DRAFT REPORT

CONCEPTUAL REMEDIATION ACTION PLAN

INCITEC FERTILIZERS LIMITED

COCKLE CREEK SITE REDEVELOPMENT

BOOLAROO, NEW SOUTH WALES

17 JULY 2008

DOC. REF: SG061313REV5

REVISION 5

FOR

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This Conceptual Remediation Action Plan was prepared by

Soil and Groundwater Consulting

in association with

Golder Associates, Sydney, NSW

EXECUTIVE SUMMARY

This Conceptual Remediation Action Plan (Conceptual RAP) addresses the remediation of the Incitec Fertilizers Limited (IFL) Cockle Creek manufacturing and distribution site located on Main Road, Boolaroo, New South Wales. The site is identified as Lot 1, DP225720 and is shown in Figure 1.

It should be noted in reading this Conceptual RAP document that its purpose is to describe the key features of the RAP approach, and that further detailed RAP documents will be prepared prior to Stages 2 to 4 of the remediation (three RAPs). The remediation process involves four stages as detailed in the body of the report. This Conceptual RAP document is not intended to be the detailed RAP document which will form the basis for remediation and therefore this document includes summary level information regarding the key aspects to the proposed RAP approach. The detailed RAP documents will be provided subsequently.

The Conceptual RAP has been prepared for three main purposes:

1. To comply with the Director-General's Environmental Assessment Requirements (the Requirements) pursuant to section 75F(3) of the Environmental Planning and Assessment Act 1979;

2. To comply with and form part of the Voluntary Remediation Agreement (VRA) to be entered into with DECC pursuant to section 26 of the *Contaminated Lands Management Act* 1997 (CLMA 1997); and

3. To remove the *Significant Risk of Harm* declaration for the site.

The Requirements state that "*the RAP and remediation proposal must specifically address the matters contributing to the site representing a Significant Risk of Harm under section 9 of the CLM Act, demonstrate that the proposal will prevent contaminated material moving off site, and demonstrate that on completion of the project the site will be suitable for the proposed land use*."

The Requirements also include that "*the RAP must be audited by a DEC accredited site auditor*." Mr Phillip Hitchcock has been appointed as the site Auditor for this purpose.

The primary objective of the Conceptual RAP is therefore to address the Declaration of Remediation Site (Declaration Number 21077 Area Number 3204) issued by the New South Wales Environment Protection Authority (EPA) on 22 July 2005 on the site.

The objective of the Conceptual RAP approach contained in this document is to remediate the site from its current industrial use with historical impacts associated with the former smelting operations which occurred in this area, to a site containing:

A. An area dedicated to a engineered containment cell (suitable for controlled open space uses); and

B. The remainder of the site is to be suitable for low density residential use. It is hoped that signoff for the residential portion will occur as soon as possible.

The purpose of this Conceptual RAP is to identify and provide an overview of the key actions to be addressed in each of the detailed RAP documents to provide a level of assurance to regulatory authorities that the detailed RAP documents prepared throughout the project will adequately address the risks and ensure that the environment is adequately protected throughout the remediation process.

Following detailed soil and groundwater investigations across the site over a number of years, a contamination extent in soil and groundwater has been identified and delineated. An assessment of a significant number of remedial options has been undertaken. It is considered the most appropriate management approach at the site would be to consolidate and contain all the soil and other materials unsuitable for use within a residential setting in isolation within a lined containment cell located on the northern portion of the site within the site boundaries. The removal of the metal impacted soils, which are the primary source of the identified groundwater contamination, to a fully lined and sealed engineered containment cell will also remove the primary ongoing source of groundwater contamination at the site. The remainder of the site is expected to be developed for residential use.

Some targeted and short term groundwater remediation is proposed for the northern area (within the proposed containment cell area) to reduce the contaminant mass present in the groundwater system prior to the installation of the containment cell. Due to the low permeability of the shallow aquifer it is likely that groundwater recovery for the initial remediation program will occur via a series of extraction trenches. Extracted water will be passed through the treatment system and will most likely be returned to the aquifer via an infiltration trench located up gradient or between extraction locations to further facilitate the recovery of impacted groundwater. The detailed design of the initial groundwater system will be developed following the finalisation of the treatment options investigations.

To ensure ongoing environmental management of the area of the site incorporating the containment cell and a suitable buffer zone, IFL will retain the ownership and responsibility for this area, including the groundwater environment. This will ensure accessibility to the area for any future management requirements and will provide a viable entity for the implementation of the environment management plan into the future.

The remainder of the site is to be divested for development purposes with the expectation that the area will be suitable for residential use as a result of the soil remediation works conducted. The groundwater beneath various parts of this divested area may contain contaminant concentrations that preclude various environmental values of the groundwater, particularly those associated with extraction and use. Due to the difficulty in remediating groundwater across the entire site, the low potential for use in the residential setting and the presence of a reticulated potable water supply system, it is anticipated that a condition may be imposed as part of the environmental audit outcome that restricts use of the shallow groundwater at the site to minimise any potential risk to site users.

The most relevant environmental value of groundwater at the site is that of aquatic ecosystems and it is expected that any residual site groundwater contamination will be demonstrated not to preclude this environmental value. If this cannot be achieved then it is anticipated that appropriate remediation or management measures will be put in place to ensure this environmental value is protected and the outcome of the audit with respect to this matter is suitably assured.

The overall scope and estimated timing of each stage of the remediation process is presented below:

Stage 1 –	Establishment of initial groundwater hotspot remediation:	Sept 2008 – April 2011
Stage 2 –	Cell construction / northern area soil remediation:	Dec 2008 – June 2011
Stage 3 –	Decommissioning / demolition and soil remediation of central portion:	Sept 2010 – June 2013
Stage 4 –	Remediation of the filled gully on the southern portion of the site:	Sept 2012 – June 2015

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APPENDICES

Appendix A - Summary of Soil and Groundwater Analytical Results

Appendix B - Preliminary Containment Cell Design and Staging

DOCUMENT INFORMATION

Rev.	Status	Date	Company	Name
0	Prelim Draft	28 March 2008	Incitec Fertilizers Limited	Mr Graham Funch
			Soil & Groundwater Consulting	File
1	Draft	16 June 2008	Incitec Fertilizers Limited	Mr Graham Funch
			Soil & Groundwater Consulting	File
2	Draft	23 June 2008	Incitec Fertilizers Limited	Mr Graham Funch
			Soil & Groundwater Consulting	File
3	Draft	1 July 2008	Incitec Fertilizers Limited	Mr Graham Funch
			Soil & Groundwater Consulting	File
4	Draft	8 July 2008	Incitec Fertilizers Limited	Mr Graham Funch
			Soil & Groundwater Consulting	File
5	Draft	17 July 2008	Incitec Fertilizers Limited	Mr Graham Funch
			Soil & Groundwater Consulting	File

1. INTRODUCTION

This Conceptual Remediation Action Plan (Conceptual RAP) addresses the remediation of the Incitec Fertilizers Limited (IFL) Cockle Creek manufacturing and distribution site located on Main Road, Boolaroo, New South Wales. The site is identified as Lot 1, DP225720 and is shown in Figure 1.

It should be noted in reading this Conceptual RAP document that its purpose is to describe the key features of the RAP approach, and that further detailed RAP documents will be prepared prior to Stages 2 to 4 of the remediation (three RAPs). The remediation process involves four stages as detailed in the body of the report. This Conceptual RAP document is not intended to be the detailed RAP document which will form the basis for remediation and therefore this document includes summary level information regarding the key aspects to the proposed RAP approach. The detailed RAP documents will be provided subsequently.

The Conceptual RAP has been prepared for three main purposes:

1. To comply with the Director-General's Environmental Assessment Requirements (the Requirements) pursuant to section 75F(3) of the Environmental Planning and Assessment Act 1979;

2. To comply with and form part of the Voluntary Remediation Agreement (VRA) to be entered into with the Department of Environment and Climate Change (DECC) pursuant to section 26 of the *Contaminated Lands Management Act* 1997 (CLMA 1997); and

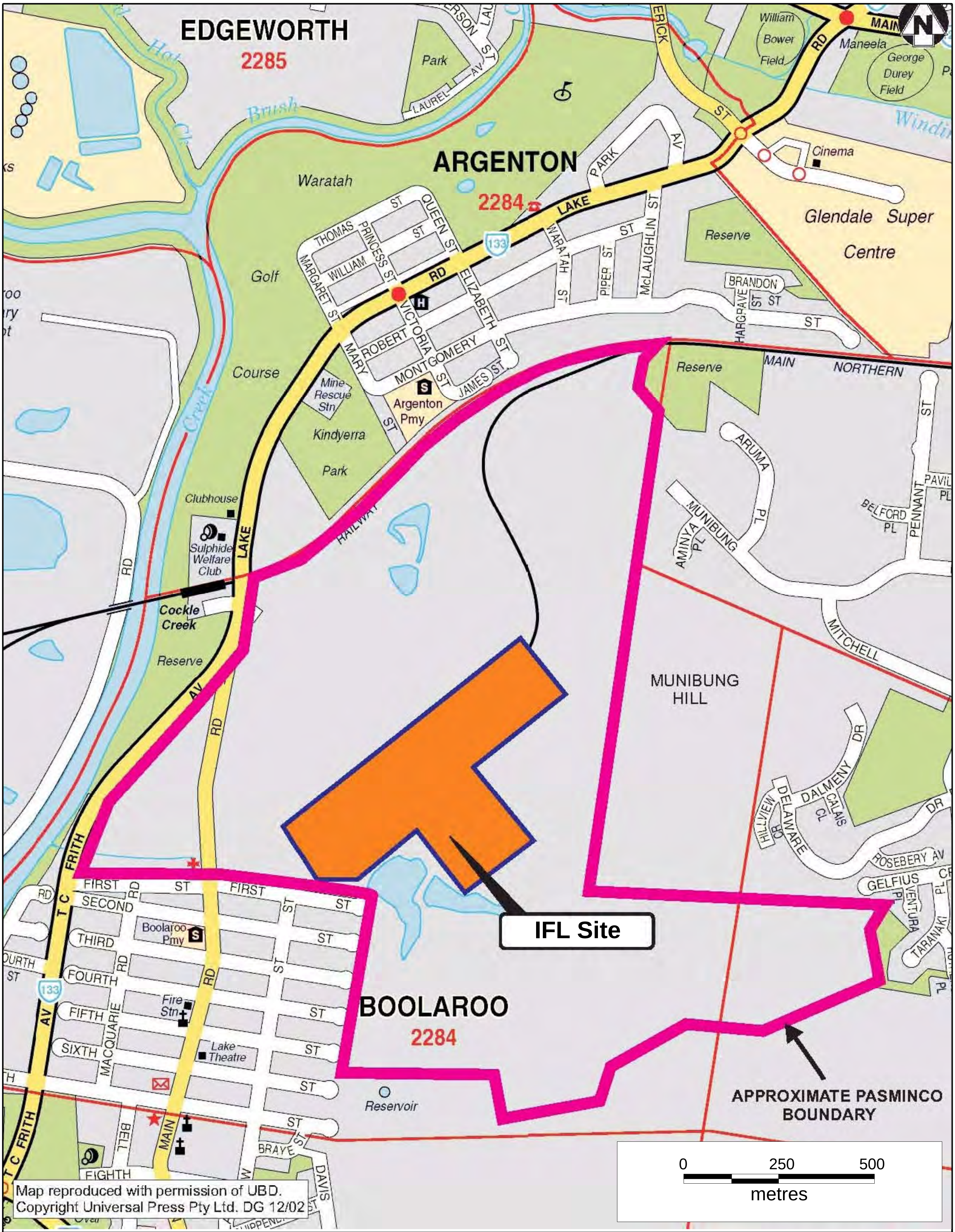
3. To remove the *Significant Risk of Harm* declaration for the site.

The Requirements state that "*the RAP and remediation proposal must specifically address the matters contributing to the site representing a Significant Risk of Harm under section 9 of the CLM Act, demonstrate that the proposal will prevent contaminated material moving off site, and demonstrate that on completion of the project the site will be suitable for the proposed land use*."

The Requirements also include that "*the RAP must be audited by a DEC accredited site auditor*." Mr Phillip Hitchcock has been appointed as the site Auditor for this purpose.

The primary objective of the Conceptual RAP is therefore to address the *Declaration of Remediation Site (Declaration Number 21077 Area Number 3204)* issued by the New South Wales Environment Protection Authority (EPA) on 22 July 2005. The Declaration was made as a result of EPA identifying that:

> *"the site is contaminated with the following substances ("the contaminants"):*



S&G Soil & Groundwater Consulting 207 The Parade Norwood SA 5067 PO Box 3166 Norwood SA 5067 T: 08 8431 7113 F: 08 8431 7115	Drawn: DJN	Job No.: SG061313	Project: Cockle Creek Assessments
	Date: 22 June 2008	Title: SITE LOCATION PLAN	Sheet 1 of 1
	Checked: APN	(adapted from URS 2004 report)	FIGURE 1
	Date: 23 June 2008	File Name: Fig1.wor	Version: Draft / Scale: As Shown / A4

> *metals in particular zinc, lead and nickel in fill and groundwater on the site. Investigations indicate that the contaminants are predominantly derived from leaching from fill material placed on the site in the past, particularly in an infilled gully area on the site. It also appears that the infilled gully is acting as a preferential pathway for the contaminants with the upgradient freshwater dam above the site providing a hydraulic head."*

EPA determined that the contaminants may "*present a significant risk of harm to the environment"* as a result of:

> *"Groundwater at the site is contaminated with metals (in particular zinc, lead and nickel) at concentrations significantly exceeding the relevant Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) trigger levels, with zinc in particular being present in groundwater at levels 2 to 3 orders of magnitude above the ANZECC 2000 levels;*
>
> *The contaminated groundwater is migrating from the site and through the adjacent former smelting facility site towards Cockle Creek, with zinc at concentrations approximately two orders of magnitude above the relevant ANZECC 2000 trigger level."*

The objective of the Conceptual RAP approach contained in this document is to remediate the site from its current industrial use, with historical impacts associated with the former smelting operations which occurred in this area, to a site containing:

A. An area dedicated to a engineered containment cell (suitable for controlled open space uses); and

B. The remainder of the site is to be suitable for low density residential use. It is hoped that signoff for the residential portion will occur as soon as possible.

It is proposed that the remediation of the site will be undertaken in a staged approach and a separate detailed RAP document will be prepared for each of Stages 2 to 4 (three RAPs). It is expected that four Stages will occur as part of the remediation and this staging is discussed later. It is expected this approach will allow the project to be fast tracked and optimise the time frame over which planning and remediation occur to minimise the impact of the remediation program on the community and on the surrounding areas which are concurrently being remediated and managed by others with a similar objective.

This approach will also allow each separate detailed RAP document to better characterise and manage the risks associated with each separate stage of the project and ensure a high level of protection of the environment and the amenity of the area for each successive stage of the remediation project.

The adopted approach will also provide for the progressive decommissioning of the active parts of the site, allowing concurrent use of sections of the site by IFL as it progressively vacates the site as operations at the site change. Manufacturing is anticipated to cease around the middle of 2009 and the distribution facility is anticipated to cease around the middle of 2010.

The purpose of this Conceptual RAP is to identify and provide an overview of the key actions to be addressed in each of the detailed RAP documents to provide a level of assurance to regulatory authorities that the detailed RAP documents prepared throughout the project will adequately address the risks and ensure that the environment is adequately protected throughout the remediation process.

This Conceptual RAP also provides an overview of the remediation approach to be adopted to ensure that the site (excluding the area of the containment cell) is rendered suitable for the intended low density residential use and that all elements of the environment have been adequately assessed and managed. The RAP will ensure that the containment cell and its buffer areas are suitable for public open space uses. The RAP will also ensure that these uses are protected now and into the future and that any environmental impacts arising from the site are limited, are determined to be acceptable in the context of environmental protection and do not preclude use of the site for its intended purposes.

In accordance with the requirements outlined above, IFL is currently in the process of preparing and entering into a VRA with DECC. It is proposed that this Conceptual RAP as well as the separate RAPs prepared for three of the four stages of the remediation process, will form part of the VRA conditions. In particular, the RAPs will address the following issues in order to satisfy the terms of the VRA:

- The objectives of the proposal specifically referring to the requirements set out under the CLM Act and relevant EPA guidelines;

- The principal features of the proposal, including the capital works involved; detailed description of the remediation works to be completed and details on the proposed monitoring and recording methods to be adopted;

- The proposed reporting requirements including the timeframes in which each report will be submitted to DECC;

- Setting out the key milestones for each major remediation activity undertaken on the site.

It is proposed that each stage of the RAP must be completed to the satisfaction of DECC before the next stage can commence.

This Conceptual RAP has been prepared in accordance with the *Guidelines for Consultants Reporting on Contaminated Sites* (NSW EPA, 1997). This reference notes that the RAP should:

- Set remediation goals to ensure the site is suitable for its intended use and will not pose an unacceptable risk to human health or to the environment.

- Detail all procedures and plans to be undertaken to manage the risks such that they are acceptable for the proposed use.

- Establish appropriate environmental safeguards to ensure that the remediation is conducted in an acceptable manner and not to the detriment of the environment and community.

- Identify and obtain approvals and licenses required from the appropriate regulatory authorities.

- Determine ongoing management requirements to ensure that the long term risks to the environment and the community are appropriately managed to ensure that any such risks are acceptable.

Soil and Groundwater Consulting (S&G) was engaged by IFL to undertake the environmental assessment of the site and determine appropriate management methods for the identified contaminated materials to render the remediated site suitable for its intended uses. The adopted management approach for the predominantly heavy metal impacted soil / fill materials at the site is isolation within a lined containment cell located within the site boundaries.

The removal of the metal impacted soils, which are the primary source of the identified groundwater contamination, to the engineered containment cell will remove the primary ongoing source of groundwater contamination at the site.

The design of the containment cell and associated environmental management infrastructure is being undertaken by Golder Associates (Golder) and sections of this document detailing the location of the cell, the staging of remediation works, the containment cell design and the management of the cell within the environment have been produced separately by Golder and included herein. Golder has also developed the majority of the section detailing the development of the Construction and Demolition Management Plan and contributed substantially to other sections of this report including the Remediation Approach & Objectives and the Environment Management Plan. The section relating to Licences and Approvals was developed by Manidis Roberts, the planning consultants for the project.

2. SITE HISTORY AND CONTAMINANT SOURCES

2.1 Summary of Environmental Investigations

Various rounds of investigation and assessment have been conducted at the IFL Cockle Creek site. The following provides a summary of the previous investigation reports:

- November 1992 - *Preliminary and Supplementary Investigations into Groundwater in the vicinity of the Boolaroo Refinery, for Pasminco Metals-Sulphide Pty Ltd (Technical Report No. 4).* Environmental and Earth Sciences Pty Ltd;

- December 1992 - *Preliminary Hazard Analysis of the Proposed Upgrade of Smelter Facilities, Boolaroo, NSW (Technical Report No. 11).* Industrial Risk Management;

- September 1993 - *Preliminary Site Contamination Assessment, Main Road, Boolaroo, for Incitec Limited.* Resource Planning Pty Limited;

- April 1994 - *Review and Summary of Available Data, Soil Lead Distribution around Boolaroo Smelter (Technical Report No. 9).* Dames & Moore;

- June 1995 - *Groundwater Discharge Study of the Sulphide Corporation Refinery, Boolaroo, NSW, June 1995.* Environmental and Earth Sciences Pty Ltd;

- July 1996 - *Hydrochemistry of the Munibung Catchment Boolaroo, New South Wales, Australia.* Andrew P. Dawkins, UNSW Groundwater Centre, Dept. of Applied Geol. UNSW;

- February 1999 - *Investigation of Water Trends 1992- 1999.* Howard Bridgman, Pasminco Cockle Creek Smelter Pty Ltd;

- June 2003 - *Detailed Environmental Assessment, for Incitec Fertilizers, Cockle Creek Plant, Main Road, Boolaroo*. URS Australia Pty Ltd;

- July 2003 - *Interpretive Environmental Assessment, for Incitec Fertilizers, Cockle Creek Plant, Main Road, Boolaroo*. URS Australia Pty Ltd;

- December 2004 - *Overall Soil and Groundwater Assessment, Incitec Pivot Limited Cockle Creek Plant, Main Road, Boolaroo.* URS Australia Pty Ltd;

- March 2006 – *Draft - Remediation Cost Estimate Incitec Pivot Cockle Creek Site*. Thiess Services;

- April 2007 - *Conceptual Hydrogeological Model & Preliminary Numerical Modelling Report, Cockle Creek Fertiliser Production & Distribution Facility, Boolaroo, New South Wales*. Soil and Groundwater Consulting; and

- April 2008 - *Environmental Site Assessment Cockle Creek Manufacturing & Distribution Facility Boolaroo, New South Wales.* Soil and Groundwater Consulting. Rev 1;

- April 2008 - *Further Environmental Investigations, Cockle Creek Manufacturing and Distribution Facility, Boolaroo, New South Wales*. Soil and Groundwater Consulting.

Only a limited number of later reports were made available for review. The URS summary report included reference to the earlier reports and a summary of the various report findings. However, as these earlier reports were not available, a review of the information by S&G was not possible and the findings reported by URS could not be verified.

Both soil and groundwater have been extensively investigated at the site to assess the risk to human health and the environment and to determine appropriate remediation strategies for both impacted soil and groundwater. It is thought that most of the primary contaminants of concern at the site have been investigated although there may be gaps in the site history and some contaminants, particularly fluoride, nitrate and asbestos, may not have been fully assessed. It is expected that a thorough validation program will assure that the residual soils post remediation will be acceptable for use. The validation program is discussed in more detail in Section 9 of this document.

2.2 Site History

The site is located immediately to the east of the former Pasminco zinc and lead smelter. The layout of the site and the adjacent Pasminco facilities (now largely removed) are shown in Figure 2.

The site was originally part of the Pasminco facility (formerly the Sulphide Corporation), with the superphosphate manufacturing process commencing around 1913 and utilising sulphuric acid created as a by-product from the treatment of the smelter off gases. The production of sulphuric acid was and is still commonly undertaken at smelter facilities and limits the discharge of sulphur compounds to the environment, producing a valuable chemical precursor for manufacturing processes. One use is the combination of sulphuric acid with phosphate rock to produce superphosphate.

The site history information has been generally derived from the URS December 2004 summary report, which compiled the site history findings from the previous assessment reports. It is noted that the site has a long history and the capacity to accurately describe the details of the site history beyond the recent past are limited. The site history was developed based on the review of historical information, aerial photographs and interviews with long standing personnel. Whilst this is considered to be a suitable basis for the purpose of the assessment there are likely to be data gaps in the available site history, particularly in relation to specific occurrences of site contamination or details of activities that have occurred in the more distant past.

