 | 4.57E+05 | 1.07E+01 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

SL-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 71432 | | Benzene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 400 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| 1.68E+01 | 1.68E+02 | 1.68E+01 | 4.57E+05 | 1.68E+01 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| 3.31E+01 | 3.31E+02 | 3.31E+01 | 4.57E+05 | 3.31E+01 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 71432 | | Benzene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 800 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| 3.31E+01 | 3.31E+02 | 3.31E+01 | 4.57E+05 | 3.31E+01 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 205992 | | Benzo(b)fluoranthene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| 1.51E+06 | NA | 1.51E+06 | 3.69E+03 | NOC |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.
NOC = NOT OF CONCERN. The contaminant is a solid at the soil temperature and not of concern for this pathway.
MESSAGE: Risk/HQ or risk-based soil concentration is based on a route-to-route extrapolation.

END

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 218019 | | Chrysene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| 4.81E+07 | NA | 4.81E+07 | 5.02E+03 | NOC |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.
NOC = NOT OF CONCERN. The contaminant is a solid at the soil temperature and not of concern for this pathway.
MESSAGE: Risk/HQ or risk-based soil concentration is based on a route-to-route extrapolation.

**END**

DATA ENTRY SHEET

SL-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 100414 | | Ethylbenzene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 1.11E+04 | 1.11E+04 | 1.47E+05 | 1.11E+04 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 100414 | | Ethylbenzene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 400 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 1.76E+04 | 1.76E+04 | 1.47E+05 | 1.76E+04 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 100414 | | Ethylbenzene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 800 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^v$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^v$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^v$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 3.48E+04 | 3.48E+04 | 1.47E+05 | 3.48E+04 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 1.41E+07 | 1.41E+07 | 5.49E+04 | NOC |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.
NOC = NOT OF CONCERN. The contaminant is a solid at the soil temperature and not of concern for this pathway.
MESSAGE: Risk/HQ or risk-based soil concentration is based on a route-to-route extrapolation.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [X]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 86737 | | Fluorene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

DATA ENTRY SHEET

SL-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 108383 | | m-Xylene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 1.40E+03 | 1.40E+03 | 1.54E+05 | 1.40E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 2.23E+03 | 2.23E+03 | 1.54E+05 | 2.23E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 108383 | | m-Xylene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 400 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 108383 | | m-Xylene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 800 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 4.41E+03 | 4.41E+03 | 1.54E+05 | 4.41E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 91203 | | Naphthalene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 3.73E+03 | 3.73E+03 | 1.28E+05 | 3.73E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 91203 | | Naphthalene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 400 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 5.94E+03 | 5.94E+03 | 1.28E+05 | 5.94E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 95476 | | o-Xylene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 1.48E+03 | 1.48E+03 | 1.53E+05 | 1.48E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 95476 | | o-Xylene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 400 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 2.33E+03 | 2.33E+03 | 1.53E+05 | 2.33E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 95476 | | o-Xylene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 800 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 4.60E+03 | 4.60E+03 | 1.53E+05 | 4.60E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 106423 | | p-Xylene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 1.19E+03 | 1.19E+03 | 1.70E+05 | 1.19E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 106423 | | p-Xylene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 400 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ (g/$cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3$/$cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 1.88E+03 | 1.88E+03 | 1.70E+05 | 1.88E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 106423 | | p-Xylene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 800 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 3.72E+03 | 3.72E+03 | 1.70E+05 | 3.72E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

DATA ENTRY SHEET

SL-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [X]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 129000 | | Pyrene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 3.24E+08 | 3.24E+08 | 2.84E+05 | NOC |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.
NOC = NOT OF CONCERN. The contaminant is a solid at the soil temperature and not of concern for this pathway.
MESSAGE: Risk/HQ or risk-based soil concentration is based on a route-to-route extrapolation.

**END**

DATA ENTRY SHEET

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 108883 | | Toluene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 250 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 2.52E+03 | 2.52E+03 | 2.65E+05 | 2.52E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

DATA ENTRY SHEET

SL-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES | X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES |

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 108883 | | Toluene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 400 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 3.97E+03 | 3.97E+03 | 2.65E+05 | 3.97E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

SL-SCREEN Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial soil conc., $C_R$ (µg/kg) | Chemical |
|---|---|---|
| 108883 | | Toluene |

MORE ↓

| ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm) | ENTER Depth below grade to top of contamination, $L_t$ (cm) | ENTER Average soil temperature, $T_S$ (°C) | ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined vadose zone soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|
| 15 | 800 | 15 | SC | | |

MORE ↓

| ENTER Vandose zone SCS soil type (Lookup Soil Parameters) | ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Vadose zone soil total porosity, $n^V$ (unitless) | ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ($cm^3/cm^3$) | ENTER Vadose zone soil organic carbon fraction, $f_{oc}^V$ (unitless) | ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|
| SC | 1.63 | 0.385 | 0.197 | 0.002 | 5 |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-05 | 1 |
| | | | | Used to calculate risk-based soil concentration. | |

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

| Indoor exposure soil conc., carcinogen (µg/kg) | Indoor exposure soil conc., noncarcinogen (µg/kg) | Risk-based indoor exposure soil conc., (µg/kg) | Soil saturation conc., $C_{sat}$ (µg/kg) | Final indoor exposure soil conc., (µg/kg) |
|---|---|---|---|---|
| NA | 7.82E+03 | 7.82E+03 | 2.65E+05 | 7.82E+03 |

INCREMENTAL RISK CALCULATIONS:

| Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) |
|---|---|
| NA | NA |

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

**END**

# Appendix C
# Evaluation of Short-list Remedial Options

| General Remedial Action | Remedial Option | Description | Remedial Approach and Application to Site Area/ Material Type | Evaluation of Remedial Approaches | | Outcome |
|---|---|---|---|---|---|---|
| | | | | Advantages | Disadvantages | |
| No action | No Action | No remedial action undertaken. | A no action remedial approach for:<br>• Southern Gasholder - this site area would require application of a management plan and access restrictions.<br>• Remaining site area | • Minimal cost expenditure. | • Does not reduce, remove or control exposure risks to human health or ecological receptors and does not address Significant Risk Of Harm (SRoH) issues.<br>• Is not aligned with RailCorp's decision to enter into a Voluntary Remediation Agreement with the NSW EPA.<br>• Would not be accepted by regulators or the local community as a 'do nothing approach'.<br>• Incompatible with RailCorp's long term objectives for future site use and an ongoing groundwater management plan (GMP).<br>• Not aligned with future land use aspirations. | Not preferred:<br>• Overall does not meet the long term objectives for the Site. |
| Institutional Controls | Environmental Management Plan (EMP) | EMP is designed to minimise exposure risks posed by residual contamination. | An ancillary remedial approach for:<br>• Entire site – subject to active/passive remediation. | • Controls exposure risks to human health and ecological receptors by managing (disrupting) exposure pathways to residual contamination.<br>• Short term timeframe to prepare.<br>• Regulatory acceptance.<br>• Compatible with future site use and incorporates/outlines a GMP.<br>• Cost effective.<br>• Defines procedures and company policies for ongoing site management. | • Enforcing management plan if the Site is divested. | Preferred (in combination with preferred active/passive approach):<br>• Overall provides ongoing management of contamination risks. |
| | Site access restrictions | Security fencing is installed to limit site access or limit access to specific site areas. | An ancillary remedial approach for:<br>• Entire site – to control exposure risks to general public and community.<br>• Retained Southern Gasholder heritage item – to protect historical importance. | • Controls exposure risks to human health and ecological receptors by disrupting exposure pathways.<br>• Short term timeframe to implement.<br>• Regulatory acceptance.<br>• Compatible with future site use.<br>• Cost effective.<br>• Minimal maintenance required. | • Controlling site access of a 24hr facility from illegal trespassing.<br>• Enforcing access restrictions if the Site is divested | Preferred (in combination with preferred active/passive approach):<br>• Overall provides security and protection of historic items. |

| General Remedial Action | Remedial Option | Description | Remedial Approach and Application to Site Area/ Material Type | Evaluation of Remedial Approaches | | Outcome |
|---|---|---|---|---|---|---|
| | | | | Advantages | Disadvantages | |
| Insitu Physical/ Chemical Treatment | Passive Insitu Chemical Oxidation | Oxidizing reagent converts hazardous organic contaminants to compounds that are more stable, less mobile or inert. | A passive remedial approach for:<br>• Primary Source Areas at excavation depth limits – Treating residual organic compounds in deep soils, where excavation is limited by machinery capability or deeper excavation is not feasible. Used to promote mass reduction of residual organic contaminants as well as promote groundwater plume treatment over the long term. | • Reduces exposure risks to human health and ecological receptors by reducing residual organic contamination levels (and vapour generation) in soil and groundwater over time.<br>• Short term application provides a long term benefit to enhance biodegradation depending on distribution and volume of residual organic contaminants and quantity of reagent.<br>• Preliminary investigations (CH2M HILL, 2000) indicate that natural attenuation is occurring; therefore enhancing microbial action is feasible.<br>• Is likely to get regulatory acceptance and no adverse impacts to community.<br>• Would be compatible with active (i.e. excavation) remedial approach and management plan.<br>• Would be compatible with GMP to reduce residual organic contaminant levels and enhance natural attenuation and plume reduction.<br>• Would be cost effective when considering costs to excavate deeper/wider areas to chase out residual organic contamination beyond practicable extent.<br>• Would not require ongoing maintenance, although ongoing groundwater monitoring would be required as part of GMP/EMP. | • Effectiveness may be limited on target organic material by the existence of non-target organic material that consumes large quantities of the oxidizing reagent (i.e. organic carbon in soils).<br>• Stiff and highly plastic clay at application depth (i.e. low permeability) may limit the effectiveness to localised areas.<br>• Depth and distribution of residual impact may limit the effectiveness. | Preferred (in combination with preferred active approach):<br>• Overall enhances biodegradation of residual sources |
| | Soil Vapour Extraction (SVE) | Gas/vapour-phase volatile organic compounds (VOC) are removed from soil through extraction wells applying a vacuum. | An active in-situ remedial approach for:<br>• Primary Source Areas – Treating residual organics in deep soils, where active remedial excavation is limited by machinery capability or deeper excavation is not feasible. | • Controls human health exposure risks by reducing risk posed by the residual organic contaminants and reduces generation of vapours.<br>• Would provide a short to medium timeframe for treating VOCs only. | • Applicable only to VOCs including BTEX and some PAH of low molecular weight (particularly naphthalene).<br>• Limited or ineffective on residual SemiVOCs (i.e. heavier molecular weight PAH).<br>• Stiff and highly plastic clay (i.e. low permeability) would hinder extraction and treatment rates.<br>• Does not work in saturated zones (i.e. below the groundwater).<br>• A uniform treatment may be unachievable given the nature of the clays and weathered shale rock underlying the source areas. These conditions include intermittent, discontinuous and preferential conduit pathways provided by fractures in shale.<br>• Minimal reduction of ecological risks posed by the residual organics because it only treats VOCs, and not SVOCs which may continue to impact groundwater.<br>• Would require an extended timeframe for SVOCs and non-volatiles as most are in a liquid or solid phase at depth and may not volatilise.<br>• Is unlikely to achieve regulatory or community acceptance given requirement for establishing treatment infrastructure on site and the sensitivity of neighbouring residents, considering noise and potential vapour releases.<br>• Is incompatible and may limit future redevelopment based on timeframe and locations of treatment structures.<br>• Is relatively inflexible once established on site.<br>• Provides only partial treatment of residual/potential sources.<br>• May be unnecessary if the active remedial approach achieves remedial goals.<br>• Is likely to be costly for lengthy O&M required to meet specific remedial goals. | Not preferred:<br>• Overall is unlikely treat recalcitrant compounds in source material |

| General Remedial Action | Remedial Option | Description | Remedial Approach and Application to Site Area/ Material Type | Evaluation of Remedial Approaches | | Outcome |
|---|---|---|---|---|---|---|
| | | | | Advantages | Disadvantages | |
| Insitu Thermal Treatment | Thermal Treatment | Increases volatilisation rate to facilitate and enhance SVE. | An active remedial approach for:<br>• Primary Source Areas – Treating residual organics in deep soils, where source removal by active remedial excavation is limited by machinery capability or deeper excavation is uneconomical. | Similar advantages as SVE above. May also have an increased effect on SVOC, but non volatiles (i.e. tar source) would remain insitu. | Similar disadvantages as SVE above. This option would not be appropriate alone and usually undertaken with SVE. | Not preferred:<br>• Overall is unlikely treat recalcitrant compounds in source material |
| Exsitu Biological Treatment | Biopiles | Excavated soils are mixed with soil amendments and placed in aboveground enclosures or constructed bioremediation cells. | An active remedial approach for:<br>• Excavated soil impacted by tar beneath the Retort area and surrounding source zones. For VOCs and lighter fraction PAHs. | • Removes exposure risks to human health and ecological receptors at the Site by disrupting the exposure pathway and reducing the volume of contamination.<br>• A proven technique accepted by regulators for materials impacted with low levels of volatile and lighter fraction PAH contamination.<br>• May get community acceptance at the former gasworks site if alternative site used for treatment (i.e. contamination will be removed).<br>• Is compatible with future site use and GMP and may be flexible to consider alternative approaches. | • Limited site area would require an alternative site to treat large volumes of soil. Short term exposure risks would exist at the alternative site.<br>• The high sensitivity of the neighbouring residential properties may preclude any treatment being undertaken on site (i.e. noise, dust and odour issues).<br>• Transport of potentially hazardous wastes to alternative treatment site would require approval.<br>• An alternative treatment site would require all necessary environmental safeguards particularly vapour emissions requiring treatment, construction of concrete slab/s.<br>• The process is unsuitable for grossly impacted materials such as free tar.<br>• Limited effectiveness in reducing the multi-ring (4 ring and greater) PAHs, such as chrysene and benzo(a)pyrene, to acceptable regulatory levels.<br>• Additional/alternative treatment may be necessary if remedial goal not achieved.<br>• Treatment trials would be necessary.<br>• High clay content of the soil would require pre-treatment to breakdown the physical structure.<br>• Requires an extended timeframe to treat the impacted material. Although grossly impacted material (i.e. free tar) would require an alternative treatment. Considering substantial portion of material is likely to contain free tar source, then this approach may have limited success.<br>• Is incompatible with potential reuse of the impacted materials because it is unlikely to have a significant effect on PAH contaminants with 4 or greater rings.<br>• Is likely to become costly considering timeframe, establishment and maintenance of an alternative treatment site, and if additional treatment using a different technique is required. | Not preferred:<br>• Overall is unlikely treat recalcitrant compounds in source material |
| | Composting | Excavated soils are mixed with bulking agents and organic amendments, such as wood chips, hay, manure, and vegetative wastes. | An active remedial approach for:<br>• Excavated soil impacted by tar beneath the Retort area and surrounding source zones. For VOCs and lighter fraction PAHs. | Similar advantages as Biopiles above. | Similar disadvantages as Biopiles above. The addition of compost bulking agents would substantially increase the volume of the material being treated. | Not preferred:<br>• Overall is unlikely treat recalcitrant compounds in source material |
| | Landfarming | Excavated soils are applied into lined beds, and periodically turned over or tilled. | An active remedial approach for:<br>• Excavated soil impacted by tar beneath the Retort area and surrounding source zones. For VOCs and lighter fraction PAHs. | • Relatively simple and cheap as does not require construction of cells as with ex-situ bioremediation or composting options above. | Similar disadvantages as Biopiles above.<br>• Unlikely to gain regulatory acceptance, as known to be ineffective on more complex PAHs and other SVOCs, and due to aesthetic and environmental (dust, odours, erosion) control issues.<br>• Requires greater surface area as soil needs to be thinly spread to effect biological treatment.<br>• Would require amendment (nutrients) and regular tilling over longer timeframe. | Not preferred:<br>• Overall is unlikely treat recalcitrant compounds in source material |