Soil & Groundwater Consulting 207 The Parade Norwood SA 5067 PO Box 3166 Norwood SA 5067 T: 08 8431 7113 F: 08 8431 7115	Drawn: DJN	Date: 22 June 2008	Job No.: SG061313	Project: Cockle Creek Assessments
	Checked: APN	Date: 23 June 2008	Title: SITE PLAN SHOWING CURRENT SITE LAYOUT AND FORMER PASMINCO OPERATIONS	Sheet 1 of 1
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The available title information indicates that the site was sold to a predecessor of IFL (Australian Fertilisers Limited) in 1969. Pasminco continued to provide sulphuric acid to IFL for the manufacturing of superphosphate until 2003 when the smelter operations shutdown. Sulphuric acid is currently sourced from the Incitec Pivot Limited (IPL) Kooragang Island facility via truck and stored on site. The sulphuric acid was formerly piped to the site from the Pasminco smelter via a rising main. Periodic failures of the rising main were reported anecdotally until Teflon lining of the rising main on the IFL site in the early 1990's. The rising main was located above ground or within culverts on the site so the potential for large unnoticed leaks from this source was considered to be relatively low. The more historical use of sulphuric acid within the site is poorly documented and considerable uncertainty exists on its distribution of use at the site.

The natural westerly sloping topography of the site has been altered to allow the construction of the existing site facility and infrastructure. Based on the available information, this required excavation into the hillside on the eastern section of the site in the vicinity of Storage Sheds 3 and 4 and filling of the site slope in a series of steps to the west, providing multiple level surfaces across the site for the establishment of buildings and other infrastructure.

The filling of the site has occurred through the use of natural materials resulting from the excavation works in the west and the use of predominantly slag waste materials from the operation of the early smelter on the adjacent Pasminco site. The slag used as fill is typically fine grained and black, and is visible at the surface in the northern part of the IFL site. Some blocky slag was also apparent at some investigation locations. The slag contains elevated heavy metals concentrations and is the primary source of contamination at the site.

Natural materials and reworked surface materials removed more recently during the construction of the sulphuric acid storage and access road were used as filling in the north western part of the site. The filling of parts of the depression and the low lying ground to the east of the southern drain was reportedly undertaken and incorporated inert wastes such as old plant machinery from the IFL site and from Pasminco.

A freshwater dam occurs immediately to the south east of the southern area of the IFL site and falls predominantly within the Pasminco site. The dam wall and spillway occur within the IFL property. The freshwater dam wall was reportedly constructed of predominantly natural clayey materials that are apparent in the dam face and has been confirmed by the site investigations in the vicinity of the dam wall.

2.3 Site Condition and Surrounding Environment

The site is located in a sloping section of Munibung Hill overlooking the Cockle Creek valley. Whilst the natural topography of the site is therefore consistent with a hill and valley type setting, the cut and fill techniques and the importation of fill material has left the site relatively flat to enable building development. The existing site layout is shown in Figure 2. The site is bounded by a chain mesh fence.

The peak of Munibung Hill occurs to the east of the site, with the topography steepening significantly to the east of the eastern site boundary. This area and the area to the west of the site are included in the adjacent former Pasminco Cockle Creek Smelter site. This site is currently being remediated and based on the current published Master Plan, will be utilised for a range of land uses including residential use and public open space.

The nearest surface water body is Cockle Creek, located approximately 580 m to the west of the south west corner of the site and approximately 780 m from the north west site corner. The main axis of the site is located at an angle to Cockle Creek with the site's western boundary approximately falling on a north east - south west alignment. Cockle Creek discharges to Lake Macquarie, which lies approximately 1,600 m to the south of the site.

The main entrance to the site occurs in the central western boundary. The access road occurs through the Pasminco land and connects the site to Main Road.

The site is currently an operational fertiliser manufacturing plant and storage facility and therefore consists of numerous buildings for manufacture and storage of fertiliser, liquids and products as well as administrative, maintenance and despatch buildings. The site is to be progressively closed down following rationalisation of IFL's manufacturing facilities, with the site buildings and infrastructure to be removed. The internal roadways are formed of either concrete or bitumen and are in good condition.

The site comprises a superphosphate manufacturing area in the central western part of the site and a series of large storage sheds, numbered 1 to 4, adjacent the superphosphate manufacturing area. The sheds are used for phosphate rock and superphosphate storage. Other buildings in this area house crushers and other infrastructure. The sheds and buildings are largely constructed with corrugated steel and asbestos fibre containing cement sheets. The sheds have concrete floors which are in good condition where the floors can be observed.

The manufacturing area includes a number of above ground storage tanks (ASTs) which are registered for hypochlorite, sodium hydroxide and fluorosilicic acid. A diesel AST was also identified which connects via above ground pipes to a bowser adjacent the roadway near the manufacturing plant. There was no evidence of significant losses or environmental impacts associated with the ASTs. There are no reported underground tanks at the site.

The open area to the north of the operational area is largely vacant although this area contains a former railway line and trestle structure formerly used for transport of materials to the now derelict overhead conveyor system. A number of small stockpiles of waste materials occur in this area. The southern area of the site to the south of the truck turning circle and weighbridge is vacant.

Areas of open space occur to the south and north of the manufacturing and storage areas. There is no evidence of vegetation stress in areas where vegetation occurs. There are no obvious odours or staining associated with the site soils, however, visible slag materials are present in the surface soils in the northern part of the site.

A fresh water dam is located adjacent the south eastern portion of the site although the dam itself is located outside of the site boundary. The dam wall however is located within the site boundary and consists predominantly of clayey fill material. A dam spill way occurs through the IFL site via the '6 foot drain' and subsequently discharges down slope of the IFL site to Cockle Creek.

Stormwater management at the site differs by area, with current arrangements summarised as follows:

- Runoff from the undeveloped northern part of the site is generally captured by two open drainage channels that convey water a point on the northern site boundary with Pasminco.

- The northern developed area of the site, in the vicinity of Shed 4 and the site administration buildings, drains to a subsurface drain that is believed to exit the site along the western boundary with Pasminco at a point to the north of the main site access roadway.

- Runoff from the central part of the site, the plant area, is generally directed toward the main site entrance, where a water treatment plant is located. After treatment, water is discharged through a subsurface drain that exits the site along the main site access roadway.

- Runoff from the undeveloped eastern hillside area of the site is generally captured by an open drainage channel that conveys water to eastern side boundary and into the freshwater dam.

- Runoff from the undeveloped southern area of the site generally flows overland across the western site boundary with Pasminco; a portion of this runoff flows into the depression near the freshwater dam wall and presumably enters the '6 foot drain'.

A number of drainage easements exist on the Incitec site in favour of Pasminco. These easements are intended to provide for drainage of water for Pasminco activities located on the eastern (upslope) side of the Incitec site. The consultation process with Pasminco, as discussed in Section 4.2 of this document, will include the disposition of these easements.

2.4 Geology and Hydrogeology

The 1:250 000 Newcastle Geological map shows the site to be underlain by sediments of the Permian age Newcastle Coal Measures which comprise conglomerate, sandstone, tuff, shale and coal. Quaternary age alluvial sediments were also identified in the lower valley around Cockle Creek. The geological map indicates that the Newcastle Coal measures are underlain by a sequence of Permian age coal measures and siltstone and sandstone formations.

Anecdotal information indicates there is an adit on the eastern side of the hill on which the site is located, suggesting an access or investigation point for the Coal Measures. The site lies within the Lake Macquarie Subsidence District, indicating the potential for coal mining to have occurred in the vicinity of the site.

The Newcastle Mine Subsidence Board was contacted regarding the presence of any former underground workings in the vicinity of the site. The closest workings are those associated with the shallow Sulphide Pit mine which occurred to the north west of the site but entirely within the adjacent Pasminco site. There was no historical mine workings identified within the IFL site at Cockle Creek.

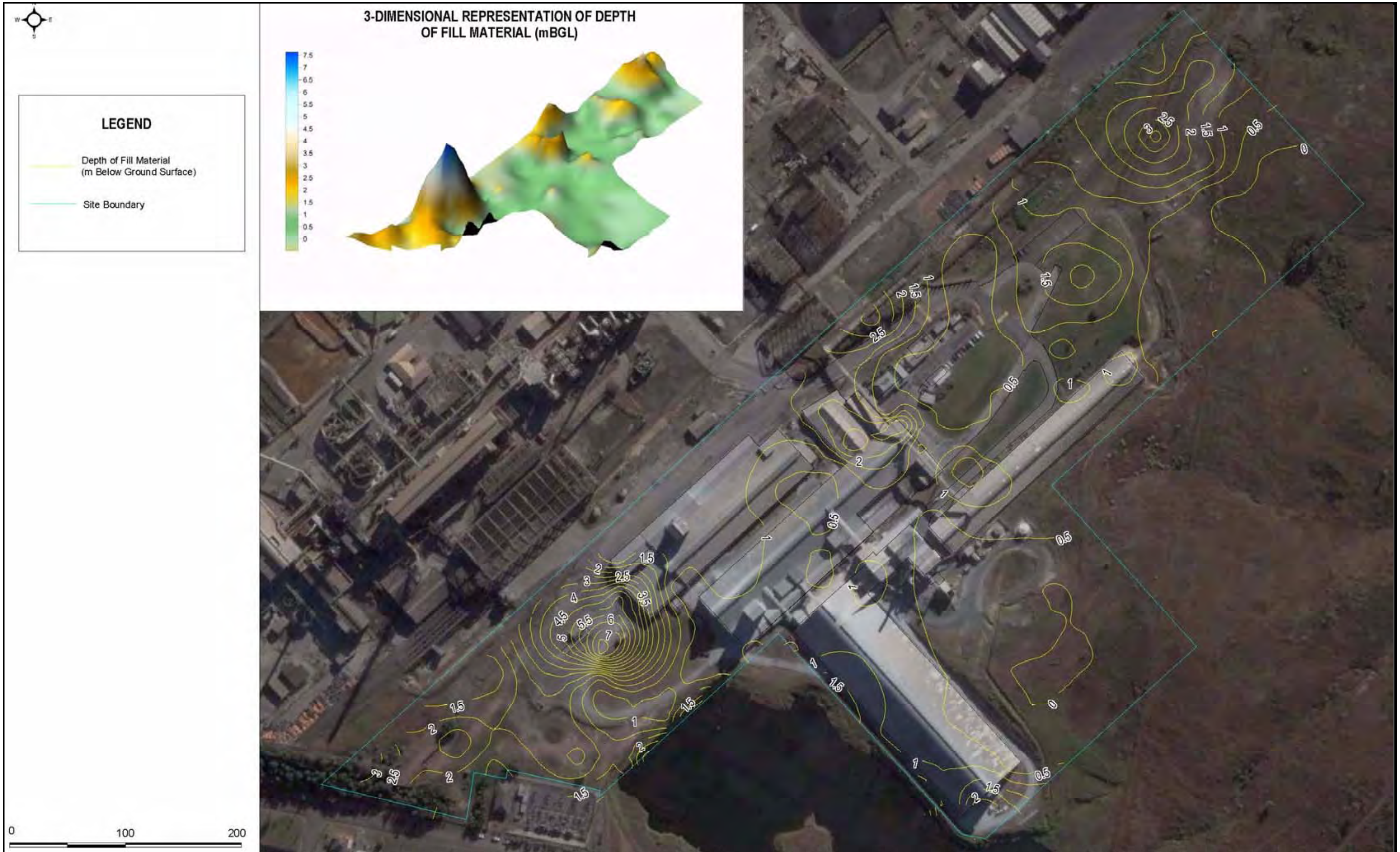
Intrusive investigations have been conducted across the site and penetrated to natural materials beneath the fill at many locations. The maximum depth of investigations at the site is 34 m. Investigations indicate the fill materials comprised slag / cinders and general industrial rubbish within a sand, gravel and clay matrix. The near surface fill materials at many locations were generally sandy and gravelly with various waste inclusions. Some asbestos containing material and asbestos fibres were identified at some limited locations within the fill material. These asbestos containing materials are expected to be restricted to the fill materials and not expected to have impacted the natural materials at the site.

The slag occurs distributed within the fill rather than occurring as discrete layers and suggests the materials were mixed prior to or at the time of placement. The majority of the filling is reported to have occurred prior to the mid 1950s, with additional minor filling occurring prior to 1966 and later around the depression and north-western section of the site. Relatively minor amounts of slag were reported to the east of the main plant and storage areas and this is consistent with the more natural topography of these areas.

Elevated concentrations of heavy metals, particularly lead and zinc, but occasionally arsenic, nickel and cadmium are present in the slag impacted fill materials. The thickness of fill at the site is typically two to three metres, except for the western edges of the site and the former creek bed gully below the dam wall where the fill and reworked colluvial materials is reported to extend to over 10 m in thickness. The inferred thickness of fill materials at the site is shown in Figure 3. The volume of impacted material was estimated to be in the order of 200,000 m^3. A cross section based on the data collected from drill logs is included in Figure 4 to provide a representation of the typical site profile.

The fill materials are underlain by the weathered siltstone and sandstone associated with the underlying natural formation, the Newcastle Coal Measures. The deeper profile included carbonaceous layers and the weathered materials grade to more consolidated materials with increasing depth, although variably weathered materials have been encountered over the section investigated. The investigations have demonstrated that the natural materials contain low contaminant concentrations and that typically these materials would be suitable for use within a low density residential setting.

A search was undertaken of the NSW Natural Resources Atlas for groundwater bores in the vicinity of the site. The search did not identify any registered bores in close proximity to the site, other than a number of shallow investigation bores. There are no registered extraction wells between the site and Cockle Creek, which is considered the probable long term discharge point of groundwater emanating from the site, although information included in the Environmental Site Assessment for the adjacent Pasminco site prepared by Fitzwalter Group Pty Limited (2006) suggests that the operations at the Teralba Colliery located to the west of Cockle Creek have depressed local



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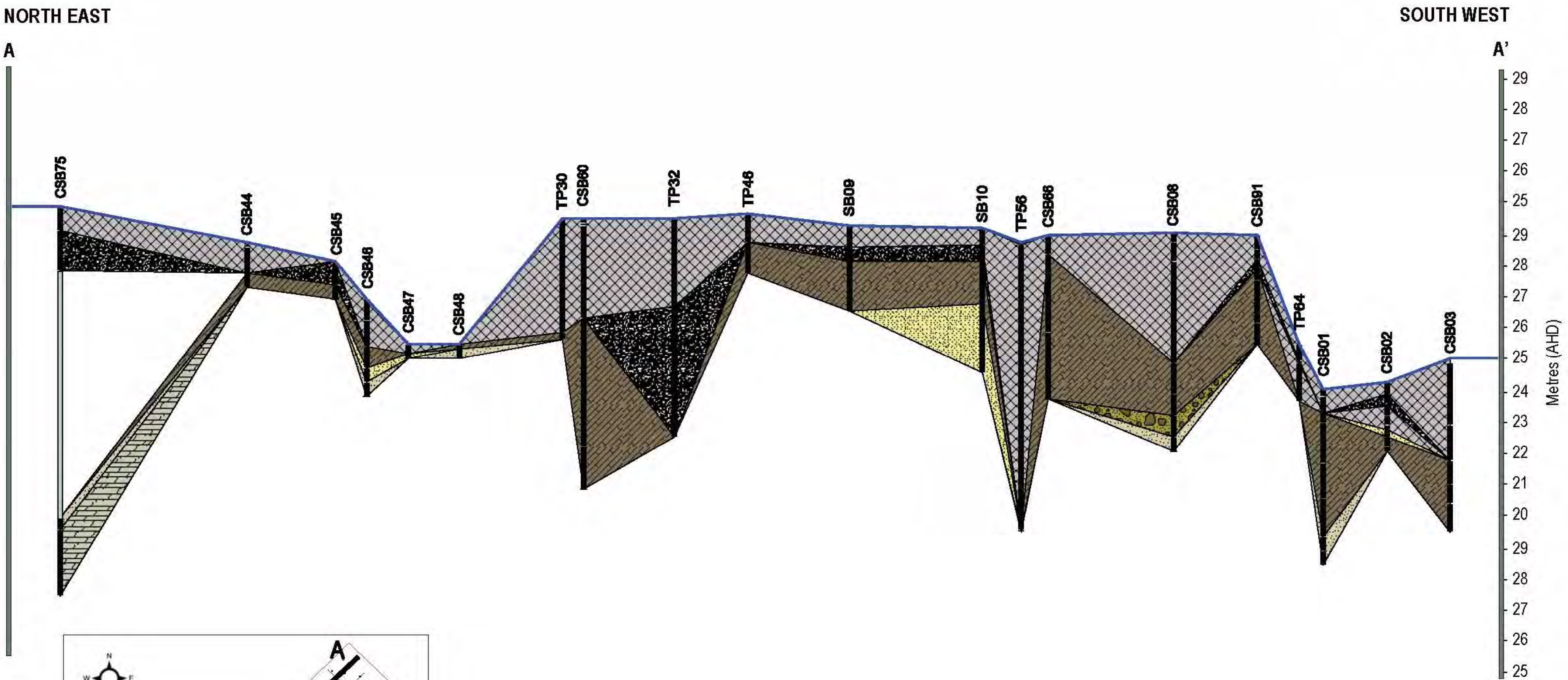
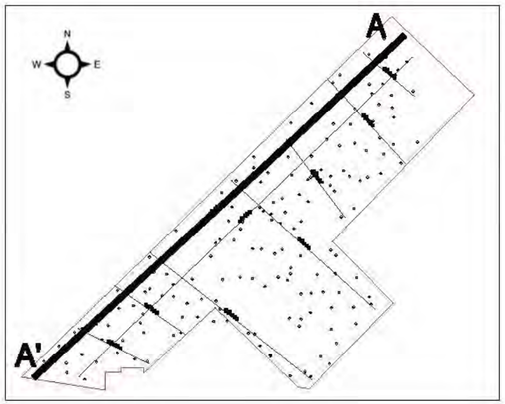
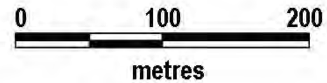
	Checked: APN	Date: 23 June 2008		Title: INFERRED DEPTH OF FILL MATERIALS After S&G 2008		Sheet 1 of 1
	File Name: Fig3.wor	Scale: As Shown	A4			FIGURE 3





LEGEND

	FILL		Sand		Gravels
	FILL – containing slag		Sandstone		Shale
	Clay		Siltstone		No recovery



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Drawn: DJN	Date: 22 June 2008		Job No.: SG061313	Project: Cockle Creek Assessments	
Checked: APN	Date: 23 June 2008		Title: INFERRED PROFILE CROSS SECTION A-A'		Sheet 1 of 1
File Name: Fig4.wor	Scale: As Shown	A4			FIGURE 4

groundwater levels and the regional groundwater system does not currently discharge to the creek. The hydrogeological investigations at the adjacent Pasminco site identified a shallow, possibly perched, groundwater aquifer underlain by a deeper groundwater aquifer.

Groundwater at the site was encountered in both the fill and natural materials at the site. A number of nested well installations have been installed as part of the investigations and these show a general downward gradient between the fill, shallow and the deep natural aquifer sequences.

There is generally a substantial downward head difference between the shallow and deep natural aquifer levels at measured locations and this may indicate the deeper aquifer is more regionally influenced by dewatering activities at the Teralba Colliery operations which occur to the west of Cockle Creek. Investigations at the adjacent Pasminco site indicated that the deep aquifer does not intersect Cockle Creek, with groundwater levels well below the creek bed level. The most likely regional sink was inferred to be the adjacent coal mine operations. The findings at the IFL site are consistent with the Pasminco conclusions.

The groundwater flow direction in all aquifer sequences was inferred to be in a broadly westerly direction across the majority of the site, with flow in the general direction of Cockle Creek, although as noted above the regional sink may be currently the Teralba Colliery. In the longer term with the closure of the colliery, the regional groundwater environment would be expected to rebound with natural discharge being to Cockle Creek or Lake Macquarie.

A reversal of the vertical groundwater head gradient was apparent at one location in the north eastern portion of the site at location 130, where the level in the natural shallow aquifer was slightly higher than that reported in the fill aquifer. No deep well was installed at this location.

Slightly artesian conditions had been reported previously at well BH19 in the north east of the site. The bore construction details for BH19 were not available, although the total depth of the well suggests it is most likely measuring the shallow natural aquifer.

A deep natural aquifer well, 125, was installed at this location to assess the vertical gradient and to determine if the deeper groundwater was responsible for the artesian conditions. This deep well indicates a downward gradient and so it was concluded that the deeper system is not influencing the observed artesian conditions. The artesian occurrence, and possibly the reversal of the vertical gradient at location 130, is thought to be related to a confining unit within the formation and an abrupt change in topography in this area. Confined conditions were also evident during the drilling of well 127 near the eastern site boundary, although the resulting groundwater level at this location was not artesian.

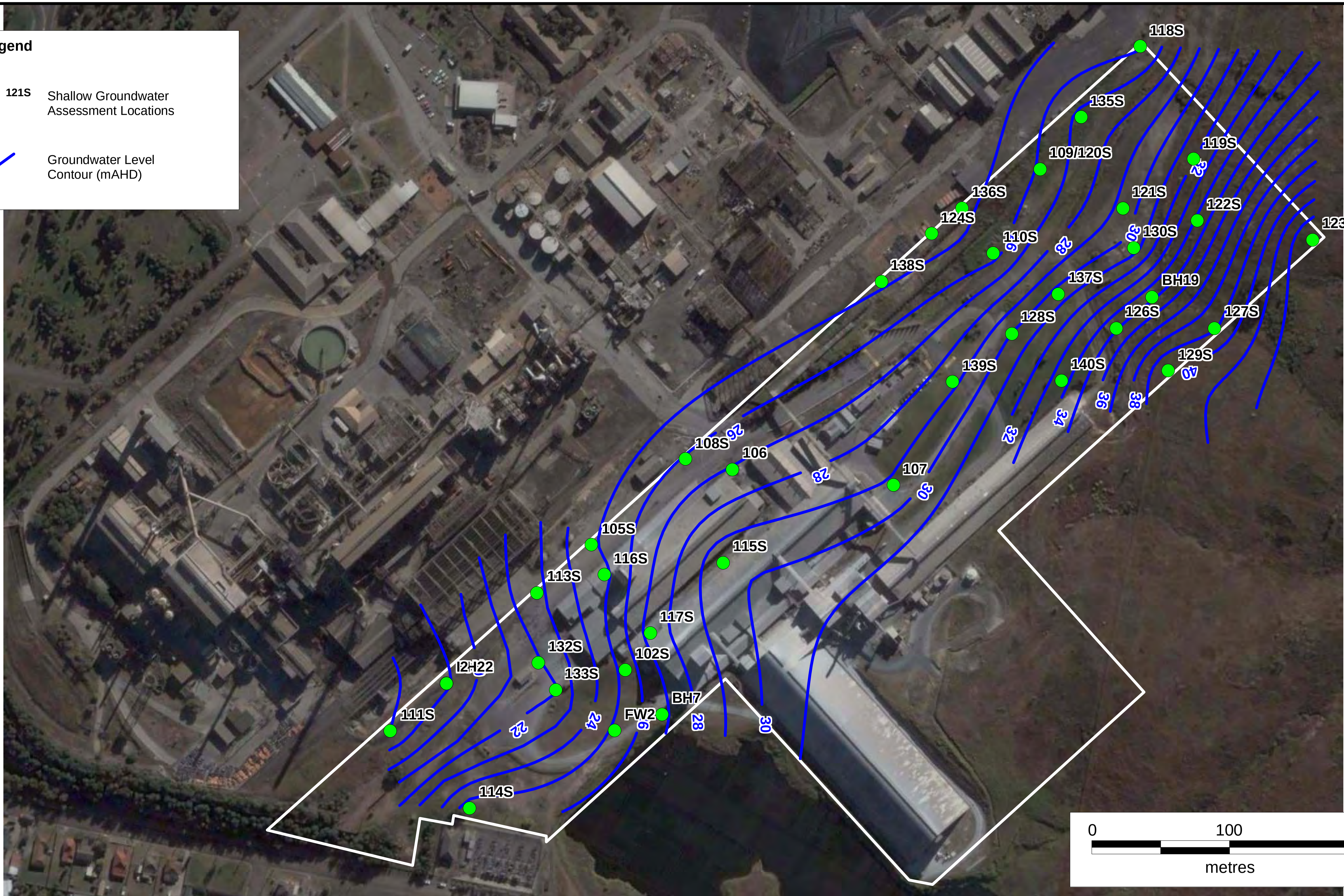
A more detailed description of the site hydrogeology is included in the S&G Environmental Site Assessment and the Conceptual Hydrogeological Model reports.

Figure 5 shows the location of the monitoring wells screening the shallow natural aquifer at the site and the inferred groundwater level contours for this aquifer. It is noted that the history and frequency of groundwater monitoring at the site is limited and so it is not possible to have fully documented the possible fluctuations that may occur in the natural groundwater system. The available monitoring record and utilisation of the numerical model will be used to assess possible groundwater variations at the site and thus provide a suitable basis for the design of the containment cell to ensure it is located above the regional watertable to the extent practicable.

2.5 Conceptual Site and Hydrogeological Model

The following provides a summary of the key features of the site conceptual model based on the investigation and monitoring data available to date:

- Shallow fill materials are impacted by slag and other waste materials.
- The contaminant concentrations, particularly heavy metals, in the fill material would preclude most uses of the site on the basis of human health risk.
- The fill materials occur across the site but are thickest in the former gully area located to the west of the freshwater dam.
- Surface impacts from metals are evident in unfilled areas of the site most likely as a result of aerial deposition of contaminants. The depth of impact is limited to the shallow soils.
- The natural soils underlying the fill materials have been shown to typically have low contaminant concentrations which would generally be suitable for low density residential use from a health based perspective. There was no evidence of aesthetic impacts in the natural soils which would preclude or restrict residential use of the land following removal of the fill materials. Metals concentrations exceed ecological based criteria at some locations and further assessment or management of these issues in the residential setting may be required.
- The site contains numerous buildings with asbestos containing materials and these will require management to prevent contamination of the environment during demolition works.
- The metal contaminants are leachable and have migrated to the groundwater environment at concentrations that greatly exceed the ecosystem protection criteria for a number of metals.



Soil & Groundwater Consulting 207 The Parade Norwood SA 5067 PO Box 3166 Norwood SA 5067 T: 08 8431 7113 F: 08 8431 7115	Drawn: DJN	Date: 12 June 2008	Job No.: SG061313
	Checked: APN	Date: 12 June 2008	Project: Cockle Creek Assessments
	File Name: Fig5.wor	Scale: As Shown A4	Title: SHALLOW GROUNDWATER LEVELS FEBRUARY 2008
		Sheet 1 of 1	FIGURE 5

- Groundwater is encountered at some locations within the fill materials and may be perched. Groundwater is also encountered in the natural weathered rock profile at shallow depths and, based on maintenance of vertical head gradients between the fill and natural aquifers, it is likely that there is some retardation to vertical flow. A series of wells have also been installed with screens set well below the surface in natural materials. A consistent downward vertical gradient is observed between the shallow and deep sections of the natural aquifer.

- Groundwater flow is predominately in a westerly direction toward Cockle Creek, although local variations occur. The hydraulic gradient is flatter in the main manufacturing area, moderate elsewhere and relatively steep in the southern area of the site adjacent the south west boundary.

- Rising head hydraulic conductivity tests were conducted at a number of locations through the site targeting various levels of the aquifer. Results ranged from 0.002 to 9.5 m/day with most results less than 1 m/day. The geometric mean of results was 0.07 m/day, consistent with the highly weathered nature of the sediments encountered.

- Recent intensive groundwater investigations in the northern area included rising head hydraulic conductivity tests on all new wells and identified hydraulic conductivity values in the fill aquifer ranging from 0.03 to 0.4 m/day, in the shallow natural aquifer of 0.01 to 3.5 m/day and in the deep natural aquifer of 0.3 to 0.5 m/day. The geometric mean for each of the three aquifer sequences tested was 0.08, 0.15 and 0.4 m/day respectively. The hydraulic conductivity appears to increase with depth.

- Two pumping tests were conducted adjacent to two existing nested sites near the western site boundary and reported results in the range of 8×10^{-4} to 6×10^{-2} m/day. The results are at the low end of the range of values obtained from the rising head tests.

- Groundwater salinity within the site ranged from 330 mg/L total dissolved solids (TDS) to 10,000 mg/L TDS, with the average salinity increasing with depth. The groundwater is generally not of a salinity level suitable for potable use without treatment.

- Off site assessments have not been conducted as part of the investigations of the IFL facility although investigations at the adjacent Pasminco site have been undertaken by others. These investigations had identified a shallow and discontinuous perched system within fill materials and a deeper natural aquifer. Assessment of groundwater levels adjacent Cockle Creek had indicated that the natural groundwater system is unlikely to be in contact with the creek, having been drawn down by the dewatering activities at the coal mine located west of the creek.

2.6 Contaminant Sources

The following table provides a summary of the principal contaminant sources which have been identified at the site.

Table 1 – Areas and Chemicals of Interest

Areas	Chemicals of Potential Concern	Likelihood	Mobility / Comments
Slag impacted fill material across site	Heavy metals, fluoride	High, known to occur across site and are leachable. Fine grained increases mobilisation potential due to increased surface area for dissolution	Moderate to high leachability, acidic conditions will promote mobilisation
Fertiliser Manufacturing & Distribution	Nitrogen species, phosphorus, sulphate, fluoride, pH, TPH at localised areas	High based on long history of use, historical practices, large volumes of materials	Phosphorus likely to have low mobility in soils, nitrogen species more mobile, acids in liquid forms and likely to be mobile, surface impacts from stack emissions, possibly local impacts from fuel storage / use
Waste materials: brick, wood, metal, plastics, glass, cement sheeting, rock	Nutrients: nitrogen and phosphorus, metals, inert material, asbestos, aesthetics	Moderate, generally inert materials but inclusion of some degradable materials	Possible inclusion of site waste materials in more recently filled areas
Site Buildings	Asbestos containing materials, heavy metals	High	Sheeting also reported to contain elevated heavy metals as a result of dust deposition and adsorption

2.7 Remediation Criteria

2.7.1 Soils

Section 105 of the *Contaminated Land Management Act* 1997 allows DECC to "make or approve" guidelines for any purpose related to the objects of the Act. The *Guidelines for the NSW Site Auditor Scheme (2nd edition)* indicates that the appropriate soil investigation levels (SILs) for the assessment of the suitability of the site are as follows:

Potential Human Health Risks

The human health-based investigation levels (HILs) and the exposure scenarios on which they are based are published in the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPM) and also in the *enHealth Monographs—Soil Series*.

The HILs are based on generally conservative assumptions for the estimated exposure of site occupants in the above land use scenario. The NEPM states that:

*"An **investigation level** is the concentration of a contaminant above which further appropriate investigation and evaluation will be required (ANZECC/NHMRC Guidelines 1992)".*

An exceedance of an investigation level does not indicate that there is a definite risk to human health, but rather that further site-specific assessment is required to quantify the potential risk to human health.

Where the NEPM investigation levels are silent, other health based guidelines, including the NSW EPA *Guidelines for Assessing Service Station Sites* (EPA, 1994) may be appropriate. It is recognised that the soil criteria provided in the *Guidelines for Assessing Service Station Sites* are provided for sensitive land use and as such, are likely to be conservative criteria for uses other than sensitive uses.

Where appropriate health based criteria are not available in the listed publications then alternative national / international criteria will be considered. This will include contaminants such as fluoride, asbestos and nutrients. The proposed criteria will be discussed and agreed with the site Auditor / DECC. Where no appropriate criteria are identified, then DECC will be contacted for advice on assessment criteria for these contaminants.

Potential Ecological Risks

The NEPM Interim Urban Ecological Intervention Levels (EILs) provide indicative screening level assessment of the ecological impact of contamination based on phytotoxicity.

The EILs aim to protect ecological values (eg. flora, fauna) in developed areas. The EILs are based on considerations of phytotoxicity (copper, chromium, lead) and soil survey data (barium, phosphorous, sulphur) from four Australian capital cities. The ANZECC B values previously included in the *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites* (*ANZECC / NHMRC*, 1992) were retained for the other contaminants.

There are limitations to the application of these criteria and it is noted that these EIL criteria are intended to be used as a screening guide only. The provided EIL values do have significant limitations because phytotoxicity depends on soil and species parameters that are not currently fully understood and the actual toxicity is likely to be related to soil texture, plant sensitivity and soil pH.

Where NEPM guidelines are not provided for a particular chemical, other guideline documents may be referenced, including the NSW EPA *Guidelines for Assessing Service Station Sites* for the protection of terrestrial organisms.

Where appropriate ecological based criteria are not available in the listed publications then alternative national / international criteria will be considered. This will include contaminants such as fluoride and nutrients. The proposed criteria will be discussed and agreed with the site Auditor / DECC. Where no appropriate criteria are identified, then DECC will be contacted for advice on assessment criteria for these contaminants.

Leachability

Residual contaminants may occur in soils that fall below relevant health or ecological based criteria. In most cases these levels are likely to be sufficient to ensure that the contaminants do not pose a significant risk to the quality of the groundwater system. However the leachability of any residual soil contaminants will be tested to verify that such contaminants are not leachable at concentrations that are likely to result in contamination of groundwater at levels that would preclude relevant uses.

Aesthetics

Soils will be remediated such that they do not present aesthetic contamination. It is noted that the Schedule B(1) of the NEPM (1999) that states that *"there are no numeric Aesthetic Guidelines but the fundamental principle is that the soils should not be discoloured, malodorous (including when dug over or wet) nor of abnormal consistency. The natural state of the soil should be considered".* Additionally, aesthetic considerations are also noted in the DECC Site Auditor Guidelines 2nd Edition. This is considered the relevant guideline for the site on this issue.

The assessment of the soils to date indicates a low probability that they will be odorous and that this will be relevant to the assessment of aesthetics in this case. There is potential for soils to be discoloured (predominantly as a result of slag or other waste) however such materials are likely to result in elevated soil concentrations and thus would require removal in any case to meet the relevant health or ecological based criteria. Nonetheless, the aesthetic criteria or olfactory or visual impact will form part of the assessment of compliance of the remediation program.

Building and Structures

As the remediated section of the site is intended for low density residential use, and this use if consistent with the Master plan for the area, it is expected that only light structures requiring shallow foundations will be developed at the site. As the soils are expected to be remediated to meet the ecological based criteria, which include sulphate concentrations being protective of concrete structures, it is considered likely that the remediated soils will not pose an unacceptable risk to the durability of concrete structures installed in the site soils.

Nonetheless, the validation program instituted at the site will be sufficiently broad to ensure that the soils do not pose a risk to the durability of structures built at the site. This will include the assessment of soil pH, sulphate, redox potential, salinity and any other potential contaminants of concern which may influence the integrity of buildings or other structures as discussed and agreed with the site Auditor.

2.7.2 Groundwater

Schedule 2 of the *Guidelines for the Assessment and Management of Groundwater Contamination* (DEC, 2007) identifies various environmental values of groundwater which may be required to be protected depending on the location of the site. These environmental values are:

- Aquatic ecosystems - these include surface water ecosystems and groundwater ecosystems;

- Human uses - these include but are not limited to potable water supply, agricultural water supply (irrigation and stock watering), industrial water use, aquaculture and human consumption of aquatic foods, recreational use (primary and secondary contact with surface waters) and visual amenity of surface waters;

- Human health in non-use scenarios - this includes consideration of health risks that may arise without direct contact between humans and the groundwater, for example, exposure to volatile contaminants above groundwater contaminant plumes; and

- Buildings and structures - this includes protection from groundwater contaminants that can degrade building materials through contact, for example, the weakening of building footings resulting from chemically aggressive groundwater.

The above Guideline also notes that Schedule B(6) of the NEPM provides a methodology for using generic or site specific groundwater investigation levels (GILs) to assess contaminated groundwater. The following six environmental values as presented in the NEPM are:

- aquatic ecosystems;

- aquaculture and human consumers of food;

- agricultural water;

- recreation and aesthetics;

- drinking water; and

- industrial water.

Section 2.2 of the Guideline identifies the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2004) for assessment of drinking water and the appropriate trigger values (as agreed with the site Auditor) included in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, 2000), hereafter referred to as ANZECC 2000, for assessment of aquatic ecosystems. Both these documents form part of the National Water Quality Management Strategy. ANZECC 2000 also provides assessment criteria for aquaculture, agricultural waters and recreational water uses.

The following table provides a summary of the environmental values of groundwater and their relevance to this site.

Table 2 – Summary of Relevant Environmental Values

Environmental Value	Comment	Relevance
Aquatic ecosystems	Groundwater may discharge to Cockle Creek, particularly in the long term as dewatering associated with the coal mine ceases	Relevant
Aquaculture and human consumers of food	Low potential of use given site setting, distance from creek and proposed residential / open space development. Ecosystem protection criteria likely protective. Nonetheless a consideration given potential use of Cockle Creek and Lake Macquarie for recreational and / or commercial fishing	Relevant
Agricultural water	Brackish groundwater unlikely to be suitable for use in residential setting or for open space watering uses without treatment to remove salts.	Not Relevant
Recreation and aesthetics	Site distant from potential surface water receptor. Possible use of shallow groundwater for swimming pool makeup water in residential setting	Relevant
Drinking water	Salinity unsuitable for potable use and presence of reticulated water supply makes this use improbable	Not Relevant
Industrial water	Residential / open space setting proposed and so use unlikely due to zoning.	Not Relevant

Based on the above assessment it is considered that the environmental values of Aquatic Ecosystems, Aquaculture and human consumers of food and Recreation and Aesthetics are the only environmental values likely to be relevant at this site.

2.7.3 Surface Waters

The quality of surface waters will be assessed in accordance with ANZECC 2000 based on the relevant uses of surface waters as included in Table 2 above. The appropriate ecosystem requiring protection and the trigger level of ANZECC 2000 for long term management of the site groundwater and surface waters will be discussed and agreed with the site Auditor and DECC, as required. During the site remediation phase, other criteria as agreed with the regulatory authorities may be applied.

2.7.4 Air Quality

Air quality will be managed during the construction phase of the remediation program to ensure that the works do not pose a risk of contamination to the wider environment.

As there are no volatile contaminants at the site, the escape of vapours to the atmosphere is not considered to be a risk associated with the proposed work program. This will be reviewed as part of the environmental assessments conducted during the remediation phase to ensure that this is the case and no further management of this issue is required.

The greatest risk to the air environment from the proposed remediation program is the generation of dusts. Where the dusts are associated with contaminated fill materials, then there is a risk that dust may pose a health risk to potential receptors. It is therefore imperative that dusts are adequately controlled during the remediation phase.

In the long term the containment cell cap will be protective of the enclosed contaminated materials and the potential for contaminated dust generation will be low. Dust could be generated from the exposed cap surface and so measures will be implemented (including planting and maintaining suitable vegetation) to prevent erosion of the capping surface leading to dust generation and nuisance.

2.8 Remediation Criteria Summary

The following assessment criteria references included in Table 3 are proposed to assess the condition and suitability for use of the main elements of the environment.

The individual assessment values for each contaminant within each element will be provided in the detailed RAP documents. Where suitable assessment criteria are not available in the above references then other suitable published criteria or appropriately derived risk based criteria will be utilised. The adoption of criteria other than those included in the above references will be discussed and agreed with the site Auditor before use. The impact of mixtures of contaminants contributing to risks will also be assessed.

Table 3 – Environmental Assessment Criteria

Environment Element	Use	Adopted Criteria / Guidelines
Soil	Residential	NEPM HIL A criteria
	Open Space (Containment Cell Surface)	NEPM HIL E criteria
	Ecological	NEPM EIL
	Aesthetics	NSW DECC Site Auditor Guidelines 2nd Edition
	Leachability	Demonstrate no impact on groundwater from residual soils
	Buildings and Structures	AS2159 / NEPM EIL
Groundwater	All Uses (on and off site)	ANZECC 2000
Surface Water	All Uses	ANZECC 2000
Air	All Uses	DECC

3. SITE CHARACTERISATION

3.1 Contamination Status of Soils

The following provides a summary of the key features of the recent extensive soil investigations at the site:

- Elevated concentrations of heavy metals were reported for a large number of fill soil samples with many exceeding the *National Environment Protection (Assessment of Site Contamination) Measure* (NEPM) health based investigation levels for commercial industrial land use (HIL F). Natural soils were found to largely comply with the NEPM HIL A criteria for residential use.

- Concentrations of total phosphorus were generally elevated in surface and fill samples. The maximum concentration detected was 102,000 mg/kg, which significantly exceeds the NEPM ecological investigation level (EIL) of 2,000 mg/kg.

- Concentrations of sulphate were generally elevated with the maximum concentration detected of 14,000 mg/kg. Concentrations of calcium were generally elevated with the maximum concentration detected of 241,000 mg/kg.

- Concentrations of ammonia and nitrate were generally low, with the maximum concentrations detected of 71 mg/kg and 39 mg/kg, respectively.

- Concentrations of total petroleum hydrocarbons (TPH) and benzene, toluene, ethyl benzene and xylenes (BTEX) were below the NSW EPA sensitive use guideline concentrations for all samples analysed.

- All concentrations of polycyclic aromatic hydrocarbons (PAHs), cyanide, organochlorine pesticides (OCP), phenols, polychlorinated biphenyls (PCB) and volatile halogenated compounds (VHC) were below the laboratory detection limits or below NEPM HILs and EILs where available.

- US EPA Toxicity Characteristic Leach Procedure (TCLP) and Australian Standard Leaching Procedure (ASLP) leach testing was undertaken on selected samples and indicates that the metals in fill materials at the site are highly leachable. In particular, lead and zinc leachability shows that all fill materials are potentially moderately to highly leachable and therefore will be required to be managed as part of the remediation design.

The reader is referred to the Environmental Site Assessment report (S&G, 2008) for a detailed discussion of the contamination status of the soils at the site. The following tables provide a summary of the statistics for the fill and natural soil investigations. A summary of the analytical results and a site plan showing the soil investigation locations are included in Appendix A.

Table 4 – Fill Soil Sample Statistics

	pH	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Total PAH	Sulphate
Count	196	214	214	214	214	214	214	214	214	11	196
Average	6.6	408	84	38	697	4581	2.3	25.0	19569	0.6	1380
St Dev	1.4	826	343	186	1223	7393	5.6	93.3	32967	1.2	2330
95% UCL mean[1]	6.8	761	186	63	1219	7737	4.0	65	33642		2420
Min	2.5	<5	<1	<2	<5	11	<0.1	<2	45	<5	<10
Max	11.3	6800	3500	2700	8900	46000	52.3	1300	229000	3.2	14000
No. > EIL		173	185	1	136	156	76	13	205	11	80
No. > HILA		108	96	0	42	181	3	1	89		
No. > HILF		45	18	0	4	115	0	0	39		

Notes:

95% Upper confidence limit (UCL) of the mean calculated using the US EPA ProUCL software and adopting preferred calculation method

Table 5 – Natural Soil Sample Statistics

	pH	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Total PAH	Sulphate
Count	71	85	85	85	85	85	85	85	85	11	71
Average	5.5	21.8	2.2	7.4	21	120	0.2	2.3	650	0.6	458
St Dev	1.1	45.1	4.8	7.3	27	165	0.8	5.4	1565	1.2	1102
95% UCL mean	5.7	34.8	3.3	9.4	27.5	198	0.4	4.7	1390		1029
Min	3.9	<5	<1	<2	<5	<5	<0.1	<2	<5	<5	<10
Max	8.6	400	38	49	140	880	6.9	35	13000	3.2	7970
No. > EIL		23	17	0	1	3	2	0	49	11	8
No. > HILA		1	1	0	0	9	0	0	1		
No. > HILF		0	0	0	0	0	0	0	0		

Where exceedances of the HIL A criteria occur for the natural materials it is expected that a relatively minor scrape of the area will result in soil concentrations that fall below the criteria. The number of exceedances of the HIL A criteria is low indicating that the natural soils will generally comply with these requirements.

The suitability of the natural soils will be verified by the detailed validation procedure proposed as part of the RAP. Where soils are found to be impacted at concentrations exceeding the adopted validation requirements, then further excavation of these areas will be undertaken until the residual materials meet the relevant acceptance criteria.

A number of exceedances of the EIL criteria are also identified in the available data set and the 95% UCL of the mean exceeded the NEPM EIL criterion for arsenic, cadmium, zinc and sulphate (as S). The extent to which these contaminants will remain elevated above the EILs following appropriate validation of the site surface is not clear. Should contaminants exceed the EILs following validation then further justification of the retention of these concentrations will be undertaken using specialist soil science advice regarding the mobility and availability of metals in the site environment. Where required, additional analyses will be undertaken to provide an appropriate data set for these assessments.

It is noted that the 95% UCL for chromium exceeds the EIL criterion for hexavalent chromium but is well below the criterion for trivalent chromium. There is no expectation based on the site history that the identified chromium is in the hexavalent valance state, however this will be verified as part of the validation program and the appropriate assessment criterion for chromium will be used for the assessment based on these findings.

3.2 Contamination Status of Groundwater

The following provides a summary of the key features of the recent extensive groundwater investigations conducted at the site and the results of recent intensive investigations targeted to the northern section of the site in preparation for the site remediation program:

- Sixty-seven groundwater wells have been installed across the site targeting the fill, shallow and deep natural aquifer sequences.

- The hydrogeological setting is discussed under Section 2.5.

- The primary metal contaminant of concern is zinc, with a maximum concentration detected in the 2006 investigation of 28 mg/L compared with the ANZECC 2000 freshwater ecosystem protection criterion 0.015 mg/L. More recent results from the northern investigation have reported zinc concentrations up to 7,000 mg/L in the shallow natural aquifer.

- A range of other heavy metals including cadmium, copper, lead, mercury and nickel occur at concentrations exceeding the ANZECC 2000 ecosystem protection criteria. Elevated metal results are typically associated with relatively low pH groundwater.