| General Remedial Action | Remedial Option | Description | Remedial Approach and Application to Site Area/ Material Type | Evaluation of Remedial Approaches | | Outcome |
|---|---|---|---|---|---|---|
| | | | | Advantages | Disadvantages | |
| Exsitu Physical/ Chemical Treatment | Solidification / Stabilisation/ Immobilisation | Contaminants are physically bound or enclosed within a stabilised mass. | An active remedial approach for:<br>• Excavated soil impacted by tar beneath the Retort area and surrounding source zones. This material can be stabilised then would qualify for general immobilisation approval from the DEC.<br>• Ash and coke fill material. Where PAH contamination can be demonstrated to be immobile without treatment within ash and coke then it would qualify for general immobilisation approval from the DEC. | • Removes exposure risks to human health and ecological receptors at the Site by disrupting the exposure pathway and reducing the volume of contamination.<br>• Enables off site disposal of former gasworks waste materials and ash/coke fill materials classified on TCLP alone using the NSW DEC general approval for immobilisation. Therefore liability of the contamination is passed onto the licensed disposal facility, which is designed to contain such materials.<br>• Provides a short timeframe to achieve the desired goals.<br>• A proven technique accepted by regulators for gasworks waste material and ash/coke fill.<br>• Likely to get community acceptance at the former gasworks site (i.e. contamination will be removed).<br>• Is compatible with future site use and GMP.<br>• Is incompatible with potential reuse of the impacted materials. | • Limited site area may require an alternative site to treat a large volume of soil. Short term exposure risks would exist at the alternative site.<br>• The high sensitivity of the neighbouring residential properties may preclude any treatment being undertaken on site (i.e. noise, dust and odour issues).<br>• Transport of potentially hazardous wastes to an alternative treatment site for stabilisation of some material would require approval.<br>• High clay content of the soil would require pre-treatment to breakdown the physical structure and to improve handling. | Preferred (in combination with off site disposal):<br>• Overall a proven technique that addresses inherent financial risk posed by other approaches |
| | Chemical Extraction | Wastes and extractant are mixed, thereby dissolving the contaminants. The extracted solution is then placed in a separator, where the contaminants and extractant are separated for treatment. | An ancillary remedial approach for:<br>• Residual tar material within old gasworks pipes and underground services. | • Removes some exposure risks to human health and ecological receptors at the Site by disrupting the exposure pathway and reducing the volume of contamination.<br>• Can be undertaken in a relatively short timeframe; however effectiveness for this application is unknown. | • The high sensitivity of the neighbouring residential properties may preclude any treatment being undertaken on site (i.e. noise, dust and odour issues).<br>• Transport of potentially hazardous wastes would require approval.<br>• Unknown treatment history for gasworks wastes and is a relatively new technology and effectiveness would be judged on treatment trials.<br>• Generates a waste liquid that would require treatment/ disposal at completion.<br>• Treated pipes may be recycled if technique is effective, however may ultimately require disposal at a landfill.<br>• Would have a cost dependency on the quantity of material requiring treatment, which is unknown.<br>• Regulatory acceptance would be based on proof of effectiveness and ultimate destination of wastes. | Potential ancillary approach:<br>• Can be used specific to old pipe work waste |
| | Segregation | Segregation techniques concentrate contaminated (or non-contaminated) solids through physical and chemical means. | An ancillary remedial approach:<br>• Specific for retaining oversize materials in general fill such as bricks, footings, concrete, metal pipe and other building rubble for off site recycling, which should exclude asbestos containing material (ACM), ultimately reducing material volumes. | • Would be beneficial in reducing the volume of contamination in combination with active remedial approaches.<br>• Short time frame.<br>• Minor costs on top of those to undertake active remediation. | • The presence of Asbestos Containing Material (ACM) in fill materials may preclude this as an appropriate option (i.e. OH&S issues). | Preferred (in combination with active approach):<br>• Overall does not affect the preferred active approach, but can reduce treatment volumes and overall costs<br>• Proven approach<br>• Follows the regulatory framework for managing wastes under the *Waste Avoidance and Resource Recovery Act 2001.* |
| Exsitu Thermal Treatment | Incineration or Co-burning | Utilises the high operating temperatures of industrial processes (between 870-1,200°C) to combust organic constituents in hazardous wastes. | An active remedial approach for:<br>• Primary tar source material including - Tar Well contents, Gasholder base annulus contents and gross tar materials (i.e. high tar content and low soil material). The material must comprise a high calorific content. This approach would only address a portion of the impacted soils. | • Would be effective in reducing the exposure risks to human health and ecological receptors at the Site posed by highly contaminated materials.<br>• Would be completed in a relatively short timeframe.<br>• Would be effective for a portion of the tar impacted material. | • Potential issues with gaining regulatory approval or acceptance of wastes by potential facilities.<br>• Limited facilities that would accept wastes to mix with coal/oil feedstock.<br>• Tar materials would require pre-treatment to improve handling and transport.<br>• Transport of potentially hazardous wastes would require approval.<br>• Regulatory acceptance (if approved) would delay the approach.<br>• Treatment trials may be necessary to demonstrate effectiveness.<br>• Only applicable to material with high tar content (high calorific value) and low soil content. Therefore deals with only a portion of contaminated material. | Not preferred:<br>• Overall unknown effectiveness, which can be addressed by other, cost effective, approaches |

| General Remedial Action | Remedial Option | Description | Remedial Approach and Application to Site Area/ Material Type | Evaluation of Remedial Approaches | | Outcome |
|---|---|---|---|---|---|---|
| | | | | Advantages | Disadvantages | |
| Exsitu Thermal Treatment | Thermal Desorption | Wastes are heated to volatilise organic contaminants. A carrier gas or vacuum system transports volatilised water and organics to the gas treatment system. | An active remedial approach for:<br>• Primary tar source material and tar impacted soils. | • Removes exposure risks to human health and ecological receptors at the Site by disrupting the exposure pathway and reducing the volume of contamination.<br>• May require disposal after treatment at a licensed facility, therefore liability of the contamination is passed onto the licensed disposal facility.<br>• Is compatible with the future site use and management of groundwater issues.<br>• Is a proven technique for destroying organic contaminants including PAHs.<br>• Treatment technique has had regulatory and community acceptance in other locations in Sydney.<br>• Relatively short timeframe for remediation once approved and set up. | • Given the limited site area, it is likely to require an alternative site to treat large volumes of soil in order to set up the thermal treatment plant and associated infrastructure. Short term exposure risks would exist at the alternative site.<br>• The high sensitivity of the neighbouring residential properties may preclude any treatment being undertaken on site (i.e. noise, dust and odour issues).<br>• Transport of potentially hazardous wastes to alternative treatment site would require approval.<br>• An alternative treatment site would require all necessary environmental safeguards particularly vapour emissions requiring treatment.<br>• Is a proven technique, however there is currently no approved off site thermal desorption facility available and onsite treatment with a portable plant would present logistical problems and regulatory and community issues.<br>• Stiff and highly plastic clay with high moisture content would require pre-treatment to improve handling.<br>• Potential issues with effectiveness on high tar content materials.<br>• Additional/alternative treatment may be necessary if the remedial goal is not achieved. | Preferred (in combination with off site disposal):<br>• Overall a proven technique that addresses inherent financial risk posed by other approaches |
| Containment | Insitu Capping | Provides a physical barrier and prevents site users being exposed to the contaminated material. Also may reduce contaminant migration from leaching by mitigating surface water infiltration. | An ancillary remedial approach for:<br>• Specific to relatively shallow impacts of non leaching material (i.e. ash/coke surface fill) in the northeast, southwest and western lot portions of the Site. | • Reduces exposure risks to human health and perhaps ecological receptors at the Site by disrupting the exposure pathway.<br>• Can be applied in a short timeframe to those specific areas and materials of the Site<br>• Would be relatively cost effective if applied to those specific areas of the Site and would not require off site treatment or disposal costs.<br>• Would require a management and maintenance policy as part of the SMP. | • Is a partial remedial approach that does not address the issue of localised buried wastes and tar impacted primary source zone areas and potential tar source hotspot areas.<br>• Does not prevent migration of groundwater carrying contaminants away from source areas beneath the cap.<br>• Is unlikely to achieve regulatory and community acceptance to address immobile surface contamination, and an alternative approach would be necessary to address potential deeper source areas.<br>• Unknown compatibility with future site development. May only be an advantage if site levels are to be raised.<br>• May be incompatible with an ongoing groundwater management strategy. | Not preferred:<br>• Overall ongoing regulatory acceptance issues and unknown redevelopment aspirations |
| | Capping in Prescribed Onsite Containment Area | Contaminated soil is consolidated and capped in one area of the site. | An ancillary remedial approach for:<br>• Specific to non-leaching material (i.e. ash/coke surface fill) in the northeast, southwest and western lot portions of the Site. | • Reduces exposure risks to human health and ecological receptors at the Site by disrupting the exposure pathway.<br>• Can be applied in a short timeframe to those specific areas and materials of the Site<br>• Would be relatively cost effective if applied to those specific areas of the Site and would not require off site treatment or disposal costs.<br>• Would require a management and maintenance policy as part of the SMP. | • A partial remedial approach that does not address primary tar sources.<br>• The limited site area is unlikely to accommodate a designated containment area.<br>• Future redevelopment would be limited and some areas of the Site would be unused.<br>• Potential for ongoing groundwater impacts.<br>• Is unlikely to achieve regulatory and community acceptance and an alternative approach would be necessary to address potential deeper source areas.<br>• Management and monitoring costs would be ongoing.<br>• May be incompatible with future redevelopment aspirations for the Site, considering levels and finished grade.<br>• May be incompatible with an ongoing groundwater management strategy. | Not preferred:<br>• Overall ongoing regulatory acceptance issues and unknown redevelopment aspirations |

| General Remedial Action | Remedial Option | Description | Remedial Approach and Application to Site Area/ Material Type | Evaluation of Remedial Approaches | | Outcome |
|---|---|---|---|---|---|---|
| | | | | Advantages | Disadvantages | |
| Off-Site Disposal | Disposal at an existing off-site facility | Material is transported to an existing licensed off-site disposal facility. | An active remedial approach for:<br>• Treated soils<br>• Asbestos impacted demolition waste<br>• Ash/coke fill material<br>• General fill material | • Controls exposure risks to human health and ecological receptors at the Site by disrupting exposure pathways and reduces the source volume at the Site and vapour generation.<br>• Can be implemented in a short timeframe to achieve the desired goal.<br>• Is a proven technique that, when implemented in combination with other treatment technologies such as stabilisation, is likely to achieve regulatory and community acceptance.<br>• Would enable the NSW EPA general approval for immobilisation to be applied to gasworks wastes subject to treatment of the material.<br>• Enables the NSW EPA general approval for immobilisation to be applied directly to ash/coke impacted material without treatment.<br>• Would be compatible with other preferred remedial approaches.<br>• Would be compatible with GMP to remove sources, promote natural attenuation and promote plume reduction.<br>• Would not require ongoing maintenance as the liability of the contamination is passed onto the licensed disposal facility, which may also accept liability at the site boundary prior to transporting the waste to the disposal site.<br>• Is comparatively cost effective.<br>• Is compatible with future redevelopment and site use. | • Tar impacted soil would require pre-treatment to apply the NSW DEC general approval for immobilisation specific for gasworks waste materials.<br>• An alternative treatment site would be required given the limited site area and local sensitivity of the adjoining residencies.<br>• High clay content of the soil would require pre-treatment to breakdown the physical structure. | Preferred (in combination with other preferred approaches):<br>Overall -<br>• Limited unknowns and disadvantages<br>• Proven approach.<br>• Meets long term objectives |
| | | A specially constructed mono-cell within a landfill is used to dispose untreated hazardous contaminated materials. | An active remedial approach for:<br>• Hazardous gasworks tar wastes.<br>• Old gasworks tar pipes. | • Can be implemented in a short timeframe to achieve the desired goal.<br>• Construction of a mono-cell at an approved waste landfill would enable disposal of potentially hazardous wastes without treatment.<br>• Would be compatible with GMP to remove sources, promote natural attenuation and promote plume reduction.<br>• Would not require ongoing maintenance as the liability of the contamination is passed onto the licensed disposal facility, which may also accept liability at the site boundary prior to transporting the waste to the disposal site.<br>• Is compatible with future redevelopment and site use. | • Transport of potentially hazardous wastes would require approval.<br>• Construction of a mono-cell within the licensed landfill would be required to accept potentially hazardous gasworks tar wastes.<br>• Is unlikely to achieve regulatory approval. | Not preferred:<br>• Overall ongoing regulatory acceptance issues |
| | | Liquid wastes require disposal at approved facilities. | An active remedial approach for:<br>• Hazardous liquid tar waste contents in Tar Wells, old gasworks tar pipes, and base annulus of Gasholder.<br>• Other impacted liquid waste. | • Controls exposure risks to human health and ecological receptors at the Site by disrupting exposure pathways and reduces the source volume at the Site and vapour generation.<br>• Can be implemented in a short timeframe to achieve the desired goal.<br>• Is a proven technique that is likely to achieve regulatory and community acceptance.<br>• Would be compatible with other preferred remedial approaches.<br>• Would be compatible with GMP to remove sources, promote natural attenuation and promote plume reduction.<br>• Would not require ongoing maintenance as the liability of the contamination is passed onto the licensed disposal facility, which may also accept liability at the site boundary prior to transporting the waste to the disposal site.<br>• Is comparatively cost effective.<br>• Is compatible with future redevelopment and site use. | • Transport of potentially hazardous wastes would require approval. | Preferred (in combination with other preferred approaches):<br>Overall -<br>• Limited unknowns and disadvantages<br>• Proven approach<br>• Meets long term objectives |
| Beneficial Reuse and Recycling | Materials retained on site and reused or removed off-site for reuse/recycling by other appropriate facilities | Some materials will have physical and chemical properties that enable beneficial reuse at the site. Some materials have value to other processing plants and may be removed from site. | An ancillary remedial approach for:<br>• Material meeting the land use criteria.<br>• Material meeting the site specific risk-based criteria for soils at depth.<br>• Demolition wastes | • Would be beneficial in reducing the volume of contamination in combination with active remedial approaches.<br>• Would reduce costs associated with importing backfill material.<br>• Can be integrated into the remedial program timeframe.<br>• Minor costs and time on top of those to undertake active remediation to recover recyclables. | • Fill materials associated with the main gasworks operations area that are impacted with tar would be suitable for reuse, even after treatment.<br>• The presence of asbestos containing materials in some fill materials may limit the availability for reuse/recycle. | Preferred (in combination with other preferred approaches):<br>• Proven approach<br>• Meets long term objectives for the site<br>• Follows the regulatory framework for managing waste and avoidance. |

# Appendix D
# RailCorp Infrastructure Engineering Standards – Geotechnical Guidelines

# TMC 411

# EARTHWORKS MANUAL

**Version 1.0**

**Issue Date September 2006**

Owner Principal Engineer Geotechnical

Approved By: John Stapleton
Group Leader Standards

Authorised By: Jee Choudhury
Principal Engineer

Version: 1.0
Issue Date: September2006

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# Chapter 1 General

## C1-1 Purpose

This document specifies procedures for the construction and maintenance of cuttings, embankments and formation for RailCorp tracks.

The procedures apply to all main lines and sidings.

Guidelines for the rehabilitation of existing track formation are given in TMC 403 “Track Reconditioning Guidelines”.

## C1-2 How to read the Manual

When you read this manual, you will not need to refer to RailCorp Engineering Standards.

Any requirements from standards have been included in the sections of the manual and shown shaded. The shaded sections are extracts from RailCorp Standard ESC 410 “Earthworks and Formation”.

Reference is however made to other Manuals.

## C1-3 References

| | |
|---|---|
| AS 1141 | Methods for sampling and testing aggregates |
| AS 1289 | Methods for testing soils for engineering purposes |
| SPC 411 | Earthworks Materials Specification |
| TMC 403 | Track Reconditioning Guidelines |
| TMC 421 | Track Drainage Manual |
| RailCorp | Asset Management Group Workplace Safety Manual |
| RailCorp | Environmental Management System |

## C1-4 Definitions, abbreviations and acronyms

| | |
|---|---|
| Earth: | All materials such as earth, clay, sand gravel, weathered or loose rock which could normally be removed by ripping by a bulldozer of 290 kilowatt brake power (382 h.p.) with heavy duty tynes. |
| Rock: | Any other material which cannot be so removed and shall include boulders greater than 1 cubic metre in volume. |
| Dispersive soil: | Soil that has the ability to pass into suspension in the presence of water |
| Highly dispersive soil: | Soil that has the ability to pass rapidly into suspension in the presence of water and has an Emerson Class number of 1. |
| Earthworks level: | The level at the centre of the earthworks prior to placing of the capping layer. |
| Formation level: | The finished level at the centre of the formation preparatory to laying ballast. It includes the required capping layer. |
| Capping layer: | Layer of compacted material that provides an impermeable seal to the earthworks. |
| Structural zone: | The upper zone of the embankment. Thickness varies from 500mm to 1000mm, depending on the CBR of the general fill. |
| General fill: | The lower zone of the embankment. |

| | |
|---|---|
| CBR: | Soaked California Bearing Ratio, Standard Compaction. |
| Scarp: | Bench formed by excavating down the slope perpendicularly |
| Geotechnical Engineer: | RailCorp's Principal Geotechnical Engineer or a competent person with delegated engineering authority for geotechnical design activities relating to earthworks. |
| Site Supervisor: | A qualified civil engineer or a competent person with delegated engineering authority for earthworks supervision. |

## C1-5 Competencies

Design of earthworks is to be approved by a Geotechnical Engineer.