- Whilst the southern area (in the infilled gully area) was the initial concern and the reason for the issue of the *Declaration of Remediation Site,* recent investigations have indicated that the groundwater in the northern area of the site is more heavily impacted. This may be due to the increased potential for recharge and leaching in this area due to the lack of any hardstand surface cover.

- The distribution of groundwater contamination generally indicates that the highest groundwater concentrations are located in areas where relatively large volumes of slag material are located directly hydraulically up gradient. This also tends to correspond with the highest soil concentrations and leachability results.

- The highest groundwater contaminants concentrations generally occur in the fill or shallow natural groundwaters at each location where nested monitoring wells are installed.

- Low pH groundwaters were encountered across the site with results ranging from 2.9 to 7.2. Almost all results were found to be below pH 7. The average groundwater pH was approximately 5.1.

- The highest concentration of ammonia detected was 0.56 mg/L which is considered relatively low and unlikely to give rise to adverse health or environmental impacts.

- Nitrate was detected at concentrations up to 11 mg/L. This is considered to be an elevated level of nitrate although unlikely to require targeted remedial activity given potential for dispersion, dilution or utilisation prior to discharge. The highest nitrate results exceed the ANZECC 2000 trigger value for freshwater ecosystems (95% level of protection) of 0.7 mg/L.

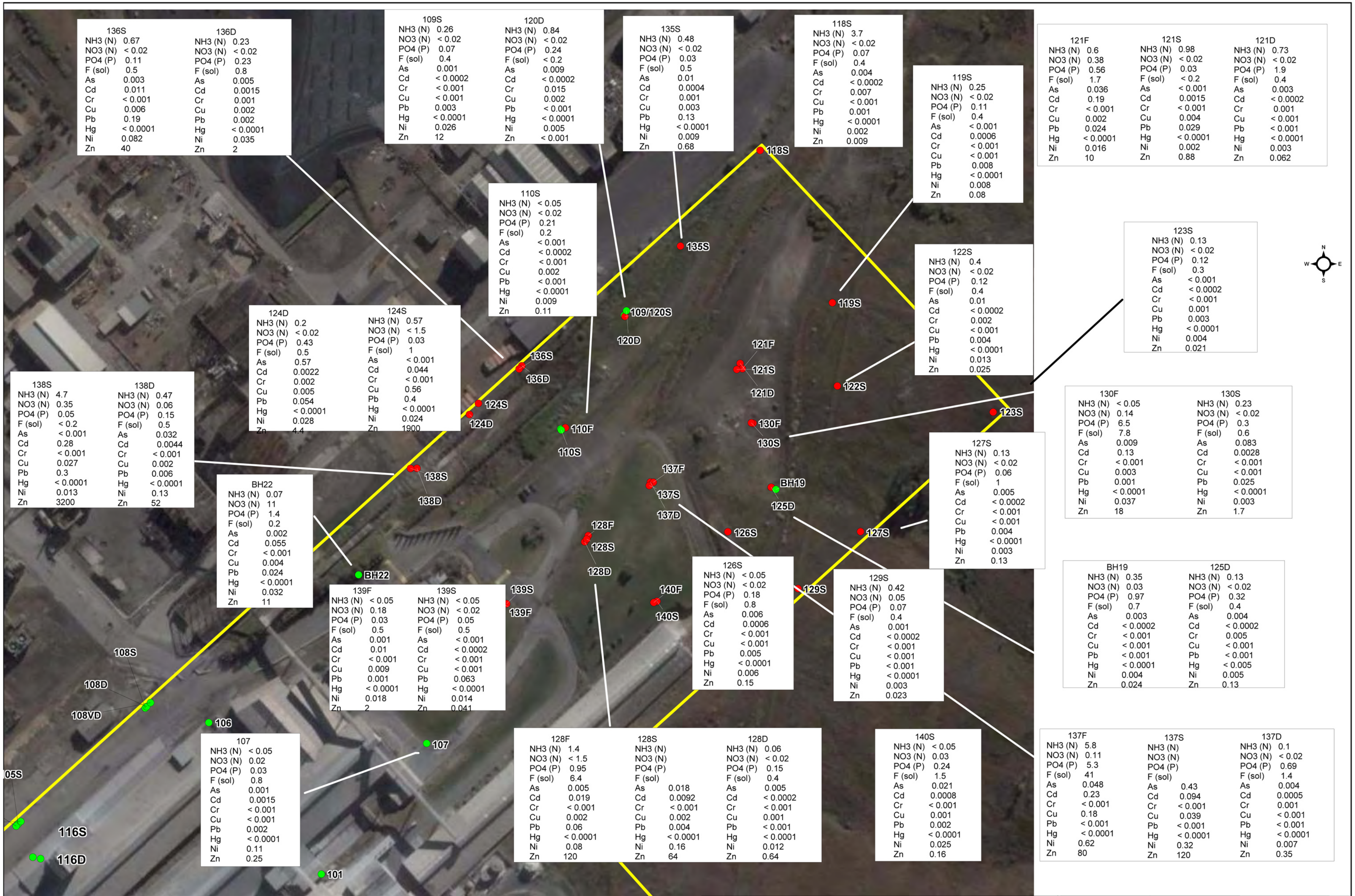
- Other potential contaminants including PAH, cyanide, organochlorine pesticides, phenols, polychlorinated biphenyls and volatile halogenated compounds were below the laboratory detection limits or below adopted guideline values.

- There was no odours apparent or visually impacted groundwater indicative of gross organic contamination during any sampling event.

- The most significant contaminants in groundwater at the site are considered to be heavy metals and of these, zinc occurs at the highest concentrations.

Figures 6 and 7 provide a summary of the latest selected groundwater results for the northern and southern areas of the site. A summary of the groundwater results and a plan of the sampling locations are included in Appendix A. The reader is referred to the Environmental Site Assessment report (S&G, 2006) and the Further Environmental Investigations report (S&G, 2008) for a detailed discussion of the contamination status of the groundwater at the site.

The following tables provide a summary of the key groundwater contaminants in the northern area and the southern area of the site for each of the designated aquifer sequences intersected by the monitoring network. A separate fill aquifer has been defined in the northern section, although this is not as persistent in the southern area and most shallow wells in this area are inferred to be screened in the shallow natural aquifer.



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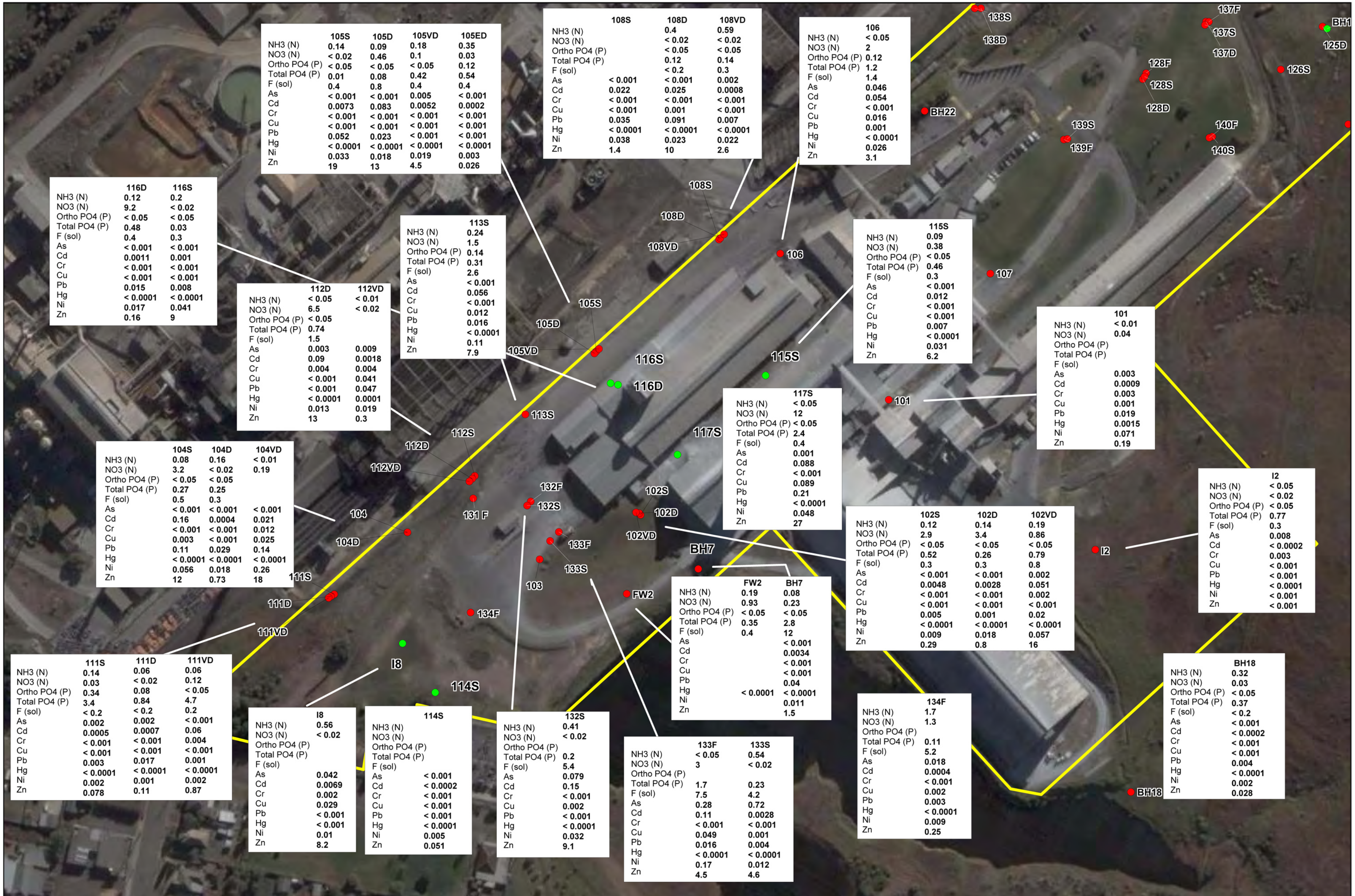
Drawn: DJN	Date: 22 June 2008	Job No.: SG061313	Project: Cockle Creek Assessments		
Checked: APN	Date: 23 June 2008	Title: LATEST SELECTED GROUNDWATER RESULTS NORTHERN AREA (mg/L)		Sheet 1 of 1	
File Name: GW N.wor	Scale: NTS	A3		FIGURE 6	



	105S	105D	105VD	105ED
NH3 (N)	0.14	0.09	0.18	0.35
NO3 (N)	< 0.02	0.46	0.1	0.03
Ortho PO4 (P)	< 0.05	< 0.05	< 0.05	0.12
Total PO4 (P)	0.01	0.08	0.42	0.54
F (sol)	0.4	0.8	0.4	0.4
As	< 0.001	< 0.001	0.005	< 0.001
Cd	0.0073	0.083	0.0052	0.0002
Cr	< 0.001	< 0.001	< 0.001	< 0.001
Cu	< 0.001	< 0.001	< 0.001	< 0.001
Pb	0.052	0.023	< 0.001	< 0.001
Hg	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Ni	0.033	0.018	0.019	0.003
Zn	19	13	4.5	0.026

	108S	108D	108VD
NH3 (N)		0.4	0.59
NO3 (N)		< 0.02	< 0.02
Ortho PO4 (P)		< 0.05	< 0.05
Total PO4 (P)		0.12	0.14
F (sol)		< 0.2	0.3
As	< 0.001	< 0.001	0.002
Cd	0.022	0.025	0.0008
Cr	< 0.001	< 0.001	< 0.001
Cu	< 0.001	0.001	< 0.001
Pb	0.035	0.091	0.007
Hg	< 0.0001	< 0.0001	< 0.0001
Ni	0.038	0.023	0.022
Zn	1.4	10	2.6

	106
NH3 (N)	< 0.05
NO3 (N)	2
Ortho PO4 (P)	0.12
Total PO4 (P)	1.2
F (sol)	1.4
As	0.046
Cd	0.054
Cr	< 0.001
Cu	0.016
Pb	0.001
Hg	< 0.0001
Ni	0.026
Zn	3.1

	116D	116S
NH3 (N)	0.12	0.2
NO3 (N)	9.2	< 0.02
Ortho PO4 (P)	< 0.05	< 0.05
Total PO4 (P)	0.48	0.03
F (sol)	0.4	0.3
As	< 0.001	< 0.001
Cd	0.0011	0.001
Cr	< 0.001	< 0.001
Cu	< 0.001	< 0.001
Pb	0.015	0.008
Hg	< 0.0001	< 0.0001
Ni	0.017	0.041
Zn	0.16	9

	113S
NH3 (N)	0.24
NO3 (N)	1.5
Ortho PO4 (P)	0.14
Total PO4 (P)	0.31
F (sol)	2.6
As	< 0.001
Cd	0.056
Cr	< 0.001
Cu	0.012
Pb	0.016
Hg	< 0.0001
Ni	0.11
Zn	7.9

	112D	112VD
NH3 (N)	< 0.05	< 0.01
NO3 (N)	6.5	< 0.02
Ortho PO4 (P)	< 0.05	
Total PO4 (P)	0.74	
F (sol)	1.5	
As	0.003	0.009
Cd	0.09	0.0018
Cr	0.004	0.004
Cu	< 0.001	0.041
Pb	< 0.001	0.047
Hg	< 0.0001	0.0001
Ni	0.013	0.019
Zn	13	0.3

	115S
NH3 (N)	0.09
NO3 (N)	0.38
Ortho PO4 (P)	< 0.05
Total PO4 (P)	0.46
F (sol)	0.3
As	< 0.001
Cd	0.012
Cr	< 0.001
Cu	< 0.001
Pb	0.007
Hg	< 0.0001
Ni	0.031
Zn	6.2

	101
NH3 (N)	< 0.01
NO3 (N)	0.04
Ortho PO4 (P)	
Total PO4 (P)	
F (sol)	
As	0.003
Cd	0.0009
Cr	0.003
Cu	0.001
Pb	0.019
Hg	0.0015
Ni	0.071
Zn	0.19

	117S
NH3 (N)	< 0.05
NO3 (N)	12
Ortho PO4 (P)	< 0.05
Total PO4 (P)	2.4
F (sol)	0.4
As	0.001
Cd	0.088
Cr	< 0.001
Cu	0.089
Pb	0.21
Hg	< 0.0001
Ni	0.048
Zn	27

	104S	104D	104VD
NH3 (N)	0.08	0.16	< 0.01
NO3 (N)	3.2	< 0.02	0.19
Ortho PO4 (P)	< 0.05	< 0.05	
Total PO4 (P)	0.27	0.25	
F (sol)	0.5	0.3	
As	< 0.001	< 0.001	< 0.001
Cd	0.16	0.0004	0.021
Cr	< 0.001	< 0.001	0.012
Cu	0.003	< 0.001	0.025
Pb	0.11	0.029	0.14
Hg	< 0.0001	< 0.0001	< 0.0001
Ni	0.056	0.018	0.26
Zn	12	0.73	18

	102S	102D	102VD
NH3 (N)	0.12	0.14	0.19
NO3 (N)	2.9	3.4	0.86
Ortho PO4 (P)	< 0.05	< 0.05	< 0.05
Total PO4 (P)	0.52	0.26	0.79
F (sol)	0.3	0.3	0.8
As	< 0.001	< 0.001	0.002
Cd	0.0048	0.0028	0.051
Cr	< 0.001	< 0.001	0.002
Cu	< 0.001	< 0.001	< 0.001
Pb	0.005	0.001	0.02
Hg	< 0.0001	< 0.0001	< 0.0001
Ni	0.009	0.018	0.057
Zn	0.29	0.8	16

	I2
NH3 (N)	< 0.05
NO3 (N)	< 0.02
Ortho PO4 (P)	< 0.05
Total PO4 (P)	0.77
F (sol)	0.3
As	0.008
Cd	< 0.0002
Cr	0.003
Cu	< 0.001
Pb	< 0.001
Hg	< 0.0001
Ni	< 0.001
Zn	< 0.001

	FW2	BH7
NH3 (N)	0.19	0.08
NO3 (N)	0.93	0.23
Ortho PO4 (P)	< 0.05	< 0.05
Total PO4 (P)	0.35	2.8
F (sol)	0.4	12
As		< 0.001
Cd		0.0034
Cr		< 0.001
Cu		< 0.001
Pb		0.04
Hg	< 0.0001	< 0.0001
Ni		0.011
Zn		1.5

	111S	111D	111VD
NH3 (N)	0.14	0.06	0.06
NO3 (N)	0.03	< 0.02	0.12
Ortho PO4 (P)	0.34	0.08	< 0.05
Total PO4 (P)	3.4	0.84	4.7
F (sol)	< 0.2	< 0.2	0.2
As	0.002	0.002	< 0.001
Cd	0.0005	0.0007	0.06
Cr	< 0.001	< 0.001	0.004
Cu	< 0.001	< 0.001	< 0.001
Pb	0.003	0.017	0.001
Hg	< 0.0001	< 0.0001	< 0.0001
Ni	0.002	0.001	0.002
Zn	0.078	0.11	0.87

	I8
NH3 (N)	0.56
NO3 (N)	< 0.02
Ortho PO4 (P)	
Total PO4 (P)	
F (sol)	
As	0.042
Cd	0.0069
Cr	0.002
Cu	0.029
Pb	< 0.001
Hg	< 0.001
Ni	0.01
Zn	8.2

	114S
NH3 (N)	
NO3 (N)	
Ortho PO4 (P)	
Total PO4 (P)	
F (sol)	
As	< 0.001
Cd	< 0.0002
Cr	< 0.001
Cu	< 0.001
Pb	< 0.001
Hg	< 0.0001
Ni	0.005
Zn	0.051

	132S
NH3 (N)	0.41
NO3 (N)	< 0.02
Ortho PO4 (P)	
Total PO4 (P)	0.2
F (sol)	5.4
As	0.079
Cd	0.15
Cr	< 0.001
Cu	0.002
Pb	< 0.001
Hg	< 0.0001
Ni	0.032
Zn	9.1

	133F	133S
NH3 (N)	< 0.05	0.54
NO3 (N)	3	< 0.02
Ortho PO4 (P)		
Total PO4 (P)	1.7	0.23
F (sol)	7.5	4.2
As	0.28	0.72
Cd	0.11	0.0028
Cr	< 0.001	< 0.001
Cu	0.049	0.001
Pb	0.016	0.004
Hg	< 0.0001	< 0.0001
Ni	0.17	0.012
Zn	4.5	4.6

	134F
NH3 (N)	1.7
NO3 (N)	1.3
Ortho PO4 (P)	
Total PO4 (P)	0.11
F (sol)	5.2
As	0.018
Cd	0.0004
Cr	< 0.001
Cu	0.002
Pb	0.003
Hg	< 0.0001
Ni	0.009
Zn	0.25

	BH18
NH3 (N)	0.32
NO3 (N)	0.03
Ortho PO4 (P)	< 0.05
Total PO4 (P)	0.37
F (sol)	< 0.2
As	< 0.001
Cd	< 0.0002
Cr	< 0.001
Cu	< 0.001
Pb	0.004
Hg	< 0.0001
Ni	0.002
Zn	0.028

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Drawn: DJN	Date: 22 June 2008	Job No.: SG061313	Project: Cockle Creek Assessments		
Checked: APN	Date: 23 June 2008	Title: LATEST SELECTED GROUNDWATER RESULTS SOUTHERN AREA (mg/L)		Sheet 1 of 1	
File Name: GW S.wor	Scale: NTS	A3		FIGURE 7	

Table 6 – Groundwater Statistics – Fill Aquifer

Analyte	Northern Area					Southern Area				
	count	Min (mg/L)	Max (mg/L)	No. > ANZECC	No. > NHMRC	count	Min (mg/L)	Max (mg/L)	No. > ANZECC	No. > NHMRC
Ammonia (N)	10	< 0.05	5.8	3	4	2	< 0.05	1.7	1	1
Nitrate (N)	10	< 0.02	1.5		0	2	1.3	3		0
TKN (N)	10	< 0.1	7.2			2	4.9	13		
Total Nitrogen (N)	6	< 0.2	7.4	5		2	6.5	16	2	
Nitrate + Nitrite (N)	6	< 0.02	0.55	3	0	2	1.6	3.2	2	0
Phosphate ortho (P)	4	< 0.05	< 0.05							
Total Phosphate (P)	10	< 0.01	6.5	7		2	0.11	1.7	2	
Sulphate (S)	10	85	880		3	2	450	480		0
Fluoride (sol)	10	0.5	41		5	2	5.2	7.5		2
Arsenic	10	< 0.001	0.048	3	4	2	0.018	0.28	2	2
Cadmium	10	0.0063	0.53	10	10	2	0.0004	0.11	2	1
Chromium	10	< 0.001	< 0.001	0	0	2	< 0.001	< 0.001	0	0
Copper	10	0.002	0.18	10	0	2	0.002	0.049	2	0
Lead	10	< 0.001	0.22	7	7	2	0.003	0.016	1	1
Mercury	10	< 0.0001	0.0084	1	1	2	< 0.0001	< 0.0001	0	0
Nickel	10	0.016	0.62	10	7	2	0.009	0.17	1	1
Zinc	10	2	210	10	9	2	0.25	4.5	2	1
Benzene	2	< 0.001	< 0.001	0	0					
Ethylbenzene	2	< 0.001	< 0.001	0	0					
Toluene	2	< 0.001	< 0.001	0	0					
Xylenes	2	< 0.001	< 0.001	0	0					
Total PAH	2	< 0.001	< 0.001							
TRH C29-C36	2	< 0.05	< 0.05							
TRH C10-C14	2	< 0.1	< 0.1							
TRH C15-C28	2	< 0.1	< 0.1							
TRH C6-C9	2	< 0.02	< 0.02							

Table 7 – Groundwater Statistics – Shallow Aquifer

Analyte	Northern Area					Southern Area				
	count	Min (mg/L)	Max (mg/L)	No. > ANZECC	No. > NHMRC	count	Min (mg/L)	Max (mg/L)	No. > ANZECC	No. > NHMRC
Ammonia (N)	43	< 0.01	6.6	7	10	33	< 0.05	0.56	0	2
Nitrate (N)	43	< 0.02	11		0	33	< 0.02	12		0
TKN (N)	39	< 0.1	14			15	< 0.1	8.2		
Total Nitrogen (N)	25	< 0.2	7.4	19		2	0.8	8.2	2	
Nitrate + Nitrite (N)	25	< 0.02	0.35	1	0	2	0	0	0	0
Phosphate ortho (P)	14	< 0.05	< 0.05			13	< 0.05	< 0.05		
Total Phosphate (P)	39	< 0.01	1.4	18		15	0.01	3.4	13	
Sulphate (S)	39	31	4100		8	15	33	790		2
Fluoride (sol)	39	< 0.2	46		3	15	< 0.2	12		4
Arsenic	45	< 0.001	0.43	6	12	34	< 0.001	0.72	6	10
Cadmium	45	< 0.0002	17	29	15	34	< 0.0002	0.16	25	21
Chromium	45	< 0.001	0.007	3	0	34	< 0.001	0.004	1	0
Copper	45	< 0.001	2.3	16	1	34	< 0.001	0.089	19	0
Lead	45	< 0.001	0.64	23	16	34	< 0.001	0.21	23	14
Mercury	45	< 0.0001	0.0094	3	3	35	< 0.0001	0.049	5	5
Nickel	45	< 0.5	0.32	24	17	34	< 0.001	0.11	21	17
Zinc	45	0.008	6600	44	16	34	< 0.001	28	33	15