Earthworks shall only be carried out under the supervision of a Site Supervisor.

Some aspects of the earthworks may require the approval of a Geotechnical Engineer.

Certification of the track during earthworks or after earthworks has been completed may only be undertaken by persons with the following competency:

- TDT B38 01A - Maintain track geometry.

## C1-6 Safety and Environmental

Safe work method statements shall be prepared for earthworks construction work.

Earthworks shall be carried out so as not to undermine any adjacent track structure.

An environmental management plan is required for all earthworks construction sites. The plan is to include control measures for erosion and sedimentation.

The disposal of unsuitable material shall be in accordance with the requirements specified in RailCorp's Asset Management Group Workplace Safety Manual and Environmental Management System.

Service searches shall be conducted to identify all underground services.

The location of the services shall be marked on site prior to the commencement of any earthworks.

Services that are located within the construction zone may require relocation so as not to adversely affect the performance of the completed earthworks.

# Chapter 2 Earthworks & Formation

## C2-1 General

The formation for single track mainlines and single track sidings shall comply with the appropriate dimensions shown on Drawing SP 521 in Appendix 1.

The formation for multiple track mainlines and multiple track sidings shall comply with the appropriate dimensions on Drawing SP 522 in Appendix 2.

## C2-2 Formation Shoulder Distance

Earthworks are to be constructed to achieve the formation shoulder distance as detailed in Appendix 3.

Where reduced shoulder distances exist due to physical constraints, an assessment is to be made of the need for safety refuges, handhold devices and limited clearance signs. The requirements are specified in ESC 350 “Retaining Walls and Platforms”.

## C2-3 Train Examination Areas

Where nominated, train examination areas are to be provided. The minimum requirement is to cover these areas with a 50mm layer of 10mm single sized aggregate as shown on Drawings SP 521 and SP 522.

The train examination area is not to be assumed as available for road access purposes.

## C2-4 Walkways

Where nominated, walkways are to be provided for staff to walk along the track cess. The minimum requirement is to cover walkways with a 50mm layer of 10mm single sized aggregate as shown in Drawings SP 521 and SP 522.

## C2-5 Drainage

The basic requirements for drainage are shown on Drawings SP 521 and SP 522.

Cess drains, sub-surface drains and top drains to cuttings shall be designed and installed in accordance with TMC 421 Track Drainage Manual.

## C2-6 Compaction

Compaction standards shall be as follows:

| | | |
|---|---|---|
| Compaction A: | - | Cohesive soils - Not less than 100% Relative Compaction as determined by AS 1289 Tests 5.1.1 and 5.3.1 (Standard Compaction) |
| | - | Rock fill or cohesionless soils - No visible deflection of surface under 10 tonne vibratory rollers after 6-8 passes. Relative density shall not be less than 75%. |
| Compaction B: | | Not less than 95% Relative Compaction as determined by AS 1289 Tests 5.1.1 and 5.3.1 (Standard Compaction). |

## C2-7 Non-compliance with Compaction Standards

Material not complying with the specified compaction standard shall only be used with the approval of the Principal Engineer Geotechnical.

# Chapter 3 Preparation for Earthworks

## C3-1 General

Prior to commencing earthworks, the Site Supervisor shall determine proposed work methods, taking into account the physical conditions at the site.

## C3-2 Site Clearing

The whole area to be occupied by the completed works is to be cleared and grubbed plus a clearance of 2m from tops of cuttings and toes of embankments.

Clearing includes removal and disposal of all trees, stumps, logs, timber, scrub, vegetation, rubbish and other material unsuitable for incorporation in the work. Unsuitable material includes topsoil, peat and other highly organic soils, logs, stumps, perishable material, material susceptible to spontaneous combustion, free draining materials susceptible to scouring, very fine sand, silt, organic clay, highly dispersive soils and material with a CBR < 1%.

Dispersive soils can be used only in accordance with guidelines provided by a Geotechnical Engineer.

Where unsuitable material exists in excessive depths the advice of a Geotechnical Engineer is required.

Grubbing is to be carried out to the level of 0.5m below natural surface or 1.5m below finished earthworks level.

Holes left after grubbing under proposed embankments are to be filled with sound material and compacted in layers as for embankments.

Topsoil shall be removed over the area that will be occupied by the completed works plus a clearance of 2 metres.

Where required for re-use in landscaping and revegetation, topsoil shall be placed in a stockpile clear of the work.

All material unsuitable for incorporation in the work shall be disposed off-site, unless approved for re-use on site e.g. noise barriers.

# Chapter 4 Embankments

## C4-1 Preparation of embankment base

Preparation includes clearing, grubbing, removal of topsoil and removal of unsuitable material and subsequent restoration as described in C3-2.

It also includes cutting of terraces into slopes, scarifying and compaction of embankment base and provision of drainage works as specified below.

Where embankments are to be constructed on a natural slope or on the slope of an existing embankment steeper than 4 to 1 (horizontal to vertical), the existing slope is to be cut in horizontal terraces at least 1.5m wide.

The terraces are to be cut progressively as the embankment is constructed (refer to Appendix 4).

Suitable material excavated in cutting the terraces may be incorporated in the embankment but unsuitable material must be disposed off-site.

The area of the base of the embankment shall be scarified to a depth of 100mm, parallel to the embankment axis.

A layer of general fill 100mm thick shall be spread over the scarified area, and the whole area shall be compacted to Compaction B standard as detailed in C1-8.

## C4-2 Drainage Blanket

Where shown on the drawings a drainage blanket is to be provided at the base of the embankment.

It will comprise a geotextile fabric (as approved by the Geotechnical Engineer) laid along the base and around a layer of free draining filter material to a depth of 300mm, and spall protection provided at the outlet.

Manufacturer's instructions concerning installation of the fabric shall be followed.

The free draining filter material shall be crushed rock, river gravel or slag composed of hard, strong and durable particles, and complying with SPC 411.

The filter material shall be spread in uniform layers to give the specified compacted thickness in such a manner as to avoid damage to the fabric.

Compaction is to be obtained using at least 8 passes of a vibratory roller of static drum load of 6 tonnes.

Bad ground, seepage or springs encountered during embankment preparation may require additional special treatment (refer to Appendix 4). Advice of the Geotechnical Engineer should be sought.

## C4-3 Embankment material

Embankment materials shall comply with Engineering Specification SPC 411 Earthworks Materials.

The embankment shall consist of two zones of embankment material:

- Structural Zone
- General Fill

The zones of the embankment shall be defined by the thickness of the structural zone (H) at the top of the embankment as determined by the following relationship with the general fill in the embankment:

For general fill with CBR 3-8%, H = 500mm

For general fill with CBR 1-3%, H = 1000mm.

Material for use in the structural zone shall comply with SPC 411.

Unsuitable material as defined in C3-2 shall not be used as general fill.

Material not complying with the above requirements is only to be used with the approval of the Geotechnical Engineer.

## C4-4 Placing embankment material

Embankments shall be constructed in full width horizontal layers.

Normally layers should not exceed 200mm thickness unless it can be shown that the specified compaction can be obtained for a thicker layer.

Layers or pockets of substantially varying material should be avoided.

The maximum particle size should be less than 2/3 of the compacted layer thickness.

Construction shall be carried out in such a manner as to ensure adequate drainage of the works, and to avoid scour and erosion.

## C4-5 Compaction of embankment material

Compaction shall be carried out at a moisture content that will allow the specified compaction to be achieved, normally within 2 per cent of optimum moisture content.

Where necessary water shall be added uniformly or drying carried out.

Bond between layers is to be ensured, if necessary by wetting or scarifying.

Embankments shall be compacted to:

| | |
|---|---|
| General Fill: | Below Structural Zone<br><br>= Compaction B |
| Structural Zone: | To 500mm or 1000mm below formation layer (i.e. Earthworks Level)<br><br>= Compaction A |

The earthworks in embankments shall be placed and compacted to a level 30 millimetres above the base of the capping layer.

Immediately prior to the placement of the capping, the fill shall be trimmed by grading to the final profile and compacted by a minimum of three passes of a smooth steel drum roller which has a static mass not less than 10 tonnes.

The finished, rolled surface shall be true to profile to a tolerance of +0 to -30mm, and shall be free of depression and ruts.

No traffic shall be allowed on the finished surface.

Field testing for Relative Compaction control shall be carried out for every 500 cubic metres (minimum) of fill placed, or more frequently as determined by the Geotechnical Engineer or Site Supervisor.

## C4-6 Embankment profile

Embankment batter slopes shall be as shown on the Drawings. Unless shown otherwise, the standard batter slope for embankments shall be 2:1 (horizontal:vertical), subject to confirmation by site specific stability analysis taking account of materials, height and foundation conditions.

# Chapter 5 Cuttings

## C5-1 Excavation

Excavation shall be carried out to the lines, levels, dimensions and slopes shown on the Drawings.

The excavated faces shall be neatly trimmed and the top edges of the cuttings neatly rounded.

Under cutting of slopes or the excavation of the toe of batters at a slope steeper than specified will not be permitted under any circumstances.

Excavation shall be carried out in such a manner as to prevent erosion or slips, working faces shall be limited to safe heights and slopes, and surfaces shall be drained to avoid ponding and erosion.

Overhanging, loose or unstable material likely to slip should be cut back removed or stabilised.

Rock cuttings and exposed rock surfaces shall be excavated so as to obtain smooth, uniformly trimmed surfaces.

Excavation at the base of cutting shall be finished at a level to suit the capping thickness, normally 150mm, and with crossfalls shown on the drawings. Tolerance on levels is between +0 and -50mm.

In addition the finished surface shall not deviate from the bottom of a 3 metre straight edge laid in any direction by more than 25mm.

## C5-2 Batter Slopes

Batter slopes in rock cuttings in excess of 3m high and closer than 6m from the track centreline shall be determined on the advice of a Geotechnical Engineer.

Unless shown otherwise on the Drawings, cutting slopes should be in accordance with the following guidelines:

| | Material | Slope Horizontal | : | Vertical |
|---|---|---|---|---|
| 1. | Sand | 2 | : | 1 |
| 2. | Wet clay, loose gravel | 2 | : | 1 |
| 3. | Sandy clay, boulders and clay compact gravelly soil, talus | 1.75 | : | 1 |
| 4. | Poor rock | 1.5 | : | 1 |
| 5.* | Sound shale dipping sharply towards railway formation, tight cemented gravel | 1 | : | 1 |
| 6.* | Ordinary rock | 1 | : | 1 |
| 7.* | Solid well bedded rock | 0.25 | : | 1 |

Typical (minimum) cutting slopes

* Maximum height without bench - 7m.

* Batter slopes in rock shall be confirmed by a Geotechnical Engineer.

The slopes shown above are subject to confirmation by site specific stability analysis taking account of materials, height and excavation conditions.

Slopes shown on the Drawings represent the estimated requirements for the expected types of material and will be subject to re-determination on the basis of site inspection and investigation during excavation. Any doubtful cases must be referred to a Geotechnical Engineer.

Batters in cuttings shall be carried around curves in an even and regular manner. Finished batters shall not have a slope steeper than that specified.

## C5-3 Compaction

Compaction of the top 150mm layer in the base of cuttings or of material required to fill over-excavation shall be 95 per cent relative compaction (modified) as determined by AS 1289 Test 5.2.1 or shall be solid rock.

# Chapter 6 Capping

Capping material shall comply with Engineering Specification SPC 411.

The capping material shall be suitably damp during transit from the source to the worksite to prevent segregation.

The capping layer shall be constructed in layers. No single layer shall have a compacted thickness greater than 150 millimetres or less than 75 millimetres.

The material shall be spread in uniform horizontal layers so as to achieve the specified compacted thickness for the full width of the capping layer.

Spreading shall be undertaken by a method that will ensure segregation does not occur, and so as not to rut or disturb the compacted material beneath it.

Where required for compaction purposes, water shall be added as necessary to achieve optimum moisture content and mixed uniformly with the capping material by approved mechanical means.

Compaction shall achieve a minimum density of 95 per cent relative compaction (modified) as determined by AS 1289 Test 5.2.1.

Rock and rock fines shall be distributed throughout each layer so that all voids are filled. The top of the final layer shall be graded and trimmed, and material shall be added as necessary to produce an even and impermeable surface.

The following tolerances are required for the capping layer:

## C6-1.1 Width

The width from the design centreline shall not be less than the dimensions for shoulder distance required by Appendix 3.

## C6-1.2 Level

The finished surface of the formation shall be within 25mm of the level shown on the drawings and:

- The algebraic difference of the deviations from the correct level for any two points 20 metres apart on the centreline shall not exceed 15mm.
- The deviation from a three (3) metre straight edge laid on the surface parallel to the centreline shall not exceed 10mm.

## C6-1.3 Transverse Slope

When tested with a three (3) metre straight edge laid perpendicular to the centre line the deviation from design profile shall not exceed 10mm concavity.

# Chapter 7 Widening of Existing Embankments

## C7-1 General

Embankments are widened:

- To dispose of spoil from other works
- To provide access to the track side
- To provide width for structures such as electrification masts
- To provide for additional tracks
- To rectify unstable or over-steep embankments.

Although embankments are often widened as a spoil disposal measure, the widened section becomes part of the embankment structure. Hence it is necessary for the work to be done in accordance with proper earthworks practice.

All work is to be in accordance with this Manual.

Sites for embankment widening are to be approved by the Civil Maintenance Engineer.

## C7-2 Preparation

### C7-2.1 Survey

The embankment widening shall be properly set out using batter pegs for toe of embankment and necessary survey for drainage structures.

### C7-2.2 Foundation Preparation

Unsuitable materials, including vegetable matter, organic clay and silt, ash and material which is unstable when wet, are to be moved from the base of the embankment widening and the side of existing embankments.

The embankment base is to be prepared in accordance with C4-1.

### C7-2.3 Drainage Structures

Existing culverts and particularly suburban drains are to be located, extended and cleared by hydroblasting or similar to ensure satisfactory flow of watercourses.

Care is to be taken to ensure that moisture is not trapped between the existing and the widened embankment, and water does not pond against the toe of the embankment.

See other standards for details of culvert construction.

### C7-2.4 Drainage Blanket

A drainage blanket is to be laid at the base of the embankment in accordance with C4-2.

The procedure is:

- Excavate into the embankment toe to give a 1m scarp.
- Spread and compact layer of coarse rock 300mm thick. Scour protection shall be provided by placing large boulders on the outer edge of the drainage layer.
- Place geotextile over the drainage layer.
- The geotextile is to be covered with a layer of fill material 500mm thick compacted to Compaction B standard as detailed in C1-8.

## C7-3 Embankment Construction

The embankment shall be constructed by a benching procedure as specified in C4-1, as follows:

- Excavate into the embankment to give a 1 metre scarp
- Dispose of vegetation and other unsuitable material
- The exposed material is to be identified as either:
  - Non-porous such as clay
  - free draining such as ash, sand, cobbles and boulders
  - seepage zones
- If free draining or seeping water, the bench must be connected to the lower drainage blanket, or an additional drainage layer may be constructed using coarse rock 300mm thick, as in C5-2.4
- Place compacted fill until a compacted thickness of 0.5 m is achieved
- Repeat the above steps until the top of required embankment widening is achieved.

A capping layer using spent ballast or other suitable material is to be provided at the top of the embankment, constructed in accordance with Chapter 6.

The capping layer is to be at a level below the track capping level or track formation level, with a crossfall of 1 in 30 away from the track.

## C7-4 Drainage and Erosion Control

A windrow is to be provided on the embankment shoulder in sandy soils and the shoulders graded to drain to controlled drains down the embankment.

Cess drains, catch drains and mitre drains are to be provided in accordance with other standards.

Drains down the embankment are to be protected from erosion.

Appropriate erosion control is to be carried out including topsoiling, mulching and re-vegetation of embankment slope with grass and native plants.

# Chapter 8 Earthworks near Structures

## C8-1 Construction

Care shall be exercised in constructing earthworks within 5m of structures to avoid damage to the structures.

Non-vibratory compaction equipment shall be used within this distance of the structure and adjacent to the structure.

Free draining filter material encapsulated in geotextile fabric should be placed adjacent to weep-holes, horizontally for at least 300mm from, and vertically for 450mm above the weep-hole.

Select back fill material complying with the requirement for capping material, except that a minimum of 60% shall be retained on a 2.36mm sieve, shall be used adjacent to structures as follows:

| **Structure** | **Minimum Width & Height of Selected Fill** | **Compaction Method** |
|---|---|---|
| Bridge abutment and wing walls | 2m wide for full height | Hand held compaction equipment for full structure height for a distance of 2/3 H (H = 0verall height of structure) |
| Pipe Culverts | 300mm width each side and above top pipes | Hand held compaction equipment for distance D from pipe to top of pipe (D= diameter of pipe) |
| Box culverts & culvert wing walls & retaining wall | H/3 wide for full height (H= overall height) | Hand held compaction equipment for full structure height for a distance 2/3 H from wall (H = overall height) |

Earthworks near Structures

## C8-2 Excavation

Care should also be exercised when excavating within 5m of structures (for example near overhead wiring structures when benching into slopes for embankment widening or when excavating for track reconditioning).

No excavation should be made within this 5m distance without prior analysis of structure stability with respect to the effects of the excavation.

No excavation shall be made below the base of the footings of any structure (for example bridges, retaining walls and station platform walls) without prior analysis of structure stability with respect to the effects of the excavation.

# Chapter 9 Earthworks - Geotechnical Problems

## C9-1 General

Geotechnical problems require expert attention to determine the nature of the problem and the remedy required.

Maintenance staff should be aware of the warning signs that could point to potential geotechnical problems so that investigation of the problem can be undertaken by the Geotechnical Services Section.

The supporting track structure should be inspected during track patrols and detailed walking inspections.

Some warning signs to look for are detailed below.

## C9-2 Embankment problems

### C9-2.1 Tension Cracks

Tension cracks along the shoulder of the embankment could indicate movement of the embankment and possible shear failure.

### C9-2.2 Bulge in the Slope or Toe

Bulges in the slope or at the toe could indicate heaving of the material during failure.

Any bulge in an embankment should be reported and checked.

### C9-2.3 Seepage from Toe

Seepage could indicate that the embankment is saturated or the base is being weakened and a flow movement or shear failure could result.

### C9-2.4 Slacks in the Track

Slacks or holes in the track could indicate embankment problems, especially if associated with tension cracks or bulges.

### C9-2.5 Culverts or Pipes, Cracked or Broken

This could indicate movement within the embankment and should be reported and montitored.

### C9-2.6 Local High Ballast

Ballast that is of a far greater depth than the surrounding track could indicate an old depression suggesting areas of previous problems or failure. Other warning signs could include:

- Leaning poles of structures
- Water Ponding at the toe
- Loss of Shoulder Ballast

## C9-3 Problems in cuttings

The danger of rockfalls in cuttings is very high and close attention must be paid to cutting faces during inspections.

### C9-3.1 Small Rock Falls

These could indicate that larger rocks may be in danger of falling.

### C9-3.2 Cracks in Rock Face

Cracks should be checked as large rocks may become loose and fall. This is especially dangerous if the cracks isolate a section or block of rock especially if this isolated block is undercut.

### C9-3.3 Seepage in Rock Face

Seepage could undermine or create a slipery surface causing rocks to become dislodged.

### C9-3.4 Undermined Rocks

Should be investigated to determine the danger of them falling.

### C9-3.5 Trees Growing from Cracks

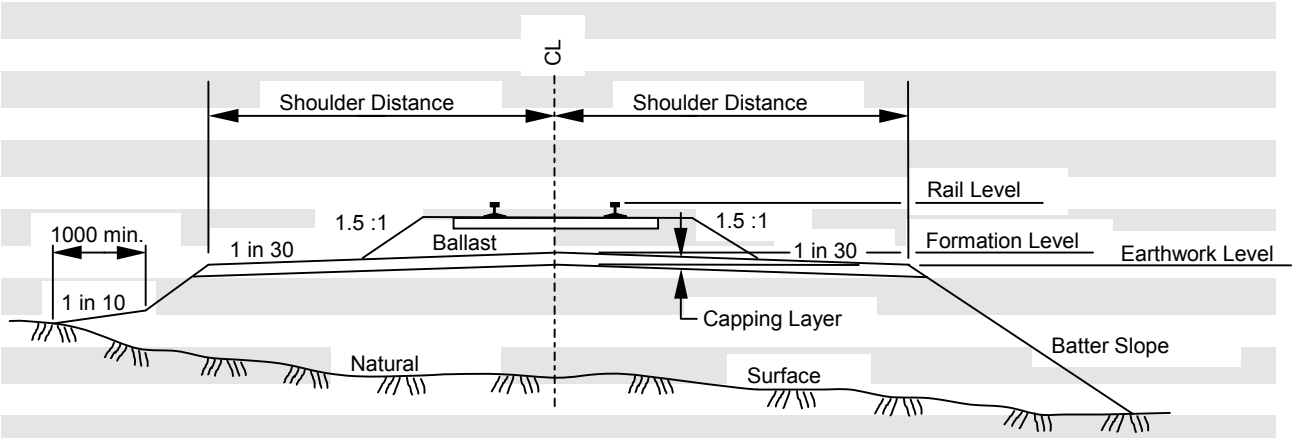
Trees growing from cracks in rock cuttings should be removed as the root action will dislodge rocks. Trees should be cut and the stumps poisoned within 5 seconds of cutting to ensure they are killed.

### C9-3.6 Thick Vegetation

While thick vegetation on earth cuttings and embankments may assist in holding them stable and should not be removed,in rock cuttings it may indicate an area of soft moist earth that may undermine or cause large rocks to slip.

If any of these conditions are noticed by track maintenance staff they should be reported to their controlling officer who will arrange for the Geotechnical Services Section to investigate.

# Appendix 1 – Single Track Formation (SP 521)

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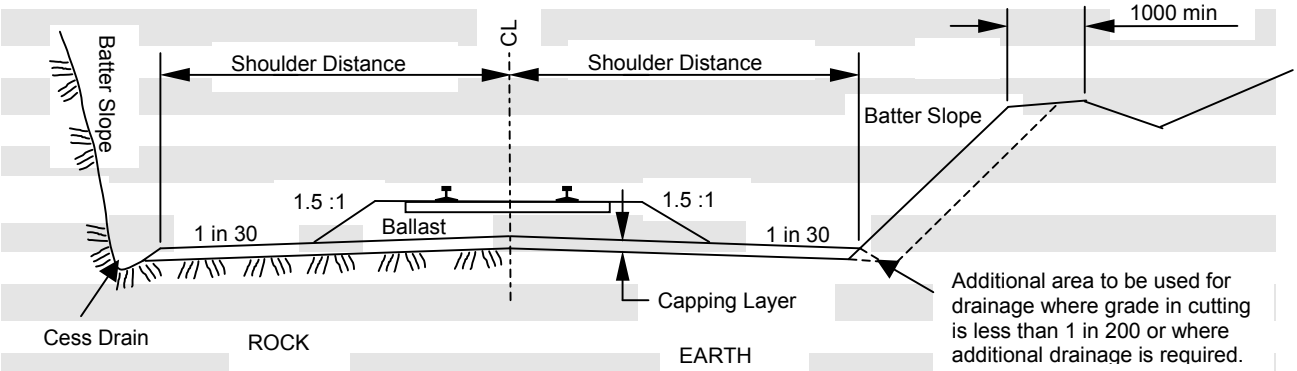
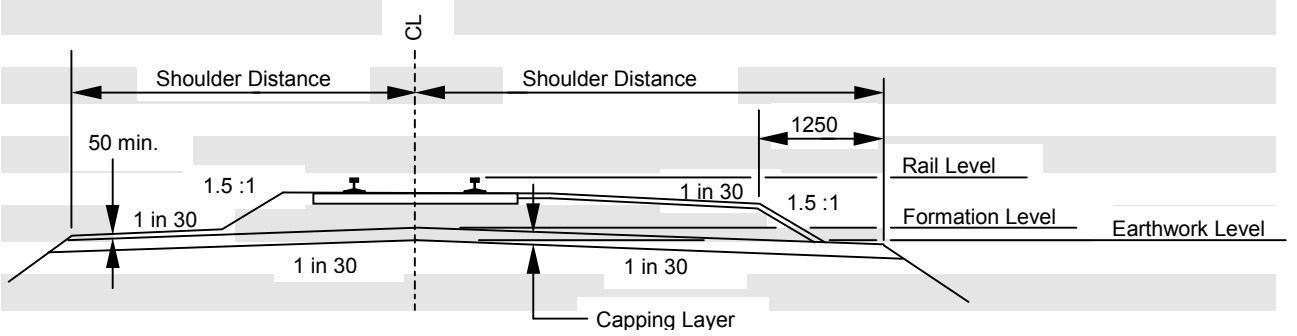



**CUTTING**

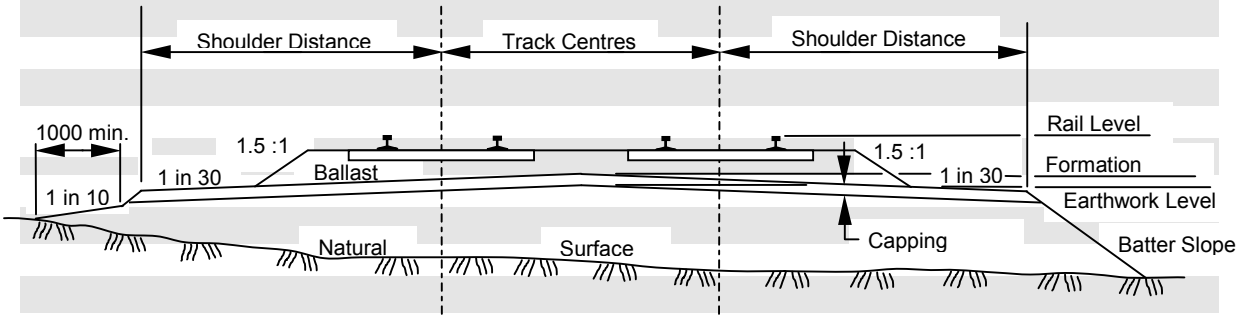



Typical section where shunters' and guards' walkways are required.

Typical section where examinations areas are specified.

**SPECIAL WIDTH REQUIREMENTS**

# Appendix 2 – Multiple Track Formation (SP 522)

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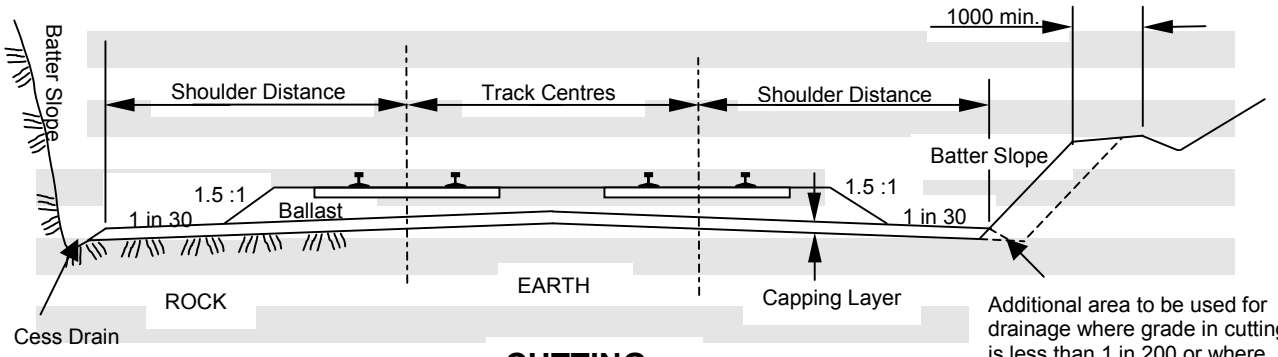
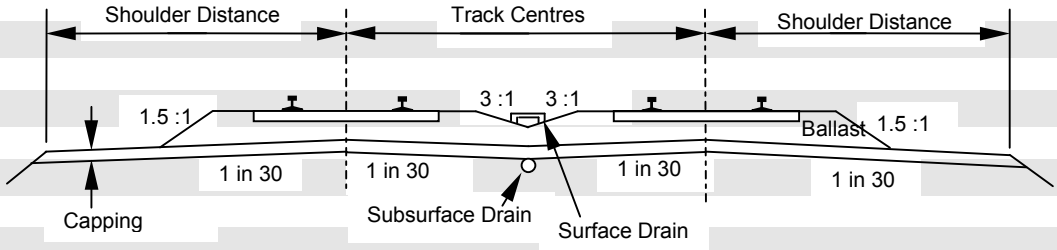
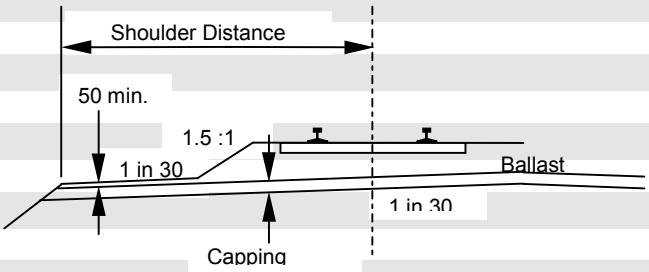



**CUTTING**




**CENTRE DRAIN**



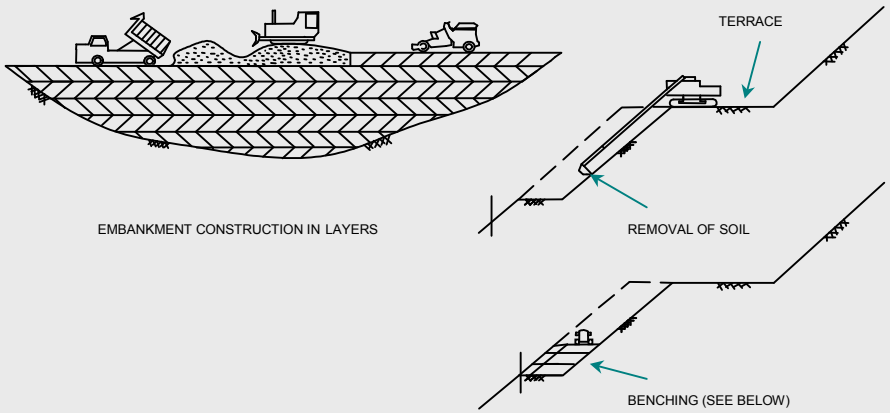

Typical section where shunters' and guards' walkways are required.