Cont over…

Analyte	Northern Area					Southern Area				
	count	Min (mg/L)	Max (mg/L)	No. > ANZECC	No. > NHMRC	count	Min (mg/L)	Max (mg/L)	No. > ANZECC	No. > NHMRC
Benzene	3	< 0.001	< 0.001	0	0	2	< 0.001	< 0.001	0	0
Ethylbenzene	3	< 0.001	< 0.001	0	0	2	< 0.001	< 0.001	0	0
Toluene	3	< 0.001	< 0.001	0	0	2	< 0.001	< 0.001	0	0
Xylenes	3	< 0.001	< 0.001	0	0	2	< 0.001	< 0.001	0	0
Total PAH	3	< 0.001	< 0.001			2	< 0.001	< 0.001		
TRH C29-C36	3	< 0.001	< 0.001			2	< 0.001	< 0.001		
TRH C10-C14	3	< 0.001	< 0.001			2	< 0.001	< 0.001		
TRH C15-C2	3	< 0.001	< 0.001			2	< 0.001	< 0.001		
TRH C6-C9	3	< 0.001	< 0.001			2	< 0.001	< 0.001		

Table 8 – Groundwater Statistics – Deep Aquifer

Analyte	Northern Area					Southern Area				
	count	Min (mg/L)	Max (mg/L)	No. > ANZECC	No. > NHMRC	count	Min (mg/L)	Max (mg/L)	No. > ANZECC	No. > NHMRC
Ammonia (N)	11	0.06	0.95	1	4	28	< 0.01	0.59	0	1
Nitrate (N)	11	< 0.02	0.08		0	28	< 0.02	9.2		0
TKN (N)	11	0.1	18			12	< 0.1	6.4		
Total Nitrogen (N)	8	< 0.2	8.8	5		0	0	0	0	
Nitrate + Nitrite (N)	8	< 0.02	0.08	0	0	0	0	0	0	0
Phosphate ortho (P)	3	< 0.05	0.21			12	< 0.05	0.12		
Total Phosphate (P)	11	< 0.01	1.9	10		12	0.08	4.7	12	
Sulphate (S)	11	44	820		2	12	68	640		1
Fluoride (sol)	11	< 0.2	1.4		0	12	< 0.2	1.5		0
Arsenic	11	< 0.001	0.57	2	3	28	< 0.001	0.018	1	2
Cadmium	11	< 0.0002	0.0044	5	3	28	< 0.0002	0.09	24	13
Chromium	11	< 0.001	0.015	3	0	28	< 0.001	0.012	9	0
Copper	11	< 0.001	0.005	4	0	28	< 0.001	0.041	11	0
Lead	11	< 0.001	0.054	2	1	28	< 0.001	0.28	17	14
Mercury	11	< 0.0001	< 0.005	0	0	28	< 0.0001	0.012	3	3
Nickel	11	0.003	0.13	4	3	28	< 0.001	0.26	19	10
Zinc	11	< 0.001	52	9	2	28	0.026	23	28	10

The removal of the primary source of groundwater contamination through the isolation of the fill materials within an engineered containment cell will greatly diminish the ongoing risks to groundwater quality from the site. Management of the residual groundwater contamination is expected to result in an improvement in groundwater quality with time due to the marked reduction in mass inputs to the groundwater system with the removal of the fill materials which will prevent the further leaching of contaminants to the groundwater from the site fill materials.

4. REMEDIATION OBJECTIVES AND APPROACH

4.1 Objectives Regarding Future Land Use

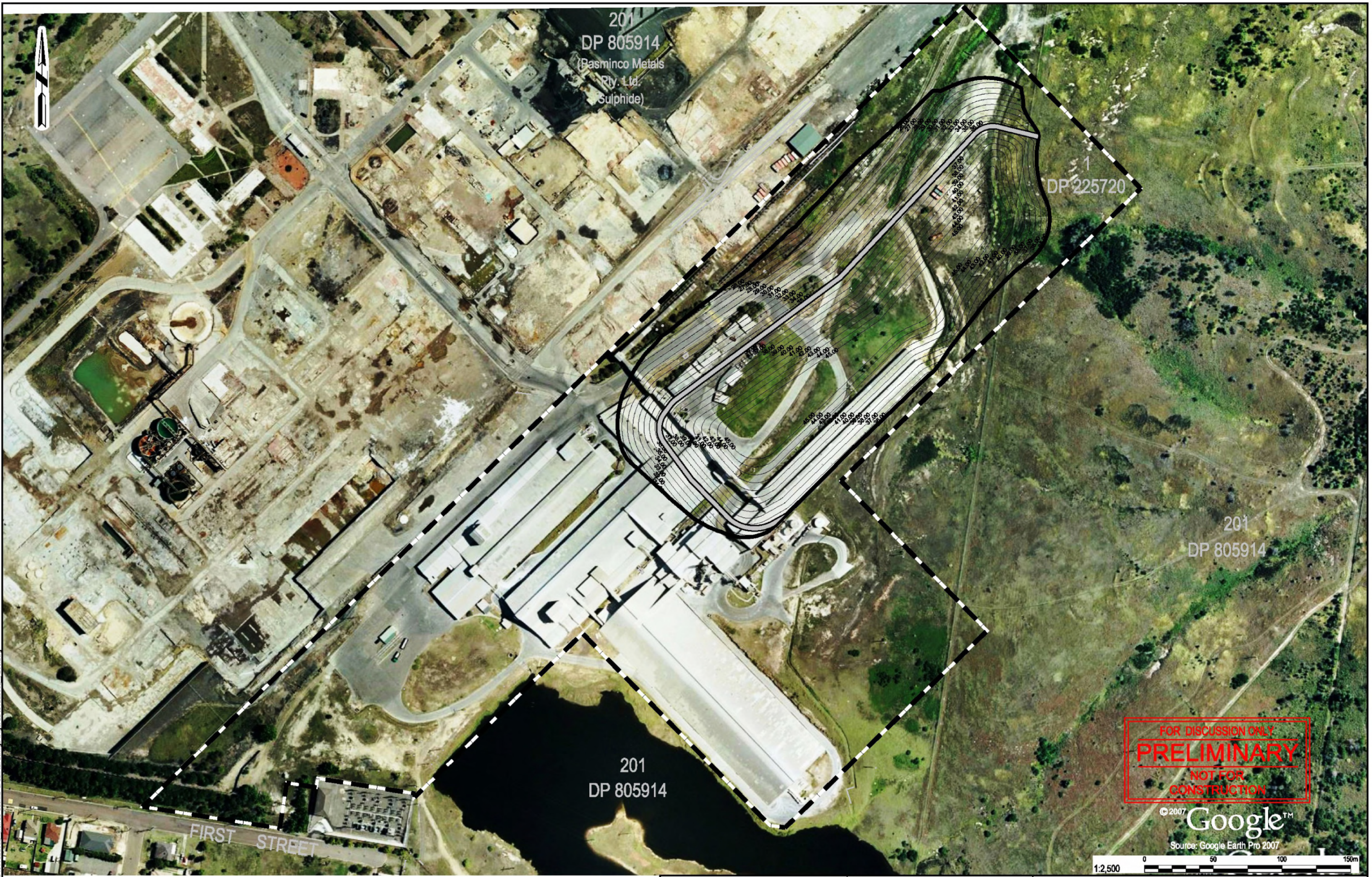
The site will be remediated to a condition suitable for low density residential development, with the exception that the landform of the proposed engineered containment cell (Figure 8) will be used as controlled open space.

The cell landform will be vegetated with low-maintenance vegetation such that erosion and sediment control measures will not be required for the cell landform after remediation and revegetation is complete. Engineering measures will, however, be required for stormwater management and erosion and sediment management during site remediation works.

4.2 Compatibility with Remediation of Adjacent Pasminco Property

The remediation of the IFL Cockle Creek site is programmed to occur in conjunction with the remediation of the adjacent former Pasminco smelter and industrial complex. While most aspects of the two remediation programs can progress independently, it is recognised that there are certain cross-boundary issues that must be coordinated between the two remediation programs. The primary cross-boundary issues include:

- Scheduling and communication of planned remediation activities along the common property boundaries.
- Control of discharge of potentially contaminated media (surface water, groundwater, soil/sediment) across the common property boundaries.
- Coordination of remediation activities in the buried southern gully, where large retaining walls currently support a significant topographic difference between ground levels along the common property boundary. There is a potential risk that excavation close to the foot of the retaining structures on Pasminco property could destabilise the walls. As such, close coordination will be required for the remediation of this area to ensure that slope stability along the common property boundary in this area is not compromised.
- Coordination regarding management of the freshwater dam adjacent to the southern end of the property. The dam wall is currently on IFL property, while the dam itself is on Pasminco property. Remediation of fill material in the buried gully on IFL property will likely require removal of the current dam wall, and as such control measures for water entering the dam must be coordinated between IFL and Pasminco. Both this point and the former point are discussed also in Section 4.3 of this report.
- Agreement regarding provision or reinstatement of basic services (water, sewer, gas, power) as required throughout the remediation program.



LEGEND

PROPOSED CELL EXTENT AND LANDFORM LOCATION

SITE BOUNDARY

DRAWING TAKEN FROM MONTEATH & POWYS DRG. NO. 07208C.DWG DATED 12 MARCH 2008

Golder Associates

124 PACIFIC HIGHWAY ST. LEONARDS, N.S.W. 2065 Telephone (02) 9478 3900 Facsimile (02) 9478 3901

CLIENT	INCITEC FERTILISER LTD.		PROJECT	INCITEC - COCKLE CREEK
DRAWN	HC	20.06.08	TITLE	PROPOSED CELL EXTENT AND LANDFORM
CHECKED	GRS	20.06.08		
SCALE	1:2,500	A3	PROJECT No 077623082\F500	FIGURE No FIGURE 8

cadfile:- J:\07Proj\051-100\077623082_Incitec Cockle Creek\Drawings\aerials_25p Premium google jpg\xref-Survey_077623082\cell outline.dwg\082xref-grid.dwg
cadfile:- J:\07Proj\051-100\077623082_Incitec Cockle Creek\Drawings\Figures\07623082_F500.dwg

- Agreement regarding easement requirements for discharge of various water streams such as manufacturing effluents, surface water runoff, and extracted and treated groundwater.

- Establishing consistent and compatible post-remediation ground levels and land use across the common property boundaries.

Remediation activities with cross-boundary implications will be discussed openly between IFL and the Pasminco administrators and project managers during the course of remediation to ensure that the relevant issues are identified in advance and managed appropriately. The specific communication methods will include mutual attendance at regular project status meetings and conducting specific cross-boundary coordination meetings.

4.3 Staged Remediation Plan

A staged approach to the remediation program is proposed to expedite approval and commencement of remediation works in certain portions of the site that are not affected by operational constraints, and to address urgent environmental control requirements to accommodate the early stages of the Pasminco remediation program. The current proposed stages of remediation are described below.

4.3.1 Stage 1

Objective

The objective of Stage 1 is to establish a targeted hot-spot groundwater recovery system and water treatment facility to remediate localised areas of highly metal impacted groundwater along the north-western site boundary.

Environmental Controls

The groundwater remediation system will be operated under an environmental management plan to identify and appropriately address environmental risks associated with the installation and operation of the plant.

The treatment plant and the extraction and injection infrastructure will be fitted with appropriate monitoring and control systems such that the plant can be operated remotely through a programmed PLC unit, although manual replacement of the reagents will be periodically required. The system will incorporate a number of failsafe and backup controls such that any breach of the system or operational parameters occurring outside an acceptable range will result in plant and pump shutdown. The treatment plant and all the control and management functions will be tested and verified during the commissioning phase. In the case of shutdown, the system will only be reset following correction of the malfunction.

Site Works

The hot-spot groundwater system requires the installation of groundwater recovery trenches at a number of locations perpendicular to the site boundary. One trench will be located along a portion of the site's western boundary. A groundwater injection trench is proposed to be installed between the extraction trenches to accommodate the return of treated groundwater to the aquifer. This will improve the rate of recovery of impacted groundwater at the extraction trenches. The location and spacing of the trenches will be determined using the numerical model which has been developed for the site.

Installation of the trenches will require removal of contaminated fill materials and excavation of natural soils. The contaminated fill materials will be stockpiled within Shed 4 or otherwise managed to mitigate and environmental risks pending placement in the containment cell once constructed. The natural materials will be stockpiled and either utilised in the trench backfill or otherwise utilised as part of the cell construction or capping. The temporary stockpile will be managed to ensure the natural materials do not pose any environmental risks. Any seepage water from the natural material stockpile will be returned to the trench for collection and treatment.

The trenches will have collection pipes installed and be backfilled with ballast gravel to above the watertable which occurs within the natural soils. Geotextile and compacted natural backfill will prevent infiltration of surface water to the trenches. Each extraction trench will connect to a sump from which the water will be extracted and transferred to the treatment plant.

A precipitation and sedimentation treatment plant will be installed within an existing site building nearby the extraction trenches. Water and electrical conduits will be installed between the treatment plant and the injection and extraction trenches to enable fluid transfer and operation of remote pumping and monitoring equipment.

Implementation of Stage 1 would involve the demolition of the former railway gantry located near part of the north-western boundary of the site to provide suitable access for construction of the extraction infrastructure. No other demolition works are required for this stage.

As the infrastructure of the extraction and injection systems is to be installed below the site surface, the installation associated with Stage 1 works is not expected to significantly alter the site surface profile.

Groundwater Monitoring.

A baseline groundwater monitoring program will be conducted in the area of interest. Periodic groundwater monitoring will be conducted throughout the remediation program to characterise the influence of the remediation program on groundwater contaminant concentrations. Monitoring of the treatment plant influent and effluent concentrations will be undertaken routinely to verify the performance of the treatment plant and ensure that injected water complies within the nominated target criteria.

4.3.2 Stage 2

Objective

The objectives of Stage 2 are firstly, the establishment of a containment cell and associated environmental controls in the northern portion of the site as a repository for contaminated site soils from the site and secondly, the remediation of accessible contaminated soil material to the north of the operational areas of the facility. The intent of the containment cell design is to create a low maintenance repository structure for on-site contaminated soils with a limited potential for impact to the surrounding environment into the future.

Environmental Controls

A detailed Stage 2 RAP will be prepared prior to the commencement of the Stage 2 works and this will include a Construction Environment Management Plan (CEMP) and the appropriate environmental controls to address the identified environmental risks. The RAP and CEMP will identify all environmental and other risks associated with the Stage 2 works and identify the required measures to appropriately mitigate the risks. Separate sections of the CEMP would be developed for the cell construction activities and the contaminated soil excavation / placement programs. Further discussion of typical environmental controls to be employed during the soil remediation work programs is included in Section 8.3 and Section 10..

Site Works

The containment cell base will be constructed below the remediation surface on a validated excavation surface (as approved by the site auditor) that is expected to be completed within the natural soil. The cell base is expected to be generally above the high level of seasonal fluctuation of the shallow natural aquifer. Excavated contaminated materials will be held in temporary stockpiles or located within Shed 4. All stockpiles will be managed to prevent environmental impacts.

The base liner system will be a geosynthetic composite liner, comprising a welded high-density polyethylene (HDPE) geomembrane with an overlying geotextile cushion layer for puncture protection and with an underlying geosynthetic clay liner (GCL) and soil bearing layer. A blanket leachate collection system will be installed overlying the composite base liner and will include collection sumps and risers. The cell will be capped using a linear low-density polyethylene (LLDPE) geomembrane with an overlying drainage system (see next bullet) and revegetation layer and with an underlying GCL and seal bearing layer. The cell construction is described further in Section 8.2.

This Stage will involve the remediation of the contaminated soil in the northern area of the site (to the north of the existing buildings) and the progressive construction of the containment cell that will be the final repository for all contaminated material on-site. The soils will be screened to remove inert oversize material, which will be stockpiled and removed from site to an appropriate landfill following testing and approval by the site auditor. The final excavated site surface will be validated in accordance with the validation protocol and to the satisfaction of the site auditor.

It is expected that the removal of the contaminated material will result in the site surface (outside the containment cell footprint) resembling the previous natural site surface prior to the deposition of the waste fill materials from the smelter operations, aside from areas excavated for building construction. Hence the remediation program will generally restore the natural shape of the landform for areas outside the cell footprint.

The groundwater treatment facility will be utilised to continue treating groundwater during this Stage of the project

Groundwater Monitoring.

A baseline groundwater monitoring program will be conducted in the area of interest. Periodic groundwater monitoring of selected wells will be conducted throughout the remediation program to characterise the influence of the remediation program on groundwater contaminant concentrations and to provide a temporal record of the variation in groundwater concentrations.

4.3.3 Stage 3

Objective

The objectives of Stage 3 are firstly, to demolish the existing site buildings and infrastructure and secondly, the remediation of contaminated soil material beneath the former buildings.

Environmental Controls

A detailed Stage 3 RAP will be prepared prior to the commencement of the Stage 3 works and this will include a Construction Environment Management Plan (CEMP) and the appropriate environmental controls to address the identified environmental risks, including those associated with demolition works and the management of asbestos containing materials. The RAP and CEMP will identify all environmental and other risks associated with the Stage 3 works and identify the required measures to appropriately mitigate the risks. The ongoing cell construction activities (which will be progressed to accommodate the Stage 3 soils) will be conducted under the existing RAP and CEMP established for Stage 2.

Site Works

This stage will involve demolition of all site buildings and infrastructure within the central area of the site. This will remove all manufacturing and storage facilities and the pavements not required for traffic movements as part of the remediation program. Uncontaminated waste materials will be disposed off site to appropriate handling or disposal facilities. It is expected that the asbestos containing materials will be buried within the containment cell, pending appropriate approvals. If these approvals cannot be obtained for on site disposal within the cell, the asbestos containing materials will be disposed offsite to an appropriately licensed landfill.

Following removal of the site buildings and infrastructure, the contaminated soil materials from this area of the site will be excavated and placed within the containment cell. The final excavated site surface will be validated in accordance with the validation protocol and to the satisfaction of the site auditor. The final landform of this area of the site will approximate the previous natural site surface prior to the deposition of the waste fill materials from the smelter operations, aside from the areas excavated for building construction.

Groundwater Monitoring.

A baseline groundwater monitoring program will be conducted in the area of interest. Periodic groundwater monitoring of selected wells will be conducted throughout the remediation program to characterise the influence of the remediation program on groundwater contaminant concentrations and to provide a temporal record of the variation in groundwater concentrations. Groundwater monitoring will continue routinely across the remainder of the site.

4.3.4 Stage 4

Objective

The objectives of Stage 4 are firstly, to demolish any remaining site infrastructure (roadways and weighbridge) in the southern area of the site and secondly, the remediation of contaminated soil in the southern area, including the infilled gully area.

Environmental Controls

A detailed Stage 4 RAP will be prepared prior to the commencement of the Stage 4 works and this will include a Construction Environment Management Plan (CEMP) and the appropriate environmental controls to address the identified environmental risks, including those associated with any demolition works and the management of asbestos containing materials. The RAP and CEMP will identify all environmental and other risks associated with the Stage 4 works and identify the required measures to appropriately mitigate the risks. The ongoing cell construction activities (which will be progressed to accommodate the Stage 4 soils) will be conducted under the existing RAP and CEMP established for Stage 2.

Site Works

This stage will involve demolition of all remaining site infrastructure, particularly that occurring in the southern area of the site. Uncontaminated waste materials will be disposed off site to appropriate handling or disposal facilities. It is expected that the asbestos containing materials will be buried within the containment cell, pending appropriate approvals. If these approvals cannot be obtained for on site disposal within the cell, the asbestos containing materials will be disposed offsite to an appropriately licensed landfill.

Following removal of the site infrastructure, the contaminated soil materials from this area of the site, including those in the infilled gully and the contaminated material within the dam wall, will be excavated and placed within the containment cell. The steep grade near the site boundary and the extension of fill materials in this area onto the Pasminco site will require liaison with the adjacent site operators to facilitate the effective removal of the contaminated soils from this area.

The final excavated site surface will be validated in accordance with the validation protocol and to the satisfaction of the site auditor. The final landform of this area of the site will approximate the previous natural site surface prior to the deposition of the waste fill materials from the smelter operations, aside from the areas excavated for building construction. This will reinstate the former gully area across this southern section of the site which may form a natural drainage course as part of the site re-development. It is anticipated that the dam wall occurring within the IFL property will not be required for future water management and this will be removed as part of these works.

Groundwater Monitoring.

A baseline groundwater monitoring program will be conducted in the area of interest. Periodic groundwater monitoring of selected wells will be conducted throughout the remediation program to characterise the influence of the remediation program on groundwater contaminant concentrations and to provide a temporal record of the variation in groundwater concentrations. Groundwater monitoring will continue routinely across the remainder of the site.

4.3.5 Stage Sequencing

The northern portion of the site is relatively unaffected by the commercial operations at the site, and will be the focus of early remediation activities. We currently anticipate that the Stage 3 and 4 remedial activities will progress in that order, but the implementation of Stage 4 in particular will require careful coordination with Pasminco with regards to slope stability along the south-western site boundary, and the excavation of the current freshwater dam wall, the majority of which falls on IFL property and will need to be removed during remediation. As such, the potential exists for the relative scope of work and timing of remedial activities in Stages 3 and 4 to vary if, for example, cross-boundary coordination of excavations in the southern gully requires an expedited timeframe for completion.

4.3.6 Approvals and Detailed RAPs

IFL has petitioned with the Department of Planning for endorsement of a staged approval approach to the remediation program, with approval for each stage contingent on the submission and approval of a detailed RAP specific to that stage. Approval of each detailed RAP will also need to be obtained from DECC in accordance with the terms of the proposed VRA.

Each detailed RAP will include, at a minimum:

- Summary of the nature and extent of contamination issues associated with the remediation stage;

- Clear statement of the remedial objectives for the remediation stages;
- Outline of the scope of works and estimated timeframe to achieve the remedial objectives of the stage;
- Details of the materials management protocols for potentially contaminated fill, soil and hazardous building materials;
- Specifications for the environmental controls to be implemented during remediation;
- Details of the safety management system and safe work procedures for all relevant activities to be undertaken during the remediation stage;
- Contingency plans to respond to health, safety and environmental issues arising during the course of remedial activities;
- Summary of the regulatory compliance framework associated with the remedial activities, including required licenses and approvals;
- Specifications for the post-remediation validation procedure;
- Specifications for long-term site management;
- Technical specifications for civil works specific to the remediation stage (eg. detailed design drawings and material supply and construction specifications for construction of the containment cell);
- Details of any capital works associated with the remediation activities;
- Details of the monitoring and recording methods to be used during and after the remedial activities;
- Details of the reporting requirements to be submitted to the relevant authorities and associated timeframes; and
- Setting out key milestones completed during each stage of the remediation activity.

4.4 Groundwater Management / Remediation

The *Declaration of Remediation Site* identifies that the migration of metal impacted groundwater from the site presents a significant risk of harm to the environment and that remediation should be undertaken to mitigate the risks posed by this contamination.

It is expected that the groundwater environment will benefit from the removal of the metal impacted fill materials which are the primary source of the groundwater contamination at the site. Nonetheless, groundwater management is required to intercept the highly impacted groundwater currently occurring in the north western area of the site and to prevent contaminated water migrating onto the adjacent Pasminco site once remediated.

As noted above, Stage 1 of the remediation plan for the site will target the highly elevated groundwater concentrations occurring in the shallow aquifer in the north west portion of the site and these works will precede the development of the containment cell in this section of the site. As this area of the site will accommodate the containment cell, opportunities to access the contaminated groundwater will be limited following the cell construction. The objective of this remediation approach is to reduce the contaminant mass present in the groundwater system prior to the installation of the containment cell. This approach is discussed in more detail in section 8.4.1.

Pasminco has indicated the requirement to prevent the migration of contaminated groundwater arising from the IFL site onto the Pasminco land following its remediation. To this end it is expected that a groundwater interception and treatment system will be required at selected locations along the IFL site's western boundary to prevent migration of contaminated groundwater onto the Pasminco site. The criteria for establishing and operating any groundwater interception scheme will be based on the results of numerical modelling using the site numerical model which has been developed by Noel Merrick of Heritage Computing.

In addition to the interim management of off site migration of groundwater there may be a longer term requirement to mange groundwater contamination arising from the site to limit or prevent potential impacts on the adjacent environments, including Cockle Creek. The extent to which long term groundwater remediation works are required will be established during the remediation program and will be based on the response of the aquifer to the soil remediation and groundwater remediation (interim and offsite groundwater migration containment measures) programs. The long term management of groundwater is discussed in Section 8.4.2.

The capacity of natural attenuation of the metal contaminants will be considered in detail with site specific data collected to justify inputs to the numerical model. The long term risks to the environment will be estimated through the numerical model and appropriate remediation / management measures put in place to mitigate the risks to acceptable levels as discussed and agreed with the site auditor and DECC. Any long term groundwater management measures will be implemented by IFL.

4.5 Ongoing IFL Environmental Responsibilities

The proposed soil remediation approach will create a fully lined containment cell in the northern section of the site that will consolidate and contain all the soil and other materials unsuitable for use within a residential setting. The remainder of the site is expected to be developed for residential use.

An Environment Management Plan (EMP) with adequate procedures to ensure it is enforceable through the planning process will be developed for the area of the site incorporating the containment cell and a suitable buffer zone, and will outline the environmental management procedures to ensure that the soils contained in this area and the groundwater system are managed appropriately to ensure that the remediation approach does not pose any unacceptable risks to human health or the environment into the future. The detailed procedures for the environmental management of this area of the site will be developed in conjunction with the Auditor.

To ensure this outcome, IFL will retain the ownership and responsibility for the area of the site containing the containment cell and a suitable buffer zone, including the groundwater environment. This will ensure accessibility to the area for any future management requirements and will provide a viable entity for the implementation of the environment management plan into the future.

The remainder of the site is to be divested for development purposes with the expectation that the area will be suitable for residential use as a result of the soil remediation works conducted. The groundwater beneath various parts of this divested area may contain contaminant concentrations that preclude various environmental values of the groundwater, particularly those associated with extraction and use. The salinity of the groundwater would likely limit its use for most environmental values without treatment for the removal of salts which give rise to the elevated salinity. Due to the difficulty in remediating groundwater across the entire site, the low potential for use in the residential setting and the presence of a reticulated potable water supply system, it is anticipated that a condition may be imposed as part of the environmental audit outcome that restricts use of the shallow groundwater at the site to minimise any potential risk to site users.

The most relevant environmental value of groundwater at the site is that of aquatic ecosystems and it is expected that any residual site groundwater contamination will be demonstrated not to preclude this environmental value. If this cannot be achieved then it is anticipated that appropriate remediation or management measures will be put in place to ensure this environmental value is protected and the outcome of the audit with respect to this matter is suitably assured.

A series of contingencies and triggers will be established as part of the practicable extent of cleanup reporting proposed to ensure that there are adequate safeguards and monitoring proposed to ensure groundwater concentrations continue to attenuate over time.

4.6 Final Landform

Post-remediation ground surface levels for the site will be generally similar to the original levels that existed at the site before filling and development commenced and will be suitable for the intended land use and compatible with Pasminco ground levels.

Final ground surface levels in the vicinity of the buried southern gully and in the northern portion of the site where the proposed containment cell is located (Figure 8) will, however, differ from original levels as described below.

- Southern Gully – Final ground surface levels will differ from original levels to provide smooth grades suitable for both controlled surface water flow and proposed land uses.
- Containment Cell – The proposed containment cell landform in the northern area of the site has the following characteristics, which may be modified for final design:

- overall rectangular shape; plan dimensions of approximately 400m by 150m; north eastern corner shaped to allow free surface water drainage around cell.
- maximum elevation of approximately 46m AHD.
- batter slopes of 4H:1V (horizontal:vertical).
- maximum batter height of approximately 21m with mid-slope bench.
- base of landform offset from property boundaries by approximately 10-20m on east side, 20m on north side, and 30m on west side.
- landscaping to be low maintenance native grasses.

Visual amenity for the proposed containment cell landform will be considered, in consultation with Pasminco, when the detailed RAP for Remediation Stage 2 is prepared.

5. ROLES AND RESPONSIBILITIES

To facilitate the completion of the proposed remediation works in accordance with the various RAP documents to be prepared, the stakeholders and their roles and responsibilities are identified in Table 9.

Table 9 – Project Stakeholders

Role	Company	Representative	Roles and Responsibility
Principal	IFL	Mr Graham Funch	To provide financial support for the project and to manage publicity and other aspects of the project which may impact on corporate profile. Provision of OH&S requirements. To develop and manage community liaison and ensure neighbours and the wider community are informed about the works being undertaken. Provide liaison and interface with adjacent Pasminco remediation and management team. To liaise with Council and regulatory authorities.
Regulatory	Department of Environment and Climate Change	Mr John Coffey	Provision of guidance regarding legislative controls and local guideline levels where available. Provide support for the comment on the design of the remediation system including re-injection of treated water to the aquifer.
	Department of Water and Energy	Mr Hemantha Desilva	Licensing of groundwater extraction for the groundwater remediation / management systems.
	Department of Planning	Ms Ann-Maree Carruthers	To ensure the project meets all planning requirements and that all appropriate licences and approvals are obtained.
	City of Lake Macquarie	Ms Angel Troke	To ensure the project meets the requirements and objectives of community and that the master plan for the area is consistent with Council's objectives.
Auditor	Environ	Mr Phillip Hitchcock	The Auditor's role is to provide Site Audit Statements (SAS) and Site Audit Reports (SAR) as required throughout the process including Part B sign offs for each stage of the (conceptual and detailed RAPs) and a final Part A sign off of the site following completion of the remediation program. This approach will ensure that the objectives of the RAPs as stated are met to the extent practicable and ensure that adequate data is collected through the process to ensure that the outcomes can be independently verified and that the quality of the data is sufficient to allow conclusions to be drawn.
Community Liaison	IFL	Mt Scott Nairn	To provide information to the community regarding the proposed works and the objective for remediation at the site. To provide a central path for communication with the project between the community and the project team.

Role	Company	Representative	Roles and Responsibility
Legal Counsel	Mallesons Stephen Jaques	Mr Stephen Davis	To provide legal advice to the project to ensure compliance with legislative requirements.
Environmental Consultant	S&G	Mr Andrew Nunn / Mr David Nunn	Management of environmental aspects of the project to ensure completion in accordance with client expectations. Management of contractors to ensure compliance with design requirements, quality of services and verification of environmental outcomes. Completion and supervision of groundwater remediation system commissioning, operation and monitoring.
Remediation Soil Containment Consultant	Golder Associates	Dr Gary Schmertmann / Dr Lange Jorstad	To undertake the design of the soil remediation containment cell, develop remediation earthwork and surface water management staging plans, assist with the tendering process and provide verification monitoring of the contractor performance against specified objectives. To liaise with other consultants and ensure the cell design meets technical and amenity objectives.
Planning Consultant	Manidis Roberts	Mr Nick Johnson	To manage the interface of the project with the regulatory planning function. To manage a series of sub-consultants engaged to address key aspects of the planning process and in support of the site management plans.

6. LICENCES AND APPROVALS

6.1 State Planning

6.1.1 Contaminated Land Management Act 1997 (CLMA 1997)

The CLMA 1997 aims to establish a process for investigating and remediating land where contamination presents significant risk of harm to human health and other aspects of the environment.

On 22 July 2005 the IFL site was issued with a declaration of remediation site under Part 3, Division 3 of the Act. Under s21 of the CLMA 1997:

> "*The EPA may declare land to be a remediation site if the land has…been found to be contaminated in such a way as to present a significant risk of harm*."

As discussed previously, following the EPA's declaration of the IFL site as a remediation site, IFL has committed to preparing and entering into a voluntary remediation agreement (VRA) with DECC in order to remediate the site in accordance with the terms of the CLMA 1997. This RAP is intended to form part of that VRA.

6.1.2 State Environmental Planning Policy Major Projects 2005 (Major Projects SEPP)

The Major Projects SEPP aims to identify developments of economic, environmental and social significance either at a regional or state scale within NSW. Major Projects SEPP provides consistency in the assessment and approvals process for developments identified as being of state or regional significance. As outlined in clause 28 of Schedule 1 of Major Projects SEPP (as at July 2005), developments for which the Major Projects SEPP applies for remediation projects include:

> *"(a) premises subject to a notice requiring prescribed remedial action to be taken under section 35 or section 36 of the Environmentally Hazardous Chemicals Act 1985 (as continued in force by the Contaminated Land Management Act 1997), or*
>
> *(b) land declared as a remediation site under Division 3 of Part 3 of the Contaminated Land Management Act 1997*."

In light of the site being declared a remediation site in 2005, any proposed remedial activity will be subject to assessment and approval under Part 3A of the Environmental Planning and Assessment Act 1979.

6.1.3 Environmental Planning and Assessment Act 1979 (EPAA 1979)

Part 3A of the EPAA 1979 consolidates the assessment and approvals process for all major projects that require Ministerial approval. Part 3A applies to projects deemed to be critical infrastructure, major projects and other projects declared by the Minister.

In light of the IFL site's inclusion under the Major Projects SEPP, the site is subject to assessment under Part 3A of the EPAA 1979. As outlined under section 75B of the Act, Part 3A Major Infrastructure and other projects applies to developments that are either declared:

"(a) by a State environmental planning policy, or

(b) by order of the Minister published in the Gazette."

This means that IFL must seek approval from the Minister to carry out remediation action at the IFL site.

In response to this IFL, prepared and submitted a preferred project application with the NSW Department of Planning (DoP) in February 2007. This was accepted by the DoP and the Director General's Requirements were issued in March 2007. IFL is currently preparing an environmental assessment with all relevant specialist studies to meet these requirements.

6.1.4 State Environmental Planning Policy 55 Remediation of Land (SEPP 55)

The proposed remediation works on the IFL land are in alignment with the aims of SEPP 55. The objective of this policy is to provide a statewide planning approach for the remediation of contaminated land.

The aims of the SEPP include remediation of contaminated land for the purpose of reducing risk of harm to human health and the environment. Remediation of the IFL site is consistent with the provisions of this policy.

As the remediation of the IFL site has potentially significant environmental impacts, the proposed remediation would be defined as Category 1 work under clause 9 of the SEPP. Under SEPP 55, Category 1 work requires consent.

6.1.5 Protection of the Environment (Operations) Act 1997 and (General) Regulations 1998

The *Protection of the Operations Act 1997* (POEO Act) is the key piece of environment protection legislation administered by DECC. Clean-up notices, prevention notices and prohibition notices are the provided for under the legislation.

The POEO Act provides a single licensing arrangement to replace the different licences and approvals under existing separate Acts relating to air pollution, water pollution, noise pollution and waste management.

Licences usually are issued with conditions. Examples of conditions that can be attached to a licence are included in the POEO Act. These 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.

There is provision for a public register to be kept by all regulatory authorities, which must include a range of specified information on licences, review of licences, prosecutions, notices and the conclusions of any mandatory audit report. The register must be available for public inspection and copies provided on request.

An amendment Act was introduced in 2005 which addressed licensing administration, waste regulatory framework, the issuing of notices and related cost recovery, noise, smoke abatement notices, offences and penalties, classified waters, green offset schemes or works, powers of authorised officers, regulation-making powers, evidentiary matters and a number of other miscellaneous matters.

The *Protection of the Environment Operations (General) Regulation 1998* and its amendment in 2005 made under the POEO Act forms the basis for the licensing of activities which may impact the environment, give effect to the *National Environment Protection (National Pollutant Inventory) Measure* including green offset schemes, defines land and water pollution and the management of noise amongst other actions. The most recent *Protection of the Environment Operations Amendment (Scheduled Activities and Waste) Regulation 2008* came into affect in April 2008.

The *Protection of the Environment Operations (Waste) Regulations 2005* set out the requirements to track any hazardous, industrial, Group A or controlled waste, including asbestos waste that are generated by activities on-site and are proposed to be disposed of off-site. Licences issued under the POEO Act also usually contain conditions relating to tracking requirements if such activities are being carried out or proposed to be carried out on the site.

6.2 Regional Planning

6.2.1 Lower Hunter Regional Strategy 2006–31

The NSW Government's Lower Hunter Regional Strategy 2006-31 (LEHRS) is a land use planning document that outlines provisions for ensuring sustainable development over the next 25 years throughout the Lower Hunter region. The strategy makes provisions for ensuring sufficient housing and employment land, the protection of high quality agricultural land and natural resources, as well as the delivery of services and infrastructure.

The strategy is based upon population projections, which estimate that by 2031 an additional 160,000 people will live in the Lower Hunter region. The LEHRS applies to five local government areas (Lags) across the Lower Hunter region. The Lags to which the strategy applies includes Newcastle, Lake Macquarie, Port Stephens, Maitland and Cessnock.

The LEHRS is relevant to IFL as it provides a framework for the future use of the Cockle Creek site and surrounding lands.

6.3 Local Planning

6.3.1 Lake Macquarie Local Environmental Plan 2004

The IFL site is currently zoned 4(1) Industrial (core) zone. The proposed structure demolition and remediation of the IFL lands is consistent with the objectives of the current site zoning. These objectives include:

- Ensuring that industries are designed and located so as not to cause unacceptable environmental harm or adversely affect the amenity of the environment, including residential neighbourhoods.

- Providing for sustainable water cycle management.

The remediation of the IFL site will ensure improvements to amenity and groundwater quality. This would contribute to the establishment of sustainable water cycle management practices.

6.4 Heritage Status

Preliminary background investigation undertaken by heritage consultants included searches of a range of heritage registers (*Incitec Pivot Cockle Creek Demolition and Remediation – Heritage Assessment,* ERM Consulting, 2008). These investigations found that there were no previously recorded historic heritage sites existed within the study area, although some were located in close proximity. Similarly, there were no previously recorded Aboriginal heritage sites within the study area, although some were located in the vicinity.

A detailed heritage assessment will be conducted for the detailed RAP stages to ensure that all heritage issues have been appropriately assessed and managed.

7. EVALUATION OF REMEDIAL OPTIONS

7.1 Soil Management

Soil contamination investigations have identified that the slag impacted fill materials distributed across the site will require management to ensure the site is suitable for its intended residential / open space uses. There are significant heavy metals concentrations which have been demonstrated to be leachable and the fill includes black slag materials which present an aesthetic issue above and beyond their contamination status, which is also relevant given the proposed end land use.

The objectives of the soil remediation strategy therefore include:

- Minimise the ongoing impacts to groundwater and human health from contaminated soils at the site such that the identified Significant Risk of Harm is appropriately managed or extinguished.
- Maximise site areas of financially beneficial land use in the site redevelopment for residential allotments.
- Balance remedial costs with achievable land use outcomes in terms of cost of management of contamination for discrete areas of the site and remediated land value.
- Achieve a remediation outcome consistent with addressing the Significant Risk of Harm issue, the land use planning controls and in harmony with the surrounding land uses (current and proposed).

7.2 Review of Applicable Soil Remediation Methods

The *Guidelines for the NSW Site Auditor Scheme (2nd edition)* indicates that soil remediation and management should be implemented in the following preferred order:

1. On-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level.
2. Off-site treatment of excavated soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to the site.
3. Removal of contaminated soil to an approved site or facility, followed where necessary by replacement with virgin excavated natural materials (VENM) or material which is in compliance with the relevant guidelines issued by DECC at the time of the works..
4. Consolidation and isolation of the soil on-site by containment within a properly designed barrier.

7.2.1 Contaminant Destruction

The primary contaminants at the site are heavy metals associated with slag impacted fill materials. It is not possible to destroy the primary contaminants and so this approach to contamination management is not considered feasible. Destruction mechanisms are more applicable to organic contamination. There is no evidence of significant organic soil contamination at this site.

7.2.2 Treatment Technologies

Limited treatment technologies exist for metal impacted soils. These fall within two broad categories comprising removal methods or stabilisation methods.

Metal Removal

The metal contaminants may be removed from the soil by washing methods that extract the contaminants and create a metal rich waste stream while providing a relatively cleaned soil. The extent to which the metals can be removed from the soils will depend on the capacity to remove the metals from the matrix. As the metals in this case are associated with distributed slag materials within the fill it would be difficult to remove the source of the metal contamination without removing the slag material from the fill matrix. The matrix is clayey and this would also retard the recovery of metals contamination by this method.

It is unlikely that this will be achievable at the scale required to affect suitable remediation of the fill soils as simple screening methods will not work given the range of particle sizes of the slag and the clayey nature of some fill materials. The extracting medium and the waste stream would require further management and so this method results in a transfer of the contaminants from one environment to another. The suitability of the soils for re-use following the washing method may also be doubtful due to the breakdown of the material structure and the disturbance of grain size distributions. Due to the limitations of this method in this environment, removal of the metals by washing is not considered to be practicable.

Soil Stabilisation

Preliminary soil stabilisation trials were undertaken to assess the suitability of chemical stabilisation of the soils as an adjunct to the containment cell remediation approach. The details of the trial have not been reported although a summary of the results was tabled at a progress meeting in September 2007.

The testing was focused on the leachability of the fill materials given this would be the primary objective of the soil stabilisation approach. No assessment was made regarding the availability of the metal contaminants from a human health risk perspective and given that the elevated concentrations would remain, it is likely that some form of capping layer would be required to provide a level of isolation even if the leachability of the materials could be controlled.

Fill materials from three locations across the site were mixed with various ratios of Calgrit, Calsilt, magnesium oxide, crushed concrete fines and superphosphate. Calgrit and Calsilt are calcium carbonate products produced by Penrice Soda Products.

The stabilisation trials concluded that:

- Given costs of transport of Calgrit and Calsilt to the site and the variable performance of this method, this method is not considered feasible.

- Superphosphate results were inconclusive and therefore concluded as failed, especially given current elevated concentrations at the site.

- Magnesium oxide is expensive and unlikely to be a viable option in its own right. It may be considered for use as an adjunct with other stabilisation methods.

- Crushed concrete fines provided the most consistent results and significant reductions for most scenarios with reductions in leaching by up to ten fold. This material is likely to be available locally, either from site during demolition or imported.

The stabilisation method was determined to provide marginal benefits to the leachability of the metal contamination in this case and was not justified on a cost benefit basis.

7.2.3 Off Site Disposal

Off site disposal of waste is a relatively simple management approach which transfers the waste from one site to another. The advantage of this approach is that it removes contamination from a potentially uncontrolled environment to a specifically designed and controlled landfill environment which is licensed and administered by regulatory authorities. To this end, the off site disposal approach provides a relatively high level of assurance that the contamination will be managed in the longer term. The cost of the long term management of the contaminated waste is included in the disposal cost.

The disadvantage of the offsite disposal approach is that that it requires a large expenditure on transport costs and associated environmental impacts and it presents a risk of dispersion of the waste materials as a result of transport and handling. It also results in landfill space being taken by materials which have alternative methods of management and which can be adequately controlled using passive management methods which will require limited ongoing management yet provide high levels of environmental assurance.

Due to the large volume of impacted fill materials at the site, which is in the order of 200,000 m^3, there will be a considerable environmental and economic cost associated with the transport of the materials. These impacts can largely be off set by retaining the contaminated fill within an on site containment cell.

Whilst off site disposal provides a suitable management option for the site, it is not considered to present the best environmental outcome for the management of the contamination at this site. A similar containment outcome will occur for both the on site and off site disposal options for the contaminated fill and it is considered that there will be little difference with respect to the long term environmental impacts associated with each option. As the on site containment approach has a much lower environmental impact as a result of reduced energy, resource and noise impacts, the on site containment of the contaminated materials is considered to be favoured over off site disposal.

7.2.4 Soil Containment

Soil containment meets the primary objectives of the soil remediation approach in that it isolates the contaminated materials from contact with humans and essentially isolates the material from the groundwater system thereby limiting any environment impacts resulting from leaching of contaminants from the materials. The approach essentially isolates the contaminated material from the broader environment utilising a high security approach with various layers of protection to ensure environmental compliance.

Deep Burial

Initial assessment had included provision of a relatively flat final site profile as a project objective and therefore placement of the fill material within a deep, lined excavation was considered a viable approach. This approach would provide a large volume of excavated clean material (variably weathered rock) which could be potentially used as fill, particularly in the southern infilled valley where deeper excavations were likely.

The deep cell was proposed to be fully lined with a composite high density polyethylene (HDPE) and geosynthetic clay liner (GCL) system. The cell was to be capped with a similar liner to provide containment of the waste fill. Inclusion of a seepage collection system within the cell would maintain an inward head gradient. Any seepage water collected in such a system would most likely require treatment or at least testing prior to disposal. Management of the groundwater levels and flow paths around a deep cell might be required to minimise impacts of the contained materials of the groundwater system and ensure compliance with adopted criteria at the site boundary. Such groundwater management would require significant ongoing system operation and monitoring.

Shallow Burial

Whilst there were some perceived benefits in completing a deep burial, a lower cost and less management-intensive approach is to construct the cell in natural materials and essentially above the natural watertable. This limits the potential for interaction of the fill materials with the groundwater system and removes the reliance on the internal drainage and water level control systems to ensure ongoing management of environmental impacts. As the fill containment system will be permanent it is important that, to the extent practicable, passive systems are used for the long term management of potential risks.