**SPECIAL WIDTH REQUIREMENTS**

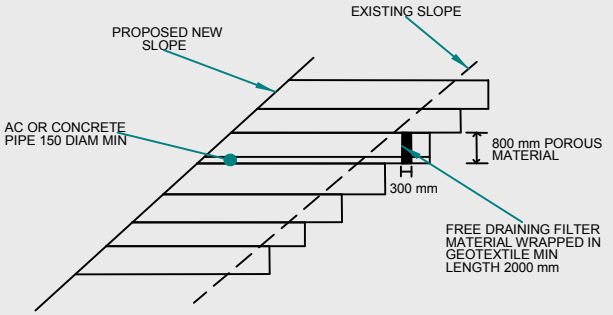
# Appendix 3 – Shoulder Distance

| Shoulder width | |
|---|---|
| **Plain track** | mm |
| Main line (Electrified or non-electrified) | 4250 |
| Siding (Electrified) | 4250 |
| Siding (Non-electrified) | 3000 |
| Main line or siding with parallel access road (Electrified) | 6200 |
| Main line or siding with parallel access road (Non-electrified) | 5500 |
| **Special Requirements** | |
| Shunters and guards parallel walkways | 4250 |
| Train Examination areas | 5500 |
| Train Examination areas with parallel access road | 7750 |
| Clear width of road from back of any structure | 3000 |

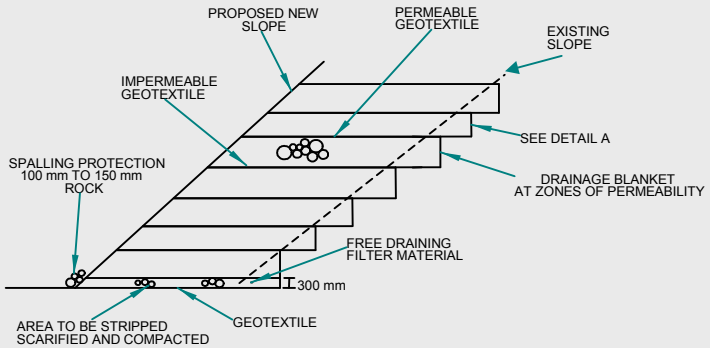
# Appendix 4 – Earthworks Construction Drawing



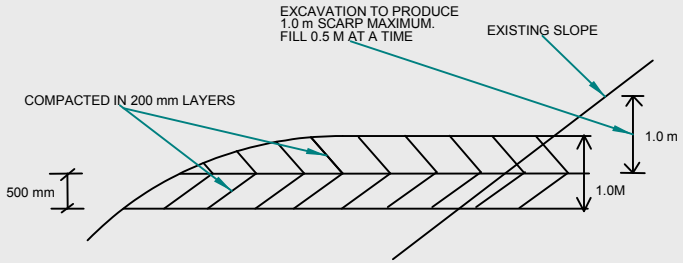

**EMBANKMENT CONSTRUCTION & BENCHING PROCEDURES**




**TREATMENT OF LOCALISED SEEPAGE OR POROUS ZONES**




**TYPICAL BENCHING PROCEDURE**




**DETAIL A**

## EARTHWORKS CONSTRUCTION

# SPC 411

# SPECIFICATION
# EARTHWORK MATERIALS

**Version 1.0**

**Issue Date October, 2006**

Owner Principal Engineer Geotechnical

Approved By: John Stapleton
Group Leader Standards

Authorised By: Jee Choudhury
Principal Engineer

# Table of Contents



# Revision Control Table

| ***Revision*** | ***Date of Approval*** | ***ECP/DCN No.*** | ***Summary of change*** |
|---|---|---|---|
| 1 | | | Original Issue |
| | | | |
| | | | |
| | | | |

# 1. Scope and Application

This specification details the material properties for soil used to provide the embankment material and the formation capping layer for track formation.

Embankment and capping materials used for RailCorp tracks shall comply with the requirements of this specification.

# 2. Version History

New specification.

This document replaces TS 3422 Standard for Formation Capping Material.

# 3. Applicable Standards

| | |
|---|---|
| ESC 410 | Earthworks & Formation |
| AS 1141 | Methods for Sampling and Testing Aggregates |
| AS 1289 | Methods of Testing Soils for Engineering Purposes |
| AS 1726 | Geotechnical Site Investigations |

# 4. Embankment Material

## 4.1. Free Draining Filter Material

The free draining filter material for drainage blankets shall be crushed rock, river gravel or slag composed of hard, strong and durable particles to satisfy the requirements of this specification.

### 4.1.1 Particle Size Distribution

| Description | Criteria |
|---|---|
| % passing 53.0mm sieve | 100 |
| % passing 37.5mm sieve | 90 - 100 |
| % passing 26.5mm sieve | 20-55 |
| % passing 19.0mm sieve | 0-5 |
| % passing 75μm sieve | 0 |

### 4.1.2 Abrasion Resistance

The Los Angeles Value (Grading A) shall be a maximum of 30%.

## 4.2. General Fill

General fill shall consist of material that can be compacted to not less than 95% Maximum Dry Density as determined by AS 1289 Tests 5.1.1 and 5.3.1.

Unsuitable material as defined in 4.2.1 shall not be used as general fill.

### 4.2.1 Unsuitable Material

Unsuitable material shall not be used. Unsuitable material includes topsoil, peat and other highly organic soils, logs, stumps, perishable material, material susceptible to spontaneous combustion, free draining materials susceptible to scouring, very fine sand, silt, organic clay and highly dispersive soils.

Dispersion shall be determined in accordance with AS 1289 Test 3.8.1. Soils with an Emerson Class number of 1 are unsuitable material.

#### 4.2.2 Soaked CBR

The soaked CBR shall be in excess of 3%.

### 4.3. Structural Zone Fill Material

Structural zone fill material shall comply with the following specification requirements.

#### 4.3.1 Particle Size Distribution

| Description | Criteria |
|---|---|
| % passing 53.0mm sieve | 80 - 100 |
| % passing 2.36mm sieve | 15 - 100 |
| % passing 425μm sieve | 5 - 70 |
| % passing 75μm sieve | 0 - 30 |

#### 4.3.2 Atterberg Limits

| | |
|---|---|
| Liquid Limit | Maximum 40 |
| Plasticity Index | Maximum 20 |

#### 4.3.3 Dry Density

The maximum dry density shall be a minimum of 18kN/cu.m

#### 4.3.4 Soaked CBR

The soaked CBR shall be a minimum of 8%.

## 5. Capping Material

### 5.1. Performance Requirements

Material proposed for capping shall be a well graded natural or artificially blended gravel/soil.

It shall have sufficient fines to permit it to be compacted to high densities by static or vibratory steel-tyred rollers or by ballasted pneumatic-tyred rollers.

Finished capping material shall provide an impermeable layer.

Materials such as natural ridge gravel free from vegetable matter, ripped sandstones with low clay content and crushed and blended tough, durable rock or slag, have been found to meet the material properties of this specification.

## 5.2. Material Properties

Natural gravels may be combined to provide material that conforms to this specification. Crushed rock shall include such added material as necessary for the combined material to satisfy the requirements of this specification.

The material shall have properties that conform to the following requirements.

### 5.2.1 Particle Size Distribution

Material shall be well graded with maximum nominal size of 20mm, and with typical particle size distribution as follows:

| AS Sieve Size | Percentage Passing |
|---|---|
| 53mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19.0mm | 95-100 |
| 9.5mm | - |
| 4.75mm | - |
| 2.36mm | 30-80 |
| 0.075mm | 6-10 |

### 5.2.2 Atterberg Limits

Capping material shall comply with the following Atterberg Limits:

| | |
|---|---|
| Liquid Limit | Maximum 30 (35 for arid areas) |
| Plastic Limit | Maximum 20 |
| Plasticity Index | 4 -10 (4 -15 for arid areas) |
| Linear Shrinkage | Maximum 3% |

### 5.2.3 Dry Density

The maximum dry density shall be a minimum of 20kN/cu.m

### 5.2.4 Soaked CBR

The soaked CBR shall be a minimum of 50.

# 6. Validation Requirements

## 6.1. Sampling

Samples of materials for laboratory testing shall be taken and handled in accordance with AS 1726, and AS 1141, Section 3.

Samples of material proposed for use shall be tested and the results considered in the final selection of material.

## 6.2. Test Requirements – free draining filter material

The following tests shall be carried out on the free draining filter material to confirm compliance with the specified performance requirements:

| | |
|---|---|
| Particle size distribution | AS 1289 Test 3.6.1 |
| Soft and friable particles | AS1141. 32 |
| Clay lumps | AS1141.30 |
| Los Angeles Value | AS1141. 23 |
| Particle density | AS1141.6 |

## 6.3. Test Requirements – general fill material

The following test shall be carried out on the general fill material to confirm compliance with the specified performance requirements:

| | |
|---|---|
| Soaked CBR (Standard compaction) | AS 1289 Test 6.1.1 |
| Dispersion – Determination of Emerson class number of a soil | AS 1289 Test 3.8.1 |

## 6.4. Test Requirements – structural zone fill material

The following tests shall be carried out on the structural zone fill material to confirm compliance with the specified performance requirements:

| | |
|---|---|
| Particle Size Distribution | AS 1289 Test 3.6.1 |
| Liquid Limit | AS 1289 Test 3.1.1 |
| Plasticity Index | AS 1289 Test 3.3.1 |
| Maximum Dry Density | AS 1289 Test 5.1.1 |
| Soaked CBR (Standard compaction) | AS 1289 Test 6.1.1 |

## 6.5. Test Requirements – capping material

The following tests shall be carried out on the capping material to confirm compliance with the specified performance requirements:

| | |
|---|---|
| Particle Size Distribution | AS 1289 Test 3.6.1 (Wet Sieve Procedure) |
| Liquid Limit | AS.1289 Test 3.1.1 or<br>AS 1289 Test 3.9 |
| Plastic Limit | AS.1289 Test 3.2.1 |
| Plasticity Index | AS.1289 Test 3.3.1<br>AS.1289 Test 3.3.2 |
| Linear Shrinkage | AS.1289 Test 3.4.1 |
| Dry Density | AS 1289 Test 5.2.1 |
| Soaked CBR | AS 1289 Test 6.1.1*<br>*Compacted to 95% (min) Maximum Dry Density obtained by AS 1289 5.2.1 & with 9kg surcharge. |

# Earthworks and Formation

**ESC 410** Version 1.0 Issue Date: September, 2006

## Purpose

This Standard establishes requirements for earthworks and formation for new track construction and major reconstruction of existing track.

It is applicable to main lines and sidings owned by RailCorp.

## Table of Contents



Owner Principal Engineer Geotechnical

| | | | |
|---|---|---|---|
| Approved By: | John Stapleton<br>Group Leader Standards | Authorised By: | Jee Choudhury<br>Principal Engineer |

# 1. Scope and Application

This document establishes the earthworks and formation requirements for new construction and major reconstruction of main lines and sidings owned by RailCorp.

# 2. Version History

First issue in this format.

This document replaces:

C 1100 Earthworks Construction Procedures

TS 3421 General Standards for Formation and Earthworks

TS 3422 Standard for Formation Capping Material

# 3. References

## 3.1. Australian and International Standards

AS 1289 Methods of Testing Soils for Engineering Purposes

## 3.2. RailCorp Documents

ESC 215 Transit Space

ESC 350 Retaining Walls and Platforms

ESC 420 Track Drainage

SPC 411 Earthworks Materials

## 3.3. Other References

Nil.

# 4. Definitions

| | |
|---|---|
| Rail Level: | Theoretical level of the running surface of the rails. In the case of superelevated track it is the low rail. |
| Formation Level: | Finished level at the centre of the formation preparatory to laying ballast. It includes the required capping layer. |
| Earthworks Level: | Level at the centre of the earthworks prior to placing of the capping layer. |
| Formation Width: | Width at formation level. |
| Shoulder Distance: | Distance from the track centreline to the edge of the formation. |
| Capping Layer: | Layer of compacted material that provides an impermeable seal to the earthworks. |
| Structural Zone: | The upper zone of the embankment. Thickness varies from 500mm to 1000mm, depending on the CBR of the general fill. |
| General Fill: | The lower zone of the embankment. |

# 5. Width of Property (Right of Way)

The width of property for new lines shall be a minimum of 40 metres and increased if necessary to allow for a 4m access road on each boundary at normal ground level in addition to the necessary earthworks for the formations and associated drainage.

For new lines, the track shall be designed in the centre of the property. Single tracks to be ultimately duplicated are to be aligned 2 m off the centre of the property.

The width of the right of way shall also provide for drainage as detailed in this document and associated specification.

Special consideration is to be given to additional land that may be required for deviation of creeks.

Underground cables for signalling and communications are to be located in natural ground, and not in the shoulder areas of the formation.

In multiple tracks and other restricted locations, cable connections to signals may be located in the formation, provided the formation capping is properly restored after completion of the cable laying works.

# 6. Formation

The formation for single track mainlines and single track sidings shall comply with the appropriate dimensions shown on Drawing SP 521 in Appendix 1.

The formation for multiple track mainlines and multiple track sidings shall comply with the appropriate dimensions on Drawing SP 522 in Appendix 2.

Shoulder distances shall comply with Appendix 3.

Track centres shall be in accordance with ESC 215 “Transit Space”.

Where reduced shoulder distances exist due to physical constraints, an assessment is to be made of the need for safety refuges, handhold devices and limited clearance signs. The requirements are specified in ESC 350 “Retaining Walls and Platforms”.

# 7. Embankments

Embankment materials shall comply with Engineering Specification SPC 411 Earthworks Materials.

The earthworks in embankments shall be placed and compacted to a level 30 millimetres above the base of the capping layer.

Compaction standards shall be as follows:

| | | |
|---|---|---|
| Compaction A: | - | Cohesive soils - Not less than 100% maximum dry density as determined by AS.1289 Tests 5.1.1 and 5.3.1 (Standard Compaction) |
| | - | Rock fill or cohesionless soils - No visible deflection of surface under 10 tonne vibratory rollers after 6-8 passes. Relative density shall not be less than 75%. |
| Compaction B: | | Not less than 95% maximum dry density as determined by AS.1289 Tests 5.1.1 and 5.3.1 (Standard Compaction). |

The embankment shall consist of two zones of embankment material:

- Structural Zone
- General Fill

The zones of the embankment shall be defined by the thickness of the structural zone (H) at the top of the embankment as determined by the following relationship with the general fill in the embankment:

- for general fill with CBR*3-8%, H = 500mm
- for general fill with CBR*1-3%, H = 1000mm.

* (Soaked California Bearing Ratio, Standard Compaction).

Material for use in the structural zone shall comply with SPC 411.

Embankments shall be compacted to:

| | |
|---|---|
| General Fill: | Below Structural Zone<br><br>= Compaction B |
| Structural Zone: | To 500mm or 1000mm below formation layer (i.e. Earthworks Level)<br><br>= Compaction A |

Embankment batter slopes shall be as shown on the Drawings. Unless shown otherwise, the standard batter slope for embankments shall be 2:1 (horizontal:vertical), subject to confirmation by site specific stability analysis taking account of materials, height and foundation conditions.

Immediately prior to the placement of the capping, the fill shall be trimmed by grading to the final profile and compacted by a minimum of three passes of a smooth steel drum roller which has a static mass not less than 10 tonnes.

The finished, rolled surface shall be true to profile to a tolerance of +0 to -30mm, and shall be free of depression and ruts.

No traffic shall be allowed on the finished surface.

# 8. Cuttings

## 8.1. Excavation

Excavation shall be carried out to the lines, levels, dimensions and slopes shown on the Drawings.

The excavated faces shall be neatly trimmed and the top edges of the cuttings neatly rounded.

Under cutting of slopes or excavation of the toe of batters at a slope steeper than specified will not be permitted under any circumstances.

Excavation shall be carried out in such a manner as to prevent erosion or slips, working faces shall be limited to safe heights and slopes, and surfaces shall be drained to avoid ponding and erosion.

Overhanging, loose or unstable material likely to slip should be cut back removed or stabilised.

Rock cuttings and exposed rock surfaces shall be excavated so as to obtain smooth, uniformly trimmed surfaces.

Excavation at the base of cutting shall be finished at a level to suit the capping thickness,

normally 150mm, and with crossfalls shown on the drawings. Tolerance on levels is between +0 and -50mm.

In addition the finished surface shall not deviate from the bottom of a 3 metre straight edge laid in any direction by more than 25mm.

## 8.2. Batter Slopes

Batter slopes in rock cuttings in excess of 3m high and closer than 6m from the track centreline shall be determined on the advice of a Geotechnical Engineer.

Unless shown otherwise on the Drawings, cutting slopes should be in accordance with the following guidelines:

| | | Slope | | |
|---|---|---|---|---|
| **Material** | | **Horizontal** | **:** | **Vertical** |
| 1. | Sand | 2 | : | 1 |
| 2. | Wet clay, loose gravel | 2 | : | 1 |
| 3. | Sandy clay, boulders and clay compact gravelly soil, talus | 1.75 | : | 1 |
| 4. | Poor rock | 1.5 | : | 1 |
| 5.* | Sound shale dipping sharply towards railway formation, tight cemented gravel | 1 | : | 1 |
| 6.* | Ordinary rock | 1 | : | 1 |
| 7.* | Solid well bedded rock | 0.25 | : | 1 |

Typical (minimum) cutting slopes

* Maximum height without bench - 7m.