The shallow cell is proposed to be fully lined with a composite HDPE and GCL liner, and capped with a similar liner, to provide complete encapsulation of fill materials. The cell would include a gravity leachate collection and recovery system to remove any infiltrating rainwater.

A potential negative outcome of the shallow burial approach is that the cell necessarily emerges above the natural landform and therefore visual amenity must be considered in more detail. Height restrictions could result in the cell area being larger than may have been accommodated in a deep burial approach.

The shallow burial approach is being adopted for fill materials on the adjacent Pasminco site and so there is a precedent for the change of landform. The Pasminco management zone will be created immediately to the west of the northern area of the IFL site where the proposed IFL containment cell is to be established, so there will be some consistency in the location of the two containment areas within the overall regional landform, creating some degree of visual continuity in this area.

The shallow burial option is the preferred soil remediation approach as it:

- Minimises the risks to groundwater by restricting potential contact with the groundwater system.
- Meets the remediation objectives for the site.
- Is broadly consistent with the EPA approved approach for the adjacent Pasminco site.

7.2.5 Soil Management Technology Summary

Whilst the soil contamination may potentially be immobilised and capping layers providing physical barriers could be incorporated into the design to minimise potential contact, these options were not considered to provide a satisfactory remediation approach given the proposed low density residential setting where long term management controls are not readily implemented.

Due to the limited effectiveness of soil stabilisation of the fill materials at the site, adopting the management of the soil contamination with these measures is considered unlikely to adequately address the Significant Risk of Harm issue that exists as a result of the leaching of the metal contaminants to the groundwater. As this is a key objective of the remediation of the site, the soil stabilisation approach is not considered a feasible management option.

As the end land use is a driver for the remediation project and this is controlled by both soil contamination and aesthetic considerations, the most appropriate remediation approach addressing all risks was considered to be the excavation and containment of the soils within a managed area of the site. The development of an engineered containment cell (including a fully enclosing liner system) provides a high level of assurance regarding the environmental risk posed by the contamination in the long term due to the passive level of management required with this containment approach.

Although due consideration has been given to the preferred hierarchy included in the *Guidelines for the NSW Site Auditor Scheme (2nd edition)* the most viable option for soil remediation at this site is the on-site containment of contaminated fill materials within a fully lined, engineered containment cell. This approach is considered to provide the best environmental outcome.

7.2.6 Waste Asbestos Containing Material

As noted in the site history, the site buildings contain a large amount of asbestos containing material which will require disposal as part of the site demolition works. The volume of asbestos containing material has been estimated to be in the order 2,000 m^3. Two options exist for the disposal of this waste material:

1. Management and transport off site to a licensed waste receiver.

2. Management and inclusion within the proposed containment cell on site.

The first option minimises any risk to the site as the asbestos containing materials will be removed from the site and thus cannot present any ongoing impacts. However, this will require management and transport of the materials and disposal at a remote location. The transport of these materials poses some, although limited, risk to the environment as a result of potential losses in transit and handling of materials by third parties. The cost and environmental impacts associated with the transport of a large volume of material (hydrocarbon use, energy and resource use, emission, noise, landfill management) are relevant to the consideration of the overall environmental cost of managing these materials.

The second option of managing the asbestos containing waste on site minimises the environmental impacts associated with the movement of the materials, but retains some liability at the site as a result of these material being retained. Asbestos poses a risk to the population as a result of the inhalation of asbestos fibres. Provided this pathway cannot be completed, the asbestos material will not pose a risk. Therefore isolation of the asbestos containing material within the engineered containment cell provides a suitable method of preventing exposure of the population receptors.

It is proposed that the asbestos containing materials are buried within the fill materials included in the containment cell so that there is no risk of exposure to workers or the environment following their placement. This will ensure that these material are encapsulated within the fill material and then encapsulated within the containment cell and capping.

The potential for the asbestos containing material to impact the population within these multiple levels of containment is considered to be negligible. As the on site containment also has significant environmental benefits as a result of the reduced transport and handling requirements, the onsite containment of the asbestos containing materials within the containment cell is considered to be the most appropriate management method.

The protocol for handling, transport and placement of the asbestos containing materials will be developed as part of the detailed RAP relevant to the Stage of remediation associated with building demolition activities.

7.3 Groundwater Management

The principal groundwater contaminants are heavy metals and of these the major contaminants are lead and zinc. This is consistent with the historical use of the adjacent Pasminco site as a lead – zinc smelter and the historical distribution of slag wastes from the smelter on the IFL site. The pH of the groundwater is generally moderately to slightly acidic and in many cases elevated groundwater heavy metal concentrations are associated with relatively low pH groundwater. The objectives of any treatment system are therefore to:

- Reduce the concentrations of contaminants to levels that do not preclude the protected environmental values of the groundwater; and
- Where possible, reduce the concentrations to background conditions.

It is anticipated the groundwater remediation will involve the following steps:

- Source removal and control (largely addressed by the installation of the containment cell);
- Assessment of the risks posed by the groundwater contamination to the environmental values of the groundwater, in order to:
  - Determine the degree of existing exposure, which would therefore influence the practicability and urgency of the groundwater clean up activities;
  - Derive groundwater environmental values based on a risk assessment and therefore cleanup objectives, where DECC deems this is appropriate; and
  - Derive clean up objectives where cleanup to restore all beneficial uses has been deemed to be impractical.
- Selection of groundwater cleanup technologies (discussed in further detail in the following sections of this report);
- Management of polluted groundwater in the event that either clean up to restore the environmental values of the groundwater is not practicable would include:
  - Derivation of site specific risk based cleanup objectives;
  - Groundwater monitoring, which is anticipated to be an ongoing and recurring task and will be used to facilitate assessment of the performance of the cleanup process. In addition, ongoing groundwater monitoring will assess any new releases of contamination, and confirm whether the environmental vales of groundwater outside the plume are protected.

- Derivation of trigger values to determine is the cleanup process is or will meet the clean up objectives;
- A contingency plan, which specifies the response, should the trigger values be exceeded;
- Controls on the use of the groundwater, which would include informing all potential users of the contaminated groundwater; and
- Periodic review of the practicality of cleanup.

The practically of groundwater clean up is to be assessed based on the following considerations:

- Technical considerations, such as the physical ability to remove the contamination within a reasonable timeframe.
- Logistical considerations including site access (of particular relevance during and following construction of the containment cell), the availability of materials and infrastructure and the disposal of wastes; and
- Financial considerations which includes the cost of cleanup (equipment, installation, maintenance and waste management).

The assessment of groundwater remediation options has focussed on the applicability of various treatment methodologies at effectively treating the groundwater contaminants encountered at the site. A detailed assessment of the groundwater remediation options is currently being completed. A summary of the initial findings is presented below. The remediation options generally assume that the source materials have been removed, with the exception of the capping approach.

It is noted that, in order to comprehensively assess groundwater treatment technologies and to assess the buffering capacity of soils at the site, S&G has been commissioned by IFL to undertake site specific laboratory trials to determine the heavy metals adsorption properties of the soils on site. The trials are to be undertaken by Leeder Consulting, which is a NATA accredited laboratory based in Melbourne. The trials will provide quantifiable, site specific soil buffering capacity properties for use in the assessment of groundwater treatment technologies, and in the predictive groundwater numerical modelling.

7.3.1 Reagent Injection

This method involves the introduction of reagents into the aquifer that will precipitate or immobilise the metal contaminants *in situ*, usually as sulphides or carbonates. Metal compounds or complexes with low solubility will have lower long tem mobility. Reagents can be added to buffer the groundwater pH.

The reagent influence will be limited to near the point of injection and so multiple injection points or injection trenches would be required in the relatively low permeability formation. Multiple treatments may be required to achieve the required objectives. Residual reagent may stabilise fresh groundwater migrating into the treatment zone. Care needs to be taken during injection to ensure the plume is not simply displaced by the injected reagent.

7.3.2 Capping

Capping may be effective where the fill material remains and the fill was entirely located above the watertable. At this site, the fill is partially in contact with water and so capping may have limited influence on the continued leaching of metals from the fill. The fill is to be removed from the site and so the source of the material is expected to be removed. Capping the site will have little influence on the further mobilisation of the metals and so this method is not considered to be a viable option for this site.

7.3.3 Ion Exchange

This is an *ex situ* treatment method and so requires the contaminated groundwater to be extracted and the treated water to be re-injected or disposed of. Once extracted, the water is passed through a coarse filter and then through the ion exchange resin. The resin is selected to preferentially adsorb the contaminants of concern. The resin adsorption sites are progressively utilised and once exhausted, the resin is periodically regenerated. This produces an acidic concentrated metal solution which can be removed offsite by a liquid waste contractor. The frequency of regeneration is based on the flow rate and the contaminant concentrations. This method is more applicable for relatively low concentrations and higher flow rates.

Bench trial test were undertaken using a proprietary non-styrene WP-2® silica polyamine composite ion exchange resin for heavy metals. This testing demonstrated that the selected resin was suitable for the removal of key heavy metals from the groundwater with residual concentrations approaching or at laboratory reporting limits.

This is considered a feasible method for treatment of groundwater at the site assuming concentrations are not high so that the system does not require excessive regenerations.

7.3.4 Precipitation

Precipitation is an *ex situ* treatment method and so requires the contaminated groundwater to be extracted and the treated water to be re-injected or disposed of.

Standard reagents used for precipitation include lime, caustic soda, magnesium oxide, sulphide and carbonates. Laboratory trials carried out for the treatment plant installed at another IPL site indicated that lime was the most efficient precipitant when applied at a rate of 0.5 g/L. This application rate achieves a pH in excess of 10 and this was required to achieve precipitation of cadmium, nickel and zinc. Optimal copper precipitation occurs at a pH of 8.2. The current plant may be suitable for use at the site with some modification and availability may suit project timing.

Further laboratory trials have been conducted using a magnesium based alkali. Previous laboratory trials utilised commercially available magnesium oxide powder with very fine particle size (<45 µm) and high surface area, however the desired pH could not be attained and further testing was done using a 60% slurry. The slurry potentially overcomes the issue of the slow hydration rate and initial results indicate this material may be able to precipitate the zinc, although trials are ongoing. Using this method alone or in combination with the lime may result in a significant reduction in the sludge volume generated.

This is considered a feasible method for treatment of groundwater at the site, particularly where high concentrations and relatively low water flows are required, as may occur in the initial stages of groundwater remediation or for the treatment of containment cell leachate.

7.3.5 Permeable Reactive Barrier

Permeable reactive barriers (PRB) have been used for the *in situ* precipitation of heavy metals. A variety of materials can be used to create the reactive zone. Given the large extent of contamination at this site and the limited opportunity to develop a funnel and gate treatment arrangement, it is likely that the cost of reactive materials would be high and would need to be implemented over a large length, perpendicular to the groundwater flow.

The reactive zone is likely to have a limited lifespan which may be insufficient for the required duty. There would be considerable site disturbance if the barrier required replacing at some time in the future. There is also the potential for long term clogging of the barrier due to the accumulation of reaction products and this could lead to bypass of the barrier by the majority of the contaminated groundwater flow in the long term.

Whilst this method has some application at the site, there are a number of logistical issues with its implementation and other treatment methods are considered to be more viable in these circumstances.

7.3.6 Acid Neutralisation

Acid neutralisation is a relatively simple process to implement as part of an active treatment plant design. As noted above, in the case of precipitation, the objective is to raise the pH and acid neutralisation would occur as part of the treatment method. For the ion exchange approach it is likely that a neutralisation cycle would be added following the ion exchange.

The re-injection of neutralised or basic water into the aquifer may further assist in stabilising residual metal contaminants and limiting ongoing mobility, although appropriate management would be required to ensure this did not result in pH changes outside the treatment zone.

8. SELECTED REMEDIATION OPTIONS

8.1 Evaluation of Containment Cell Location and Configuration

The basic configuration of the containment cell is a mounded landform. This configuration is preferred to a deep excavated cell for a number of reasons as indicated in Section 7.2.4 above. These reasons include keeping the cell contents above prevailing groundwater levels to generally reduce the risk of impacts to groundwater, and also to reduce reliance on ongoing cell operations and management to maintain isolation of cell contents. The proposed cell landform is described in Section 4.6 above.

Several locations were considered for the containment cell. The proposed cell location in the northern area of the site (Figure 8 in text, and Figure 1 in Appendix B) was selected based on the intended cell configuration, the existing contaminated soil distribution, and site operational constraints. Key considerations were as follows:

- A relatively large cell footprint is required due to the volume of contaminated soil to be contained in the cell and the use of a mounded, or shallow burial, landform.

- As indicated in Section 1 above, it is intended that the remediation progresses to allow concurrent use of sections of the site by IFL as it progressively vacates the site. Current plans are to cease manufacturing in 2009 and cease distribution operations in 2010.

- A cell in the southern area of the site would have to be constructed in the currently undeveloped area in order to maintain site operations during remediation. Such a cell would be significantly smaller than required. In addition, the majority of the contaminated soil is present in the infilled gully in the southern area, with fill thickness up to 10m, and this material would have to be excavated and temporarily stockpiled elsewhere on site to allow cell construction. Due to the potential environmental impacts of such an activity, along with site logistical constraints and costs for double handling, this is not considered viable. A further additional constraint is that the infilled gully, once excavated, will likely be needed as a drainage path for surface water flow for the future development of the remediated IFL and Pasminco sites.

- The currently undeveloped eastern area of the site is too small and too steeply sloping to accommodate the cell.

- The cell could not be located in the central, developed portion of the site due to the need to maintain site operations during remediation.

- The undeveloped northern area of the site is large enough to accommodate the cell without significantly affecting key site operations and, compared to the southern area, has a relatively small thickness of contaminated soil to be excavated and managed during cell construction. The cell landform in this area would not be likely interfere with future site drainage and is also in the vicinity of the proposed Pasminco containment cell such that there would be a consistency in future open space areas of the IFL and Pasminco sites.

- Existing power (Energy Australia) and drainage (Pasminco) easements in the northern area can be realigned and otherwise provided to accommodate the cell.

Based on these considerations, the northern area of the site is considered the only viable location for the containment cell. The proposed cell landform in the northern area is set back from the property boundaries by substantial amounts, 10m to 30m, to provide for site drainage and surface water management, easement relocation, and as a contingency to allow potential further remediation works.

8.2 Containment Cell Preliminary Design

The intent of the containment cell design is to create a low maintenance repository structure for on-site contaminated soils with a limited potential for impact to the surrounding environment into the future. The primary engineering controls associated with the containment cell are listed below. Preliminary cell design drawings are presented as Figure 1 to 8 in Appendix B to this document.

Cell Base Levels

An indicative remediation surface within the northern portion of the IFL property boundary and associated cell footprint is presented in Figure 2 of Appendix B, and described in further detail below:

- Cell base to be constructed below the remediation surface, that is, on a validated excavation surface that is expected to be completed within the natural soil profile beneath the excavated fill. Preliminary design levels have assumed a level 250mm below the first soil sample that exhibited acceptable contamination levels at each soil investigation boring. In areas where acceptable samples depths were variable, deeper levels were used for preliminary design.

- Cell base to be generally above the ‘high-stage’ seasonal fluctuation potentiometric surface associated with the ‘shallow’ aquifer, that is the shallowest water-bearing horizon below the remediation surface (refer also Section 10.3 below).

- Cell base grades will provide for gravity drainage through a granular blanket drainage layer installed immediately above the cell liner (refer to following section for further details) to collection pipes and to sumps located on the western cell boundary. Excavation of clean natural materials is required in some areas to maintain reasonable base grades - for example in sub cell 3 a natural ‘hill’ feature will be excavated to prevent an impediment to leachate drainage (note – the ‘hill’ feature refers to a small area of elevated ground currently located to the west of Shed 4 and bounded by roads cuts, and does not refer to excavation into the hillside on the eastern ‘upslope’ side of the cell).

Cell Base Liner and Leachate Collection System

Indicative details regarding the cell base liner and leachate collection system are presented in Figures 2 and 5 of Appendix B, and described in further detail below:

- Base liner system will be a geosynthetic composite liner, comprising a welded high-density polyethylene (HDPE) geomembrane with an overlying geotextile cushion layer for puncture protection and with an underlying geosynthetic clay liner (GCL) and soil bearing layer. A GCL is a manufactured product made up of a layer of bentonite clay sandwiched between two geotextile layers.

    - Intimate contact between the two low-permeability components of the composite liner system, the HDPE geomembrane and the GCL, is critical to achieving optimum containment efficiency and minimising the potential for advective losses through the liner system. The performance of composite liner systems has been shown to be significantly better than single-component liner systems in waste containment applications (Rowe, R.K. (2005) "Long-Term Performance of Contaminant Barrier Systems", 45th Rankine Lecture, Geotechnique, 55 (9): 631-678, refer p. 561).

    - Use of a rigorous quality assurance system during construction is essential for effective geosynthetic liner system installation (refer to further information regarding the planned construction quality assurance/ quality control (QA/QC) plan in the discussion of detailed design considerations below).

    - Both HDPE and GCL materials have high extensibility and can accommodate large differential settlements without disruption.

    - Both HDPE geomembranes and GCLs have extremely high resistance to chemical degradation in the expected leachate environment, i.e. low pH conditions with high dissolved metal concentrations. The chemical durability of the HDPE geomembrane and the GCL will be further evaluated during detailed design.

    - The permeability of GCLs is known to be negatively affected (i.e., the permeability increased) by sustained permeation with water containing high calcium or magnesium concentrations, with the effect potentially being severe if the GCL is also subjected to repetitive saturation and desiccation cycles as in some thin capping systems where a GCL is used as a single low-permeability capping component. Although high calcium concentrations are possible in cell leachate, this effect is not considered likely to significantly affect the ability of the GCL to perform as the lower component of a composite liner because repetitive saturation and desiccation would not be experienced by the GCL at the cell base. This issue will be further evaluated during detailed design.

- Given the potentially high concentrations gradients for contaminants in leachate relative to groundwater, the potential for diffusion of leachate-based contaminants across the liner system will be evaluated during detailed design. Modifications to the liner system may be considered if diffusive flux of contaminants across the liner system is considered to present a risk to groundwater below the cell. Given the presence of a blanket leachate drainage system above the liner and the intention of completing the base of the cell above the potentiometric surface of the shallowest water bearing zone, diffusive contaminant flux across the liner system at any level of significance is considered unlikely.

- In the event that the cell footprint overlays the area of identified artesian conditions around well BH19, a passive drainage mechanism will be incorporated into the subgrade below the liner system to facilitate passive depressurisation of the artesian conditions and reduce the potential for upward hydraulic pressure on the base of the liner system. It is anticipated that this would comprise either a gravel or piped system that gravity drains to a collection sump.

- A blanket leachate collection system will be installed overlying the composite base liner. The leachate collection system will comprise an inert granular drainage layer with an overlying filter geotextile layer. A network of slotted pipes within the granular layer will drain toward several sumps along the down gradient toe of the cell. The pipes will have accessible clean out points on the upslope edge of the cell. It is currently anticipated that two sumps will be sufficient for effective leachate collection and removal, but this will be further evaluated during detail design of the cell.

- Leachate risers for leachate sampling and extraction will be constructed at the sumps. These will be relatively shallow risers, in the order of a few metres high, given the planned cell base levels. In the event that asbestos containing materials (ACM) removed during demolition of site structures is stored in the cell, the location of the ACM within the cell will be surveyed for future reference, and care will be taken to site leachate risers away from the asbestos storage area.

Capping System

Indicative details regarding the capping system design are presented in Figures 3 and 5 of Appendix B, and described in further detail below:

- Capping system will comprise a geosynthetic composite cap, comprising a linear low-density polyethylene (LLDPE) geomembrane with an overlying drainage system (see next bullet) and revegetation layer and with an underlying GCL and seal bearing layer. The LLDPE geomembrane will be textured on both sides where installed on the cell batters to increase slope stability of the capping system. The resistance of LLDPE to chemical degradation is very high, although not as high as HDPE, and will be adequate for the capping system where exposure is to infiltrating rainwater only. Both LLDPE and GCL materials also have high extensibility and can accommodate large differential settlements without disruption.

- A blanket water drainage system will overly the composite cap. The drainage system will comprise a granular drainage layer with an overlying filter geotextile layer. The purpose of the drainage system is to minimise direct build up of water on the composite cap, thus promoting cap stability and reducing leakage into the cell. Slotted collection pipes and drainage outlet pipes will be located along the cell perimeter and benches to release collected infiltration water to the surface.

- The total capping system thickness will be approximately 1m. This will provide physical separation between contaminated soil materials and the cell surface. If any asbestos sheeting materials from the site are co-disposed in the containment cell they will be placed at a substantial depth, in the order of 3 m, below the cell surface.

Chemical Characteristics of Cell Materials

The materials to be placed in the cell are predominantly soils with elevated concentrations of heavy metals, phosphorus, calcium and sulphates (refer Section 3.1). Such materials are considered compatible with the proposed geosynthetic lining and capping systems described above. The chemical characteristics of these materials, and the potential for chemical reactions to occur within the completed containment cell, will be further evaluated during detailed design.

Landform

A preliminary cell landform design and associated cross-sections are presented in Figures 3 and 4 of Appendix B, and described in further detail below:

- The cell landform includes positive grades in all areas, batters (4H:1V), cell top (5%), and benches (1%) to promote surface water drainage. The landform will also include engineered channels for water to flow off the landform at controlled points, and establishment of appropriate local vegetation, such as native grasses.

- The available airspace (volume) for contaminated soil placement in the preliminary cell design is approximately 270,000 m^3. This substantially exceeds the estimated in-situ volume (refer Section 7.2.3 above) and is considered a prudent basis for preliminary design. As the excavated material is previously placed fill, a significant difference between in-situ volume and volume after compaction in the cell is not anticipated.

- The contaminated soil placed in the cell will likely be able to be compacted to a relatively high density, in the order of 95% of standard maximum dry density, such that post-remediation settlement of the landform would be in the normal range for earthwork structures and would be able to be tolerated by the planned capping system.

- The indicative RL of the top of the cell landform is approximately 46 mAHD, with the equivalent RL on the hill slope to the east of the cell occurring approximately 50 m upslope from the eastern property boundary (as presented in Section B of Figure 4 [Appendix B] for reference).

Detailed Design

Detailed containment cell design is to be performed at a subsequent stage of the project. The detailed design will further consider the following issues, which have been considered at an initial level for this preliminary design:

(i) potential for mining subsidence, including consultation with the NSW Mine Subsidence Board;

(ii) seismic loading;

(iii) cell settlement and slope stability;

(iv) hydrological studies to assist development of design specifications for drainage structures, slope stability and erosion control;

(v) development of a cell operation and maintenance (O&M) plan (as a component of the long term site Environmental Management Plan) to maintain cell integrity and environmental isolation of emplaced soils;

(vi) material property specification and construction/installation specifications, including development of a construction quality assurance/ quality control (QA/QC) plan providing details of the required quality management procedures during cell construction. This will address the standard suite of quality assurance procedures for construction of a containment cell, including (but not limited to) such issues as evaluation of material compatibility with anticipated leachate quality, material integrity inspections during installation and testing of all welds between liner sections; and

(vii) chemical characteristics of materials to be placed within the cell, including acidity, reactivity, corrosivity, and flammability; and selection of appropriate cell construction materials and design features to accommodate the placed materials.