* Batter slopes in rock shall be confirmed by a Geotechnical Engineer.

The slopes shown above are subject to confirmation by site specific stability analysis taking account of materials, height and excavation conditions.

Batters in cuttings shall be carried around curves in an even and regular manner. Finished batters shall not have a slope steeper than that specified.

## 8.3. Compaction

Compaction of the top 150mm layer in the base of cuttings or of material required to fill over-excavation shall be 95 per cent maximum dry density as determined by AS 1289 Test 5.2.1 or shall be solid rock.

# 9. Capping Layer

Capping material shall comply with Engineering Specification SPC 411 Earthworks Materials.

The capping material shall be suitably damp during transit from the source to the worksite to prevent segregation.

The capping layer shall be constructed in layers. No single layer shall have a compacted thickness greater than 150 millimetres or less than 75 millimetres.

The material shall be spread in uniform horizontal layers so as to achieve the specified compacted thickness for the full width of the capping layer.

Spreading shall be undertaken by a method that will ensure segregation does not occur, and so as not to rut or disturb the compacted material beneath it.

Where required for compaction purposes, water shall be added as necessary to achieve optimum moisture content and mixed uniformly with the capping material by approved mechanical means.

Compaction shall achieve a minimum density of 95 per cent maximum dry density as determined by AS 1289 Test 5.2.1.

Rock and rock fines shall be distributed throughout each layer so that all voids are filled. The top of the final layer shall be graded and trimmed, and material shall be added as necessary to produce an even impermeable surface.

The following tolerances are required for the capping layer:

### 9.1. Width

The width from the design centreline shall be not less than the dimensions for shoulder distance required by Appendix 3.

### 9.2. Level

The finished surface of the capping shall be within 25mm of the level shown on the drawings and:

- The algebraic difference of the deviations from the correct level for any two points 20 metres apart on the centreline shall not exceed 15mm.
- The deviation from a three (3) metre straight edge laid on the surface parallel to the centreline shall not exceed 10mm.

### 9.3. Transverse Slope

When tested with a three (3) metre straight edge laid perpendicular to the centre line the deviation from design profile shall not exceed 10mm concavity.

## 10. Drainage

The basic requirements for drainage are shown on the drawings in the Appendices.

Cess drains, sub-surface drains and top drains to cuttings are to comply with the requirements in ESC 420 “Track Drainage”.

## 11. Train Examination Areas

Where nominated, train examination areas are to be provided. The minimum requirement is to cover these areas with a 50mm layer of 10mm single sized aggregate as shown on Drawings SP 521 and SP 522.

The train examination area is not to be assumed as available for road access purposes.

## 12. Walkways

Where nominated, walkways are to be provided for staff to walk along the track cess. The minimum requirement is to cover walkways with a 50mm layer of 10mm single sized aggregate as shown on Drawings SP 521 and SP 522.

## 13. Earthworks near Structures

Care shall be exercised in constructing earthworks within 5m of structures to avoid damage to the structures.

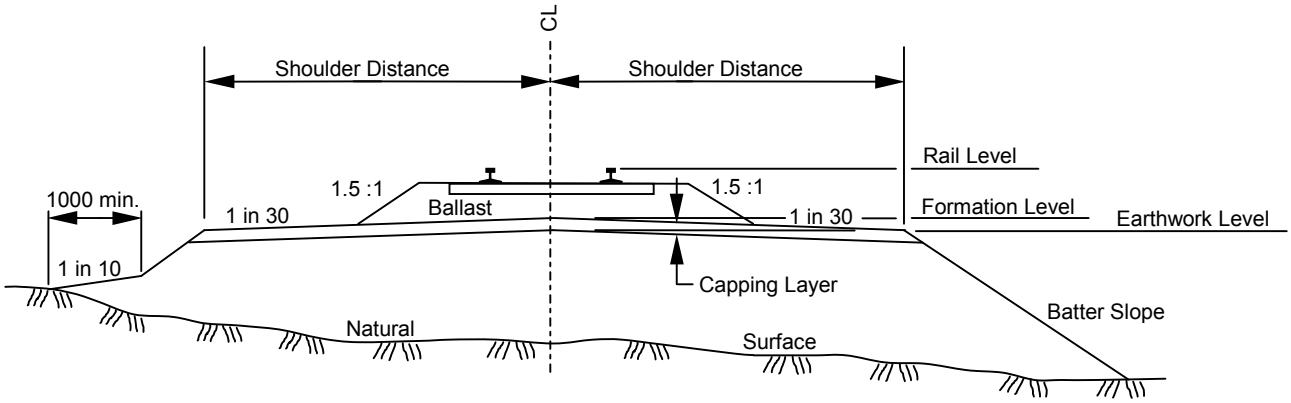
Non-vibratory compaction equipment should be used within this distance and adjacent to the structure further limitations, as defined in the Table, apply.

Free draining filter material encapsulated in geotextile fabric should be placed adjacent to weep-holes, horizontally for at least 300mm from, and vertically for 450mm above the weep-hole.

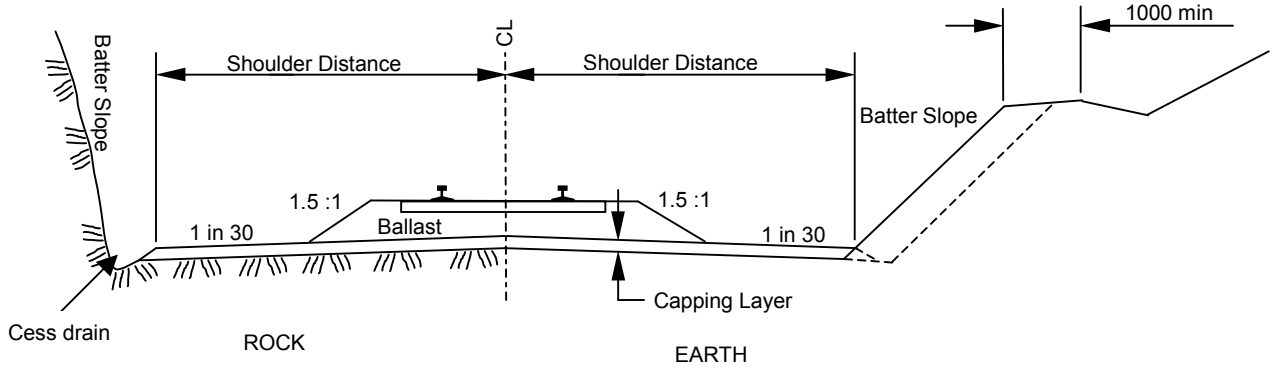
Select back fill material complying with the requirement for capping material except that a minimum of 60% shall be retained on a 2.36mm sieve, shall be used adjacent to structures as follows:

| **Structure** | **Minimum Width & Height of Selected Fill** | **Compaction Method** |
|---|---|---|
| Bridge abutment and wing walls | 2m wide for full height | Hand held compaction equipment for full structure height for a distance of 2/3 H (H = overall height of structure) |
| Pipe Culverts | 300mm width each side and above top pipes | Hand held compaction equipment for distance D from pipe to top of pipe (D= diameter of pipe) |
| Box culverts & culvert wing walls & retaining wall | H/3 wide for full height (H= overall height) | Hand held compaction equipment for full structure height for a distance 2/3 H from wall (H = overall height) |

# Appendix 1 – Single Track Formation (SP 521)




**EMBANKMENT**

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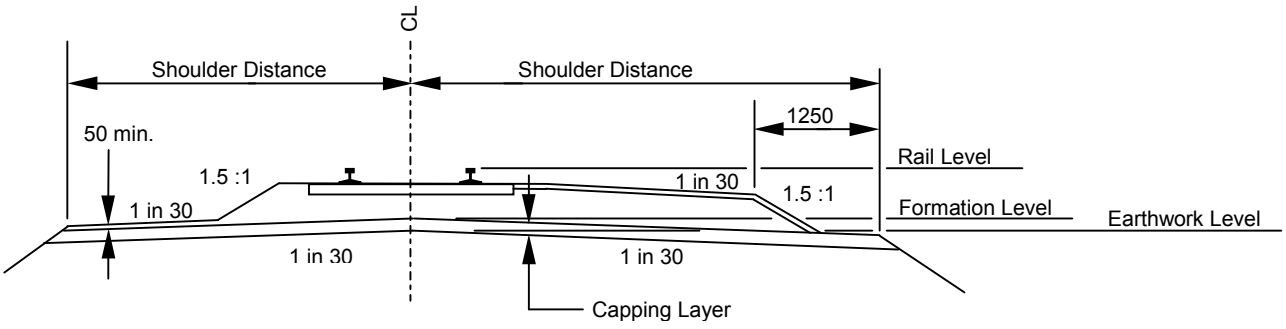
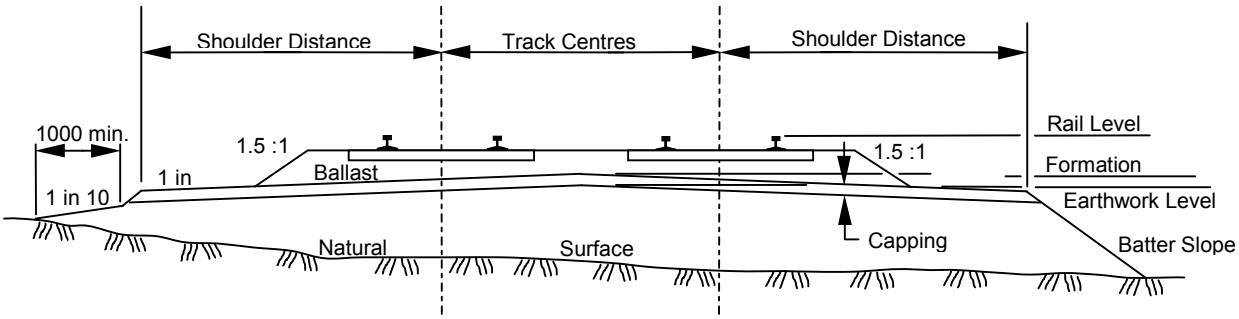



Typical section where shunters' and guards' walkways are required.

Typical section where examinations areas are specified.

**SPECIAL WIDTH REQUIREMENTS**

# Appendix 2 – Multiple Track Formation (SP 522)

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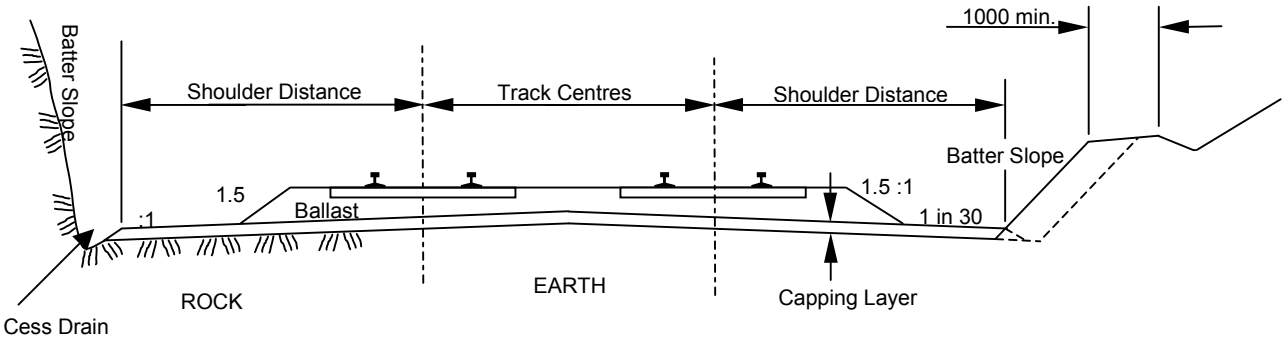


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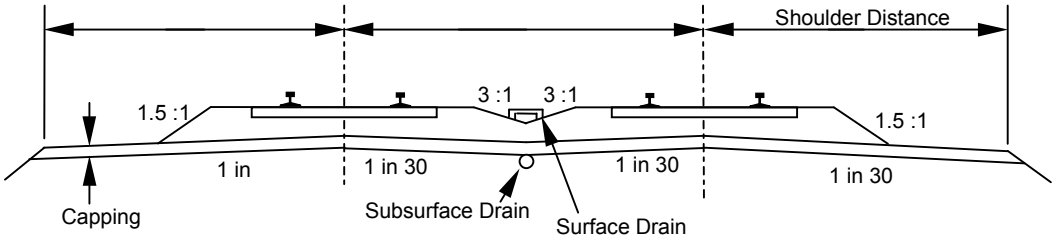
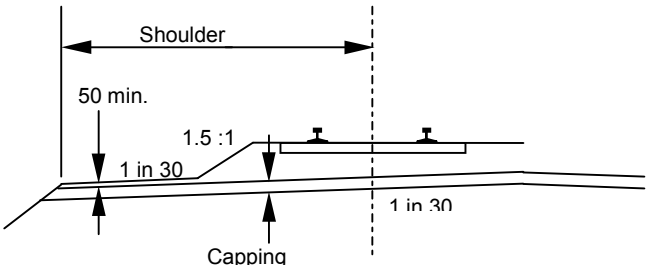



**CENTRE DRAIN**




Typical section where shunters' and guards' walkways are required.

**SPECIAL WIDTH REQUIREMENTS**

# Appendix 3 – Shoulder Distance

| Shoulder distance | |
|---|---|
| **Plain track** | mm |
| Main line (Electrified or non-electrified) | 4250 |
| Siding (Electrified) | 4250 |
| Siding (non-electrified) | 3000 |
| Main line or siding with parallel access road (Electrified) | 6200 |
| Main line or siding with parallel access road (Non-electrified) | 5500 |
| **Special Requirements** | |
| Shunters and guards parallel walkways | 4250 |
| Train Examination areas | 5500 |
| Train Examination areas with parallel access road | 7750 |
| Clear width of road from back of any structure | 3000 |

# Appendix E
# General Approvals for Immobalisation

**‘GENERAL APPROVALS OF IMMOBILISATION’**
**PUBLISHED IN THE NSW GOVERNMENT GAZETTE**

Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* (Waste Regulation) specifies that EPA may approve the immobilisation of specified contaminant(s) contained in a particular type of waste. Approvals of the immobilisation of contaminants may be given in the following ways:

- the EPA can issue general approvals which would apply to all waste generated that has the properties specified in the approval, or
- for a specific waste as a result of an individual application received by the EPA.

In either case, an approval is subject to such conditions determined by the EPA, and remains in force until such time as it is revoked by the EPA.

Approvals of immobilisation may specify conditions relating to the subsequent storage, treatment or disposal of the waste. For example, in certain cases the EPA will consider specific conditions (such as the segregation of such waste from all other types of waste in a monofill or a monocell) in order to achieve a greater margin of safety against a possible failure of the immobilisation in the future. These conditions must not be contravened, otherwise a penalty may be imposed.

The following is the substance of the legal provisions in Clause 28 of the Waste Regulation in respect of ‘Immobilisation of contaminants in waste’:

- The EPA may approve the immobilisation of contaminants in waste by issuing a general approval or a specific approval. Such approvals have the effect of enabling the waste to which the approval relates to be assessed and classified in accordance with the procedures set out in Technical Appendix 1 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) which are also accessible at this web site.
- A general approval may be given by way of notice published in the Gazette. A specific approval may be given after an application is made to the EPA.
- In giving an approval, the EPA is required to identify a person (or class of persons) to whom the approval relates (the responsible person).
- A general approval may be amended or revoked by the EPA by notice published in the Gazette.
- If an approval is given, the responsible person must comply with the conditions to which the approval is subject; otherwise they will have committed an offence.

For details on how to use general approvals that are already in place, see Technical Appendix 2 of the Waste Guidelines.

It is important to note that wherever EPA approval has been given for the immobilisation of the contaminant(s), the waste can be classified according to its TCLP test results alone. If the immobilisation of a contaminant for which TCLP limits are not specified in the guidelines is approved, the EPA will advise on the management options that are available for such materials.

The following twenty three (23) pages reproduce the text of the ten (10) ‘general approvals of immobilisation’ granted so far by the EPA. General approval 2005/14 was published in the NSW Government Gazette on 29 July 2005.

# GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

## A) APPROVAL NUMBER

1999/03

## B) SPECIFICATION OF WASTE STREAM

Cattle-dip contaminated soil.

## C) CONTAMINANTS APPROVED AS IMMOBILISED

Arsenic.

## D) TYPE OF IMMOBILISATION

Natural.

## E) MECHANISM OF IMMOBILISATION

Arsenic compounds are mineralised through adsorption and incorporation onto and within the naturally occurring minerals present in the cattle-dip contaminated soil.

## F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  None

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for Arsenic listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of cattle-dip contaminated soil. With respect to Arsenic cattle-dip contaminated soil may be classified according to their respective leachable concentration (TCLP) values alone.

  Any contaminants listed in Table A4 of the Waste Guidelines (other than Arsenic) that are contained within cattle-dip contaminated soil must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.

  The cattle-dip site soil must not contain any free liquids as defined in the Waste guidelines.

- *Disposal Restrictions*

  Cattle-dip contaminated soil subject to this approval must not be co-disposed with putrescible waste (monocell or monofill disposal is recommended).

The interpretation of the above disposal restrictions should be referred to Part 5 of Technical Appendix 2 of the Waste Guidelines.

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal of Cattle-dip contaminated soil, which is assessed as industrial waste or hazardous waste, for a period of at least 3 years from the date which the contaminated soil is disposed of off site.

- *Waste Management Requirements*

  The responsible person should ensure the landfill is permitted by conditions in its licence to receive waste subject to immobilisation approvals with the above disposal restrictions.

## G) RESPONSIBLE PERSON

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

**Environment Protection Authority**
Per: Roz Hall
Manager Waste Policy
By Delegation

## GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

### A) APPROVAL NUMBER

1999/04

### B) SPECIFICATION OF WASTE STREAM

Activated carbon waste.

### C) CONTAMINANTS APPROVED AS IMMOBILISED

All contaminants listed in Table A4 of the Waste Guidelines with the exception of Total Petroleum Hydrocarbons $C_6$ - $C_9$ and any chemicals subject to control under the *Environmentally Hazardous Chemicals Act* 1985.

### D) TYPE OF IMMOBILISATION

Natural

### E) MECHANISM OF IMMOBILISATION

The contaminants are immobilised through absorption and adsorption onto and within the extensive network of pores inside the activated carbon granules which offer a surface area of up to 1000 square metres per gram.

### F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  Powdery activated carbon wastes must be bagged or drummed or otherwise contained, such as in closed cartridges, to avoid dust generation during handling.

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for all contaminants listed in Table A4 (with the exception of Total Petroleum Hydrocarbons $C_6$ - $C_9$ and any chemicals subject to control under the *Environmentally Hazardous Chemicals Act* 1985) listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of activated carbon waste. With respect to all contaminants listed in Table A4 (with the exception of Total Petroleum Hydrocarbons $C_6$ - $C_9$ and any chemicals subject to control under the *Environmentally Hazardous Chemicals Act* 1985) activated carbon waste can be classified according to their respective leachable concentration (TCLP) values alone (when specified in Table A4).

  Total Petroleum Hydrocarbons $C_6$ - $C_9$ and any chemicals subject to control under the *Environmentally Hazardous Chemicals Act* 1985 that are contained in activated carbon waste must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.

The activated carbon waste must not contain any free liquids as defined in the Waste Guidelines.

- *Disposal Restrictions*

  None.

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal of activated carbon waste, which is assessed as industrial waste or hazardous waste, for a period of at least 3 years from the date which the timber waste is disposed of off site.

- *Waste Management Requirements*

  The responsible person should ensure the landfill is permitted by conditions in its licence to receive waste subject to immobilisation approvals with the above disposal restrictions.

## G) RESPONSIBLE PERSON

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

**Environment Protection Authority**
Per: Roz Hall
Manager Waste Policy
By Delegation

## GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

### A) APPROVAL NUMBER

1999/05

### B) SPECIFICATION OF WASTE STREAM

Ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials.

### C) CONTAMINANTS APPROVED AS IMMOBILISED

Benzo(a)pyrene (BaP) and Polycyclic aromatic hydrocarbons (PAHs)

### D) TYPE OF IMMOBILISATION

Natural

### E) MECHANISM OF IMMOBILISATION

The combustion of carbonaceous materials, such as coal, can take place at 700 to 1500 degrees Celsius. Residual PAHs and BaP present in ash generated at these temperatures are immobilised within a vitrified carbonaceous and siliceous matrix.

Any PAHs and BaP present in coal are strongly bound within the coal's carbonaceous matrix.

### F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  Powdery ash waste must be bagged or drummed or otherwise contained to avoid dust generation during handling.

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for PAHs (total) and BaP listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials. With respect to BaP, ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials can be classified according to their leachable concentration (TCLP) values alone.

  Any contaminants that are listed in Table A4 of the Waste Guidelines (other than PAHs (total) and BaP) that are contained within the ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.

The ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials must not contain any free liquids as defined in the Waste Guidelines.

- *Disposal Restrictions*

  Ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials subject to this approval that meet the requirements of the Waste Guidelines for classification as 'inert waste' or 'solid waste' may only be disposed of at solid waste landfills or industrial waste landfills which have currently operating leachate-management systems and which are licensed to receive that particular class of waste, and that have licence conditions to receive waste subject to immobilisation approvals with this type of disposal restriction. Ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials subject to this approval that are classified as 'industrial waste' must be disposed of at industrial waste landfills.

  The interpretation of the above disposal restrictions should be referred to Part 5 of Technical Appendix 2 of the Waste Guidelines.

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal of ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials, which is assessed as industrial waste or hazardous waste, for a period of at least 3 years from the date which these wastes are disposed of off site.

- *Waste Management Requirements*

  The responsible person should ensure the landfill is permitted by conditions in its licence to receive waste subject to immobilisation approvals with the above disposal restrictions.

## G) RESPONSIBLE PERSON

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

**Environment Protection Authority**
Per: Roz Hall
Manager Waste Policy
By Delegation

## GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

### A) APPROVAL NUMBER

1999/06

### B) SPECIFICATION OF WASTE STREAM

Used oil absorbent materials.

### C) CONTAMINANTS APPROVED AS IMMOBILISED

Total petroleum hydrocarbons $C_{10}$ - $C_{36}$

### D) TYPE OF IMMOBILISATION

Natural

### E) MECHANISM OF IMMOBILISATION

Oil absorbent materials for cleaning up spilt Total Petroleum Hydrocarbons $C_{10}$ - $C_{36}$ are capable of securely containing more than 100% of their own mass of such hydrocarbons. This is due to the high surface area and special physical/chemical properties of these absorbent materials, which favour the adsorption and absorption of oily hydrocarbons compounds in a stable manner. Total Petroleum Hydrocarbons $C_{10}$ - $C_{36}$ that are contained within the used oil absorbent materials are immobilised and will not be released as free liquids during handling, transportation and disposal.

### F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  Powdery used oil absorbent materials must be bagged or drummed or otherwise contained to facilitate safe handling and disposal.

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for Total Petroleum Hydrocarbons $C_{10}$ - $C_{36}$ listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of used oil absorbent materials.

  Any contaminants listed in Table A4 of the Waste Guidelines (other than Total Petroleum Hydrocarbons $C_{10}$ - $C_{36}$) that are contained within used oil absorbent materials must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.

  The used oil absorbent materials must not contain any free liquids as defined in the Waste Guidelines.

- *Disposal Restrictions*

  Used oil absorbent materials subject to this approval that meet the requirements of the Waste Guidelines for classification as 'inert waste' or 'solid waste' may only be disposed of at solid waste landfills or industrial waste landfills which have currently operating leachate-management systems and which are licensed to receive that particular class of waste, and that have licence conditions to receive waste subject to immobilisation approvals with this type of disposal restriction. Used oil absorbent materials subject to this approval that are classified as 'industrial waste' must be disposed of at industrial waste landfills.

  The interpretation of the above disposal restrictions should be referred to Part 5 of Technical Appendix 2 of the Waste Guidelines.

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal used oil absorbent materials that are classified as industrial waste or hazardous waste for a period of at least 3 years from the date which these wastes are disposed of off site.

- *Waste Management Requirements*

  The responsible person should ensure the landfill is permitted by conditions in its licence to receive waste subject to immobilisation approvals with the above disposal restrictions.

**G) RESPONSIBLE PERSON**

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

**Environment Protection Authority**
Per: Roz Hall
Manager Waste Policy
By Delegation

## GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

### A) APPROVAL NUMBER

1999/07

### B) SPECIFICATION OF WASTE STREAM

Metallurgical furnace slag or metallurgical furnace slag contaminated natural excavated materials.

### C) CONTAMINANTS APPROVED AS IMMOBILISED

Chromium (VI), Lead, Nickel, Polycyclic Aromatic Hydrocarbons (PAHs) and Benzo(a)pyrene (BaP).

### D) TYPE OF IMMOBILISATION

Natural

### E) MECHANISM OF IMMOBILISATION

Chromium, Lead or Nickel metals and their metal compounds as well as PAHs and BaP are encapsulated within the furnace slag during its formation at elevated temperature exceeding 1,000 degrees Celsius. These metals, metal and organic compounds and their silicate compounds are bonded within a vitrified solid mass.

### F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  None

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for Chromium (VI), Lead, Nickel, PAHs and BaP listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of metallurgical furnace slag or metallurgical furnace slag contaminated natural excavated materials. With respect to Chromium (VI), Lead, Nickel and BaP, metallurgical furnace slag or metallurgical furnace slag contaminated natural excavated materials can be classified according to their leachable concentration (TCLP) values alone.

  Any contaminants listed in Table A4 of the Waste Guidelines (other than Chromium (VI), Lead, Nickel, PAHs and BaP) that are contained within the metallurgical furnace slag or metallurgical furnace slag contaminated natural excavated materials must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.

  The metallurgical furnace slag or metallurgical furnace slag contaminated natural excavated materials must not contain any free liquids as defined in the Waste Guidelines.

- *Disposal Restrictions*

  None.

  Note: The classified metallurgical furnace slag or metallurgical furnace slag contaminated natural excavated materials may be disposed of to waste facilities which can legally receive them.

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal metallurgical furnace slag or metallurgical furnace slag contaminated natural excavated materials that are classified as hazardous or industrial waste for a period of at least 3 years from the date which these wastes are disposed of off site.

- *Waste Management Requirements*

  None.

**G) RESPONSIBLE PERSON**

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

**Environment Protection Authority**
Per: Roz Hall
Manager Waste Policy
By Delegation

## GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

### A) APPROVAL NUMBER

2000/08

### B) SPECIFICATION OF WASTE TO WHICH THIS APPROVAL APPLIES

This approval applies to waste consisting of Tanalith E treated timber other than waste which is specified as:

(i) building and demolition waste in Part 2 Types of Inert Waste in the "Appendix - Types of Waste" in Part 3 of the Interpretative provisions in Schedule 1 of the *Protection of the Environment Operations Act 1997*, or

(ii) municipal waste in Part 4 Types of solid waste in the "Appendix - Types of Waste" in Part 3 of the Interpretative provisions in Schedule 1 of the *Protection of the Environment Operations Act 1997*.

### C) CONTAMINANTS APPROVED AS IMMOBILISED

Tebuconazole and di-2-ethyl hexyl phthalate.

### D) TYPE OF IMMOBILISATION

Natural

### E) MECHANISM OF IMMOBILISATION

Tebuconazole and di-2-ethyl hexyl phthalate are adsorbed into the woody tissue of the treated timbers.

### F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  None

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for tebuconazole and di-2-ethyl hexyl phthalate do not apply to the assessment of Tanalith E treated timber. With respect to tebuconazole and di-2-ethyl hexyl phthalate treated timber may be classified according to their respective leachable concentration (TCLP) values alone. The applicable values for leachable concentration and total concentration recently determined by the EPA for tebuconazole and di-2-ethyl hexyl phthalate is at Attachment 1.

  Any contaminants listed in Table A4 of the Waste Guidelines that are contained within Tanalith E treated timber must be assessed in accordance with Technical Appendix 1 of the *Environmental*

*Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999).

- *Disposal Restrictions*

  None

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal of Tanalith E treated timber waste, which is assessed as industrial waste or hazardous waste, for a period of at least 3 years from the date which the timber waste is disposed of off site.

- *Waste Management Requirements*

  None

**G) RESPONSIBLE PERSON**

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

**Environment Protection Authority**
Per: Bill Gara
Manager Technical Advisory Unit
By Delegation

Dated: 1 September 2000.

**ATTACHMENT 1** TO GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE (APPROVAL NUMBER: 2000/08)

The EPA has determined the following additional values of leachable concentration and total concentration for plasticiser compounds and tebuconazole for insertion into Table A4 of the *Environmental Guidelines:Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (EPA 1999) to be used for the assessment of waste containing these chemical contaminants.

**ADDENDUM TO TABLE A4 OF THE *ENVIRONMENTAL GUIDELINES: ASSESSMENT, CLASSIFICATION AND MANAGEMENT OF LIQUID AND NON-LIQUID WASTES* (EPA 1999)**

## Leachable concentration (TCLP) and total concentration (SCC) values for non-liquid waste classification

| | Maximum values for *leachable concentration* **and** *total concentration* when used **together**. | | | | | |
|---|---|---|---|---|---|---|
| | **Inert Waste** | | **Solid Waste** | | **Industrial Waste** | |
| **Contaminant** | Leachable concentration TCLP1 (mg/L) | Total concentration SCC1 (mg/kg) | Leachable concentration TCLP2 (mg/L) | Total concentration SCC2 (mg/kg) | Leachable concentration TCLP3 (mg/L) | Total concentration SCC3 (mg/kg) |
| Plasticiser compounds* | 0.1 | 600 | 1 | 600 | 4 | 2,400 |
| Tebuconazole** | 0.64 | 230 | 6.4 | 230 | 25.6 | 920 |

*Plasticiser compounds means the total of di-2-ethyl hexyl phthalate (CAS Registry Number: 117-81-7) and di-2-ethyl hexyl adipate (CAS Registry Number: 103-23-1) contained within a waste.
** Tebuconazole (CAS Registry Number: 107534-96-3).

**Environment Protection Authority**
Per: Bill Gara
Manager Technical Advisory Unit
By Delegation

**Dated: 1 September 2000.**

## GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

### A) APPROVAL NUMBER

2001/11

This approval replaces general approval of immobilisation number: 2000/09 which is hereby revoked.

### B) SPECIFICATION OF WASTE TO WHICH THIS APPROVAL APPLIES

This approval applies to waste consisting of Copper-Chrome-Arsenate (CCA) treated timber other than waste which is specified as:

(i) building and demolition waste in Part 2 Types of inert waste in the "Appendix - Types of waste" in Part 3 of the Interpretative provisions in Schedule 1 of the *Protection of the Environment Operations Act 1997*, or

(ii) municipal waste in Part 4 Types of solid waste in the "Appendix - Types of waste" in Part 3 of the Interpretative provisions in Schedule 1 of the *Protection of the Environment Operations Act 1997*.

### C) CONTAMINANTS APPROVED AS IMMOBILISED

Chromium (VI), Arsenic and $C_{10}$ - $C_{36}$ petroleum hydrocarbons.

### D) TYPE OF IMMOBILISATION

Natural

### E) MECHANISM OF IMMOBILISATION

Chromium (VI), Arsenic compounds and $C_{10}$ - $C_{36}$ petroleum hydrocarbons are adsorbed into the woody tissue of the treated timbers.

### F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  None

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for Arsenic, Chromium (VI) and $C_{10}$ - $C_{36}$ petroleum hydrocarbons listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of CCA-treated timber. With respect to Arsenic and Chromium (VI), CCA-treated timber may be classified according to their respective leachable concentration (TCLP) values alone.

Any contaminants listed in Table A4 of the Waste Guidelines (other than Arsenic, Chromium (VI) and $C_{10}$ - $C_{36}$ petroleum hydrocarbons) that are contained within CCA-treated timber must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.

- *Disposal Restrictions*

  CCA-treated timber waste subject to this approval that meets the requirements of the Waste Guidelines for classification as 'inert waste' or 'solid waste' may only be disposed of at solid waste landfills or industrial waste landfills which have currently operating leachate-management systems and which are licensed to receive that particular class of waste, and that have licence conditions to receive waste subject to immobilisation approvals with this type of disposal restriction. CCA-treated timber waste subject to this approval that is classified as 'industrial waste' must be disposed of at industrial waste landfills.

  The interpretation of the above disposal restrictions should be referred to Part 5 of Technical Appendix 2 of the Waste Guidelines.

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal of CCA treated timber waste, which is assessed as industrial waste or hazardous waste, for a period of at least 3 years from the date which the timber waste is disposed of off site.

- *Waste Management Requirements*

  The responsible person should ensure that the landfill is permitted by conditions in its licence to receive waste subject to immobilisation approvals with the above disposal restrictions.

## G) RESPONSIBLE PERSON

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

**Environment Protection Authority**
Per: Bill Gara
Manager Technical Advisory Unit
By Delegation

Dated: 14 February 2001.

## GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

### A) APPROVAL NUMBER

2001/12

This approval replaces general approval of immobilisation number: 2000/10 which is hereby revoked.

### B) SPECIFICATION OF WASTE TO WHICH THIS APPROVAL APPLIES

This approval applies to waste consisting of Creosote-treated timber other than waste which is specified as:

(i) building and demolition waste in Part 2 Types of inert waste in the "Appendix - Types of waste" in Part 3 of the Interpretative provisions in Schedule 1 of the *Protection of the Environment Operations Act 1997*, or

(ii) municipal waste in Part 4 Types of solid waste in the "Appendix - Types of waste" in Part 3 of the Interpretative provisions in Schedule 1 of the *Protection of the Environment Operations Act 1997*.

### C) CONTAMINANTS APPROVED AS IMMOBILISED

Cresol (total), m-Cresol, o-Cresol, p-Cresol, $C_{10}$ - $C_{36}$ petroleum hydrocarbons, Polycyclic aromatic hydrocarbons (PAHs), Benzo-a-pyrene (BaP) and Phenol.

### D) TYPE OF IMMOBILISATION

Natural

### E) MECHANISM OF IMMOBILISATION

Cresol (total), m-Cresol, o-Cresol p-Cresol, $C_{10}$ - $C_{36}$ petroleum hydrocarbons, PAHs, BaP and Phenol are impregnated and adsorbed into the woody tissue of the treated timbers.

### F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  None

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for Cresol (total), m-Cresol, o-Cresol, p-Cresol, $C_{10}$ - $C_{36}$ petroleum hydrocarbons, PAHs, BaP and Phenol listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of Creosote-treated timber. With respect to Cresol (total), m-Cresol, o-Cresol and p-Cresol, BaP

and Phenol, Creosote treated timber may be classified according to their respective leachable concentration (TCLP) values alone.

Any contaminants listed in Table A4 of the Waste Guidelines (other than Cresol (total), m-Cresol, o-Cresol and p-Cresol, $C_{10}$ - $C_{36}$ petroleum hydrocarbons, PAHs, BaP and Phenol) that are contained within Creosote-treated timber must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.

- *Disposal Restrictions*

  Creosote-treated timber waste subject to this approval that meets the requirements of the Waste Guidelines for classification as 'inert waste' or 'solid waste' may only be disposed of at solid waste landfills or industrial waste landfills which have currently operating leachate-management systems and which are licensed to receive that particular class of waste, and that have licence conditions to receive waste subject to immobilisation approvals with this type of disposal restriction. Creosote-treated timber waste subject to this approval that is classified as 'industrial waste' must be disposed of at industrial waste landfills.

  The interpretation of the above disposal restrictions should be referred to Part 5 of Technical Appendix 2 of the Waste Guidelines.

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal of Creosote treated timber waste, which is assessed as industrial waste or hazardous waste, for a period of at least 3 years from the date which the timber waste is disposed of off site.

- *Waste Management Requirements*

  The responsible person should ensure the landfill is permitted by conditions in its licence to receive waste subject to immobilisation approvals with the above disposal restrictions.

## G) RESPONSIBLE PERSON

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

**Environment Protection Authority**
Per: Bill Gara
Manager Technical Advisory Unit
By Delegation

Dated: 14 February 2001.

## GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

### B) APPROVAL NUMBER

2002/13

### B) SPECIFICATION OF WASTE TO WHICH THIS APPROVAL APPLIES

This approval applies to waste consisting of used tar-treated timber arising from oyster farms (active or inactive) located in New South Wales waters and is restricted to such tar treated timber which has already been placed under water to cultivate oysters at the oyster farms prior to the date of this approval.

### C) CONTAMINANTS APPROVED AS IMMOBILISED

$C_{10}$-$C_{36}$ Petroleum Hydrocarbons, Cresol (total), m-Cresol, o-Cresol, p-Cresol, Polycyclic aromatic hydrocarbons (PAHs), Benzo-a-pyrene (BaP) and Phenol (non-halogenated).

### D) TYPE OF IMMOBILISATION

Natural

### E) MECHANISM OF IMMOBILISATION

$C_{10}$-$C_{36}$ Petroleum Hydrocarbons, Cresol (total), m-Cresol, o-Cresol and p-Cresol PAHs, BaP and Phenol (non-halogenated) are impregnated and adsorbed into the woody tissue of the treated timbers.

### F) CONDITIONS OF APPROVAL

- *Commencement/Expiry Date*

This approval commences on the date of issue and expires on 31 December 2006 unless revoked prior to that time.

- *Packaging Requirements*

  None

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for $C_{10}$-$C_{36}$ Petroleum Hydrocarbons, Cresol (total), m-Cresol, o-Cresol and p-Cresol, PAHs, BaP and Phenol (non-halogenated) listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of tar-treated timber. With respect to Cresol (total), m-Cresol, o-Cresol and p-Cresol, BaP and Phenol (non-halogenated) tar treated timber may be classified according to their respective leachable concentration (TCLP) values alone.

Any contaminants listed in Table A4 of the Waste Guidelines (other than $C_{10}$-$C_{36}$ Petroleum Hydrocarbons, Cresol (total), m-Cresol, o-Cresol and p-Cresol, PAHs, BaP and Phenol (non-halogenated)) that are contained within tar-treated timber must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.

- *Disposal Restrictions*

  Tar-treated timber waste subject to this approval that meets the requirements of the Waste Guidelines for classification as 'inert waste' or 'solid waste' may only be disposed of at solid waste landfills or industrial waste landfills which have currently operating leachate-management systems and which are licensed to receive that particular class of waste, and that have licence conditions to receive waste subject to immobilisation approvals with this type of disposal restriction. Tar-treated timber waste subject to this approval that is classified as 'industrial waste' must be disposed of at industrial waste landfills.

  The interpretation of the above disposal restrictions should be referred to Part 5 of Technical Appendix 2 of the Waste Guidelines.

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal of tar-treated timber waste, which is assessed as industrial waste or hazardous waste, for a period of at least 4 years from the date which the timber waste is disposed of off site.

- *Waste Management Requirements*

  The responsible person must ensure that the landfill is permitted by conditions in its licence to receive waste subject to immobilisation approvals with the above disposal restrictions.

## G) RESPONSIBLE PERSON

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

**Environment Protection Authority**
Per: Bill Gara
Manager Technical and Data Unit
By Delegation

Dated: 25 October 2002.

## GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority ('the EPA') has made the following general approval for the immobilisation of the following contaminants in waste. The EPA is part of the Department of Environment and Conservation (NSW).

### DEFINITIONS

SCC - Specific Contaminant Concentration, see Waste Guidelines for details.

SCC2 & SCC3 - see Table A4 of the Waste Guidelines

TCLP - Leachable Concentration assessed by the Toxicity Characteristics Leaching Procedure, see Waste Guidelines for details.

Unconfined Compressive Strength - for details, refer to the standard methods for determining Unconfined Compressive Strength specified in condition 3.5.

Waste Guidelines - *Environmental Guidelines: Assessment, Classification & Management of Liquid & Non-Liquid Wastes* issued by the EPA and in force as at 1 July 1999.

### A) APPROVAL NUMBER

2005/14

B) PERIOD OF VALIDITY

This approval commences on the 29 July 2005 and is effective until revoked or varied by the EPA.

### C) WASTE TO WHICH THIS APPROVAL APPLIES

This approval applies to coal tar contaminated soil from former gasworks sites which has been treated in accordance with the conditions of this approval.

In this approval:

- untreated waste is coal tar contaminated soil from former gasworks sites.
- treated waste is the untreated waste which has been stabilised by treatment with calcium or magnesium oxide based cement in accordance with the conditions of this approval.

### D) CONTAMINANTS TO WHICH THIS APPROVAL APPLIES ("THE CONTAMINANTS")

The following contaminants are covered by this Approval, provided that the concentration in the untreated waste does not exceed the following limits:

- Polycyclic aromatic hydrocarbons (PAHs) – 13,000 mg/kg
- Benzo(a)pyrene (BaP) – 500 mg/kg
- Non-halogenated phenols – 2,000 mg/kg
- Total cyanide – 4,000 mg/kg

All other contaminants must be assessed in accordance with the procedures specified in the Waste Guidelines.

### E) RESPONSIBLE PERSON

The persons or class of persons to whom this general approval applies are the persons who carry out the assessment and classification of the treated waste for the purpose of this approval. Responsible persons must comply with all of the conditions of this approval.

### F) CONDITIONS OF APPROVAL

The responsible person may only use this approval to classify treated waste for disposal if all of the conditions of the approval have been satisfied.

*1. Treatment Requirements*

1.1. The treatment of the untreated waste must be carried out so as not to cause adverse impacts on human health or amenity or pollution of the environment.

1.2. The reagents which must be used to immobilise the Contaminants are calcium or magnesium oxide based cement. Enhancers, substances designed to enhance the set/cure time and/or the compressive strength of the stabilised matrix or substances designed to reduce the leachability of contaminants from the matrix, may be added to the reagent provided that those substances do not affect the classification of the treated waste within the meaning of the Waste Guidelines.

1.3. The ratio of reagent (including any enhancers) to untreated waste must not exceed 2:1 (ie 2 parts by mass of the reagent to one part by mass of the untreated waste).

1.4. The mixing of the untreated waste and the reagents must be sufficient to ensure that all of the Contaminants become microencapsulated.

NOTE: The waste may only be treated at a premises which is lawfully able to treat the waste.

1.5. The Unconfined Compressive Strength of the treated waste must be 1 MPa or greater prior to disposal.

*2. Quality Control*

2.1. The responsible person must implement a quality control program to ensure compliance with the conditions of this approval. The program must include a sampling program appropriate to the quantity of treated waste generated and a testing plan for the analysis of the samples. The procedures used by the responsible person for the acceptance and rejection of treated waste must be appropriate to ensure that once treatment has taken place, only treated waste which satisfies all of the requirements of this approval is disposed of off-site to a landfill that can lawfully receive that type of waste.

2.2. All testing must be undertaken by analytical laboratories accredited by the National Association of Testing Authorities to perform the particular test.

2.3. The following parameters must be monitored and recorded as part of the testing plan:

2.3.1. total concentration of each of the Contaminants in the untreated waste;

2.3.2. total concentration of each of the Contaminants in the treated waste;

2.3.3. leachable concentration of each of the Contaminants in the treated waste;

2.3.4. Unconfined Compressive Strength of the treated waste;

2.3.5. the composition of the reagent(s) used; and

2.3.6. the ratio of reagent to untreated waste (mass/mass) used in treatment.

*3. Sampling and test methods to be used under condition 2*

3.1. Sampling of untreated waste in order to comply with condition 2 must be in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999 ('the Contaminated Sites NEPM').

NOTE: *Schedule B(2)* to the Contaminated Sites NEPM *(Guideline on Data Collection, Sample Design and Reporting)* provides relevant guidance for sampling soil from former gaswork sites.

3.2. Sampling of treated waste in order to comply with condition 2 must be by means of a statistically valid sampling program which is consistent with the acceptance/rejection procedures adopted for treated waste.

NOTE: The sampling program for the treated waste will depend on a number of factors including the quantity and variability of material to be treated.

3.3. The total concentration of each contaminant must be measured as Specific Contaminant Concentration (SCC) in accordance with the method specified in the Waste Guidelines.

3.4. The leachable concentration of each contaminant must be measured using the Toxicity Characteristics Leaching Procedure (TCLP) as specified in the Waste Guidelines.

*3.5.* The Unconfined Compressive Strength (UCS) must be measured in accordance with the NSW Roads & Traffic Authority Test Method T131, *Determination of Unconfined Compressive Strength of Road Materials Stabilised or Modified with Proportions of Cement, Lime or Other Cementitious Materials*, or Test Method T116, *Determination of Unconfined Compressive Strength of Remoulded Road Materials which are Self Cementing*. An equivalent method may be used provided that prior written approval is obtained from the EPA.

3.6. SCC and TCLP test results used for assessing compliance with the conditions of this approval must be at the 95% upper confidence limit (UCL). UCS test results used for assessing compliance with the conditions of this approval should be at the 95% lower confidence limit (LCL).

*4. Waste Assessment Requirements*

Note: Refer to Technical Appendices 1 and 2 of the Waste Guidelines for more information about waste classification including SCC and TCLP limit values for the Contaminants.

*4.1.* The untreated waste must be classified in accordance with the procedures in the Waste Guidelines.

4.2. The total concentration (SCC) limits for the Contaminants do not apply to the classification of the treated waste provided that the treatment complies with all of the conditions of this Approval.

4.3. With respect to BaP, non-halogenated phenols and cyanide, treated waste which complies with all of the conditions of this Approval may be classified according to the leachable concentration (TCLP) value alone.

4.4. With respect to PAH, treated waste which complies with all of the conditions of this Approval may be classified as solid waste.

4.5. All other contaminants in the treated waste apart from the Contaminants must be assessed in accordance with the procedure in Technical Appendix 1 of the Waste Guidelines, namely that both total concentrations and leachable concentrations (where specified) apply.

*5. Disposal Restrictions*

5.1. Treated waste that complies with all of the conditions of this approval and that satisfies the requirements of the Waste Guidelines for classification as inert waste or solid waste may only be disposed of at solid waste landfills or industrial waste landfills which have currently operating leachate management systems and which are licensed by the EPA to accept that particular type of waste.

5.2. Treated waste that complies with all of the conditions of this Approval and that satisfies the requirements of the Waste Guidelines for classification as industrial waste may only be disposed of at industrial waste landfills which have currently operating leachate management systems and which are licensed by the EPA to accept that particular type of waste

5.3. The responsible person must ensure that the landfill receiving the treated waste:

5.3.1. has a licence that allows the landfill to receive waste subject to immobilisation approvals with this type of disposal restriction; and

5.3.2. monitors landfill leachate and groundwater for PAH (or BaP as an indicator of PAH), if the total concentration of the PAH/BaP in the treated waste exceeds SCC2, for solid waste landfills, or SCC3, for industrial waste landfills.

5.4. The responsible person must advise the disposal facility in writing that the treated waste to be disposed of has been treated and classified in accordance with all of the conditions of this approval.

*6. Notification and record keeping requirements*

6.1. The responsible person must notify the EPA in writing of its intention to have the coal tar contaminated soil treated for disposal under this approval at least 28 days before it commences treatment of the waste. The notification must include details of the reagent to be used, any substances to be added to the reagent, the amount of coal tar contaminated soil proposed to be treated and the premises at which treatment will take place.

*6.2.* For treated waste disposed of under this approval, the responsible person is required to keep all test results and disposal documentation for a period of at least 3 years from the date on which the treated waste is disposed of off site.

6.3. The responsible person is required to notify the EPA in writing within 48 hours of becoming aware of a test result which shows that the treated waste does not meet the requirements for disposal under this approval.

**NOTIFICATIONS OR REPORTS AS REQUIRED BY THIS APPROVAL MUST BE SENT TO:**

Manager, Hazardous Waste Regulatory Unit
Department of Environment and Conservation
PO Box A290
Sydney South NSW 1232
Fax: 902) 9995 5930

**NOTES**

It is an offence for the responsible person not to comply with the conditions to which the approval is subject [clause 28 [11] of the Waste Regulation]. Maximum penalty for a corporation is 200 penalty units and for individuals 100 penalty units.

This approval may be amended or revoked by the EPA by way of written notice in the Gazette.

The responsible person must also ensure that all other legislative requirements relating to the waste are complied with including, for example, the use of a licensed waste transporter in circumstances where one must be used.

**Environment Protection Authority**
Per: Mark Gorta
Director Waste Management
By Delegation