The containment cell is being designed to provide long-term containment. In this respect, the design will specify appropriate construction materials, construction methods and construction quality assurance procedures, and ongoing cell operation and maintenance requirements. The cell design life will be in the order of 100 years.

8.3 Staging of Remediation Program

The overall IFL site remediation comprises four stages. A previous section of this report, Section 4.3, provides the overall staging rationale as well as a description of the remediation activities for each stage.

Stage 1 of the remediation involves groundwater recovery and treatment along the northwest site boundary and will not require significant site preparation or contaminated soil excavation.

Stages 2 to 4 of the remediation are the major stages of the remediation works, involving excavation, transport, and placement of significant quantities of contaminated site soils into the proposed engineered containment cell, as well as involving building demolition and associated waste management. These major stages have been developed to be consistent with site operational constraints, and are also considered to be consistent with current information on the remediation schedule for the adjacent Pasminco site. As noted in Section 4.2 above, coordination of cross-boundary remediation issues will be the subject of ongoing consultation with Pasminco during remediation.

Stages 2 to 4 of the remediation will require systematic environmental management, as described in Section 10 below. The following typical sequence of substages is envisaged within each stage, although all items may not be required for each stage:

1. Establish environmental controls:

    - storm water management: diversions, storage, clean and impacted water separation, discharge points.

    - groundwater management: down gradient interception, seepage collection, excavation dewatering.

    - water treatment plant (if required).

    - stockpile areas, including base preparation, seepage collection, and dust management.

    - internal haul roads.

2. Ensure that Pasminco easements across the IFL property are appropriately addressed (either maintained or relocated if required, or negotiate surrender of redundant easements).

3. Construct appropriate portion of the containment cell base liner to receive contaminated soil.

4. Soil excavation and placement:

    - excavate contaminated soil, screen to remove oversize and inert materials (eg. boulders, scrap metal).

    - validate excavated surface (refer Section 9 below).

    - place and compact contaminated soil within cell.

    - establish storm water management and erosion/sediment control measures for the newly excavated area.

    Note: In general, excavation will begin in upslope areas and progress to down slope areas to minimise the potential for contaminated stormwater to flow into and re-contaminate excavated and validated areas. In addition, excavation will be coordinated with containment cell construction to allow as much material as possible to be excavated, screened and placed directly in the cell without the need for temporary stockpiling.

5. Building demolition (if required), including asbestos management.

6. Place clean fill as needed to establish post-remediation surface levels.

7. Construct final capping for completed portions of the containment cell.

The containment cell will be constructed and filled progressively during remediation stages two to four. The cell is divided into a number of sequential subcells as depicted in Figure 6 in Appendix B to this document. The general process for cell construction process will be as follows:

- Initial cell area preparation (refer Figure 8 in Appendix B):
  - relocate existing overhead power lines in cell area (work to be performed by Energy Australia).
  - construct subsurface drains for Pasminco easements and upslope surface water flow in cell area (as needed and subject to discussion with Pasminco).
  - construct stormwater diversion (channel or berm) along upslope edge of cell.
  - excavate storm water retention pond on western side of cell.
  - stockpile the contaminated soils excavated during these cell preparation activities.
- Subcell 1 (refer Figure 7 in Appendix B):
  - excavate the subcell 1 area to remove contaminated soils and establish levels for base liner construction.
  - construct base liner underdrainage in any areas where shallow groundwater head levels are considered to be above base liner levels (potential to be needed in a limited number of local areas).
  - stockpile the excavated contaminated soils.
    note: the subcell 1 area will provide a relatively large area for base liner construction and produce a relatively small amount of contaminated soil for temporary stockpiling.
  - construct perimeter and subcell berms and install base liner system; form a temporary leachate sump against the down slope subcell berm.
  - fill lined areas with compacted contaminated soils using a temporary batters of approximately 3H:1V.
  - employ a combination of stormwater diversion berms, interim cover, and daily cover to isolate the contaminated soil and minimise generation of impacted storm water.

- Subcells 2 through 6 will be constructed in a similar process to subcell 1, although with the following additional items:

  - excavation to establish levels for base liner construction will produce substantial clean fill in some areas, notably subcell 3, which will be stockpiled for site filling and/or cell capping.

  - excavation to establish base liner levels will result in less stockpiling of contaminated soils than for the subcell 1 excavation because activities will be staged such that previously constructed subcells are available for contaminated soil placement.

  - groundwater extraction and injection trenches from interim groundwater remediation activities within the cell footprint (refer Section 8.4.1 below) will be decommissioned and then excavated and backfilled with engineered fill, or otherwise addressed, prior to base liner construction.

  - permanent leachate sumps will be established at some locations, notably in subcells 4 and 6.

  - asbestos-containing materials from site building demolition may be placed within the later subcells of the containment cell.

- The final capping system will be installed in stages across completed areas of the cell landform when sufficiently large areas are accessible, considering required economies of scale for capping works and likely elapsed times between capping stages

- In the case that the volume of contaminated soil requiring placement in the containment cell is less than anticipated, the final two subcells, subcells 5 and 6, may be reduced in size.

8.4 Groundwater Remediation Requirements / Design

8.4.1 Interim Hotspot Groundwater Remediation

Highly elevated zinc concentrations have been identified in the shallow natural aquifer in the northern section of the site. Much of this area will accommodate the containment cell and opportunities to access the contaminated groundwater will be limited following its construction. Consequently, some targeted and opportunistic groundwater remediation is proposed for the northern area to reduce the contaminant mass present in the groundwater system prior to the installation of the containment cell. The most impacted area occurs in the southern and western portion of the northern area of the site and this will be the target of the initial remediation works.

Due to the low permeability of the shallow aquifer it is likely that groundwater recovery for the initial remediation program will occur via a series of extraction trenches. Extracted water will be passed through the treatment system and will most likely be returned to the aquifer via an infiltration trench located up gradient or between extraction locations to further facilitate the recovery of impacted groundwater. This will ensure the return of the treated water to the aquifer occurs within the zone of influence of the extraction system and so the return groundwater will eventually be recovered again by the extraction system. Treated water could also be disposed to sewer or stormwater subject to regulatory approvals.

The detailed design of the initial groundwater system will be developed following the finalisation of the treatment options investigations. A preliminary layout of the interim groundwater remediation system is included in Figure 9.

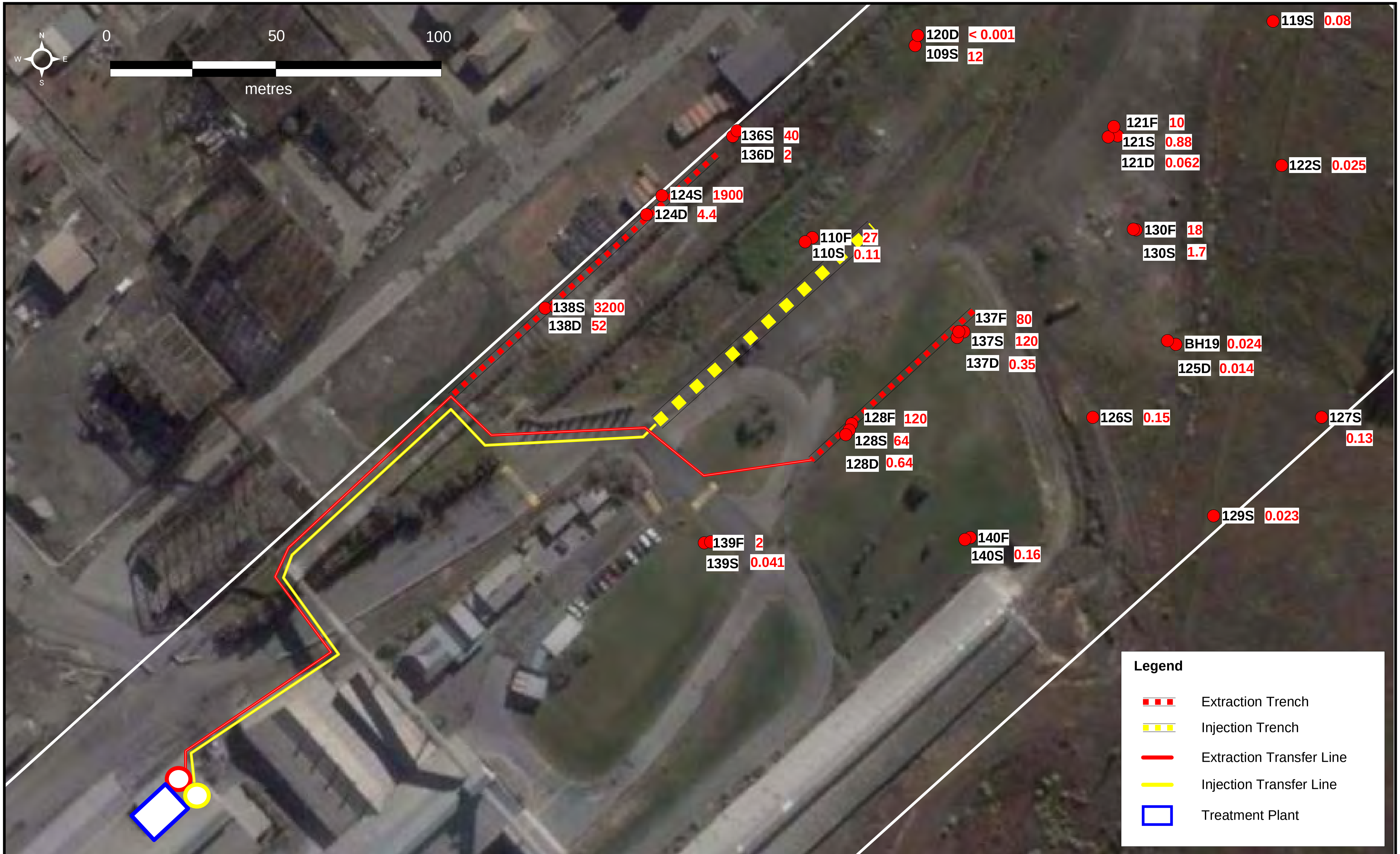
The primary objective of the hot spot remediation approach is to reduce the mass of contaminants within the groundwater system and thereby provide an opportunity for natural mechanisms such as advective dispersion and metal adsorption to clay matrix materials to further reduce the contaminant concentrations prior to the point of discharge. It is proposed that the numerical model developed for the site be utilised to determine suitable end points for the groundwater remediation approach at the site, including the interim hot spot remediation.

The modelling will be used to assess both short and long tem impacts arising from the site contamination and determine suitable target concentrations to minimise environmental impacts, particularly those associated with the ecosystem and uses of Cockle Creek. This will be supported by site specific metal adsorption studies to provide reliable data for the modelling program.

The hydrogeological assessments undertaken to date by Pasminco suggest that the regional groundwater system does not currently discharge to Cockle Creek as a result of dewatering activities at the colliery located to the west of the creek. However, when operations cease at the colliery and dewatering activities conclude, it is expected that the regional groundwater levels will eventually rebound and discharge will occur to the nearest surface water environment.

It is considered improbable that groundwater levels can remain below sea level in this area without anthropogenic influence and the natural discharge regime would be for groundwater to discharge to Cockle Creek or Lake Macquarie. Given the proximity of the site to the creek and the low water level reported in the creek, which is similar to that reported at Lake Macquarie, groundwater discharge from the site in the long term is expected to be to Cockle Creek. The long term prediction will therefore consider the creek as the probable discharge point and hence the compliance point for establishing groundwater remediation objectives at the site.

It is noted that the groundwater recovery trench located near the western site boundary occurs directly adjacent the former railway trestle structures that occur in this area. These structures consist of large slabs of hardwood and much of the structure is in a state of disrepair with the collapse of some sections. The highly elevated groundwater concentration may be the result of leaching of soils located in this immediate area. In any case, the fill materials in this area will need to be removed along with other fill materials at the site to affect remediation. Given the derelict nature of these trestle structures it is considered likely that these would need to be removed to allow for the safe excavation of soils in this area.



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Drawn: DJN	Date: 22 June 2008		Job No.: SG061313	Project: Cockle Creek Assessments	
Checked: APN	Date: 23 June 2008		Title: TARGETED GROUNDWATER TREATMENT SCHEMATIC Zinc Concentrations February 2008		Sheet 1 of 1
File Name: Fig9.wor	Scale: As Shown	A4			FIGURE 9

The trestles structures and their foundations also lie close to the site boundary and would limit the installation of the groundwater extraction trench and this will necessitate the removal of the trestle structure to provide access and a suitable level of safety. Other trench locations in this area are not considered practical due to the derelict nature of the trestle structures and the risk that our activities would undermine the structures and / or their foundations, or, the alternative locations do not meet the design requirements for the extraction system. It is our belief that without the removal of these trestle structures we cannot undertake the required works due to the health and safety concerns for contactors and professional staff involved in the works.

The proposed extraction trench system which will optimise the recovery of shallow impacted groundwater and provide a hydraulic barrier to further offsite migration of the highly impacted groundwater. The system may recover impacted groundwater that has migrated from the IFL site to the adjacent Pasminco site.

Once extracted, the water will be directed via a pipeline to a specialised precipitation treatment plant where the metal contaminants will be removed from the water stream. A semi-solid concentrated metal waste product encapsulated within a geomembrane will be generated by this process. The filled geomembrane will either be disposed within the containment cell or will be disposed off site in accordance with DECC requirements.

It is noted that the movement of groundwater is slow and that a considerable time (many months to a year or more) will be required to effectively control and manage the impacted groundwater in this area of the site. It is therefore imperative that this remediation system be installed and operated promptly so that groundwater remediation can be affected prior to the area being utilised for the containment cell.

Once the cell is constructed in this area it will limit opportunities to access the contaminated groundwater. It is expected that the remediation system will be progressively removed from areas where the containment cell is to be placed as it may provide a preferential pathway for any contamination arising from the cell (although expected to be negligible) to enter the groundwater system. The presence of the groundwater remediation system could also influence the stability of the cell liner system due to differential settlement under load.

8.4.2 Long Term Groundwater Remediation

The need for a long term groundwater remediation system will be based on a detailed assessment of the risks to the environmental values of the groundwater and will be determined in consultation with the site Auditor. It is expected that some form of groundwater interception will be required along the site boundary in the medium term, at least at some locations to ensure that elevated metal concentrations do not migrate onto the adjacent Pasminco land, particularly in the shallow system which is intercepted and treated by Pasminco.

As the source material (slag impacted fill materials) will be removed as an outcome of the soil remediation, the potential for long term contamination of the groundwater arising from the site is considered to be low. Although the potential impact from the containment cell is yet to be fully quantified, it is anticipated this impact with be negligible given the design objective of the cell.

Assuming the cell design will result in negligible groundwater impacts, once the existing contaminated water underlying the site has dispersed or been treated there is expected to be limited or no requirement for long term groundwater management.

The nature of any longer term groundwater remediation system will therefore be dependent on the objectives as determined by the risk assessment process and the assessment of potential impacts on the relevant environmental values of the groundwater and specifically, that of Aquatic Ecosystems. It may be that an intermediate term remediation system is required to manage the risk posed by the existing groundwater contamination but this will be dependent to some degree on the outcome of the initial treatment of contaminant hotspots in the northern area and subject to the risk assessment noted above.

The justification and actions required in each phase of the remediation program will be detailed in the individual RAP documents prepared. A separate RAP may be developed to specifically address the groundwater remediation.

9. SURFACE VALIDATION

A key outcome of the soil remediation program will be to provide a final surface that is suitable from both a contaminant status and aesthetic perspective that is suitable for low density residential use for the area of the site outside the containment cell and its associated buffer areas.

The containment cell and associated infrastructure will encompass the northern section of the site. This area of the site is expected to be suitable for open space uses. The central and southern areas are anticipated to be suitable following remediation for residential or open space uses. The validation of the final surface as being suitable for the intended uses is a critical objective of the remediation approach.

The objective for remediation of the northern area is to provide a base for the containment cell that will minimise the risk of mobilisation of soil contaminants as a result of any seepage from the containment cell or as a result of any incidental groundwater that contacts the materials beneath the cell. The final objectives for this area of the site are to be determined in consultation with the site Auditor based on the quantification of potential seepage rates and the risk posed to the groundwater system in the longer term. This will occur as part of the Stage 2 detailed RAP document.

The objective for remediation of the remaining areas of the site is to meet the NEPM HIL A criteria for unrestricted low density residential use and the EIL criteria or other nominated criteria for protection of ecological values. The leaching potential of the residual soils will also need to be satisfied such that the residual soils do not pose an ongoing risk to the groundwater environment. It is anticipated that if the HIL A and EIL (or other relevant criteria) are met then it is likely that the risk of contamination posed to the groundwater environment will be low.

The protocol for surface validation is yet to be confirmed with the site Auditor, although provisional discussions have occurred. It is noted that that the fill materials which are the focus of the remediation works are visually distinctive from the underlying natural soils and so this provides a convenient distinction between the materials to be excavated and contained and those that can remain, subject to validation testing. It is anticipated that the process of validation will progressively refine the material identification and excavation program.

It is anticipated that the surface validation will occur using a combination of NATA certified laboratory based analytical program. Real-time guidance validation of heavy metal concentrations to assist in determine excavation extents using a field portable X-ray fluorescence (XRF) meter. This approach is considered appropriate in this case since the primary contaminants of concern are heavy metals and principally, these contaminants are lead and zinc. The XRF will enable a high frequency of validation to ensure compliance of each allotment with the adopted assessment criteria and provide adequate data for statistically based assessments.

The validation sampling will be conducted in combination with a GPS unit to allow for accurate location of the sampling locations within the site and verify a suitable density of sampling across each residential allotment. A grid based validation program will be initiated and will meet or exceed the minimum sampling density requirement stipulated in AS4482.1 '*Guide to the sampling and* *investigation of potentially contaminated soil – Part 1: Non-volatile and semi-volatile compounds*' (2005) for a typical residential allotment size.

The XRF validation data will be verified and extended by the laboratory analytical program. Duplicate soil samples analysed by the XRF will also be analysed routinely by the laboratory. It is anticipated that multiple samples within any validation run will be duplicated with laboratory data to verify the accuracy of the XRF data. Where a discrepancy between field based and laboratory data occurs, the issue will be investigated and rectified and the affected area re-validated with appropriate laboratory analysis in support.

The laboratory analytical program will also include analyses of other broader organic and inorganic contaminants (including fluoride and asbestos) to verify the suitability of the site soils for residential or open space use. The frequency of samples tested by this method and the extent of the analyses conducted is to be discussed and agreed with the site Auditor prior to any site validation works commencing.

The residuals soils must also meet the criteria for aesthetic considerations regarding the use of the site for residential or open space purposes. Aesthetic issues include the generation of odours from the site and any discolouration of the soil as a result of contamination. The discoloration criterion would also include the presence of slag materials. As noted previously, the generation of odours is considered to be a low risk at this site due to the absence of any significant concentrations of volatile or other organic contaminants.

A detailed site validation plan will be developed for the site in consultation with the site Auditor to ensure that all stakeholders are aware of the validation works proposed and to provide a documented basis for the validation works. The validation plan will include:

- A statement of the validation objectives;
- A summary of the validation methods to be used;
- A discussion of the Data Quality Objectives and how these will be achieved;
- A description of the validation criteria and the statistically based decision methodology for determining compliance;
- A protocol for the field XRF operation and the laboratory analytical program including frequency of laboratory sampling, the laboratory analytical program, comparison of laboratory and field results and the methods for resolving discrepancies including re-validation of areas where discrepancies cast doubt on the validity of the field based data;
- A plan of the validation program demonstrating the grid spacing and density of sampling locations across the site;

- A protocol for addressing areas of the site that do not meet the validation criteria, including delineation, excavation and re-validation; and

- A method for reporting the validation results.

The final validation report will form part of the remediation report prepared for the site.

10. CONSTRUCTION & DEMOLITION MANAGEMENT PLAN

10.1 Occupational Health and Safety

As with all large-scale remediation and civil design projects, there is a broad range of work activities that have the potential to present a significant risk to the welfare of the personnel involved with the works. A comprehensive, site-specific safety management system will be developed prior to the commencement of remediation activities to ensure that safe work conduct is front of mind throughout the remediation process. The safety management system will be consistent with the requirements of the *NSW OHS Act* (2000) and the *NSW OHS Regulation* (2001). The minimum components of the safety management system will include:

- A site induction process that addresses both the IFL safety requirements (especially during the period that the remediation program overlaps with IFL commercial operations), and the general safety requirements of the remediation program.

- Clear definition of a management structure for OHS-related roles and responsibilities for the Principal Contractor, subcontractors, site supervisors and employees undertaking the various remediation tasks.

- Preparation of a Health, Safety and Environmental Plan by the Principal Contractor that specifies the safety management processes and requirements for the site, which will be provided to all major or long-term contractors and personnel associated with the remediation program for review, feedback and endorsement prior to commencement of works on site.

- All contractors and subcontractors on the project will be required to prepare and submit for review site-specific Job Safety Analyses (JSA) or Safe Work Method Statements (SWMS) for their specific work tasks prior to commencement of works on site. Safety management, performance and experience and training of personnel to conduct their tasks in a safe and professional manner will be a key evaluation criteria during tendering of the works.

- Specification of a risk-based assessment system for all work activities associated with the remediation program, including adoption of a ‘take five’ approach to evaluating risks on-the-spot associated with unexpected or changed conditions on site, or revised work tasks that aren’t adequately addressed in an existing JSA or SWMS (lessons learned from ‘take five’ assessments will be shared at the next daily toolbox talk, and incorporated into the relevant JSA/SWMS if warranted).

- Daily ‘toolbox’ talks prior to commencement of works, involving the site supervisor and all remediation personnel, to discuss the safety issues associated with the days planned activities, and update or revise SWMS and JSA to reflect new site safety guidelines and new or modified work activities.

- Clear lines of communication for hazard/near miss/incident reporting, and work processes for addressing these reports.

- A safety documentation management system to provide evidence of the implementation and proper conduct of the safety management system throughout the project.

- Emergency procedures to respond to incidents requiring urgent medical attention, or potential hazards that require isolation and/or evacuation of parts or all of the site (and potentially notification of the local authorities and surrounding community).

- A "no-fault" audit/inspection process to encourage open communication between all site personnel regarding the effectiveness of the safety system, and group contribution to continual improvement of the safety management system throughout the project.

10.2 Surface Water Management

Management of surface water will be a critical component of the remediation program for the IFL facility. The IFL facility is situated on the foot slopes of Munibung Hill, and primarily comprises an industrial plant constructed on infilled drainage gullies. Surface water management issues will generally include the following components:

- Diversion of stormwater run on from Pasminco property up slope from the IFL property, which may include the use of drainage easements that Pasminco holds across IFL land (this will primarily be the responsibility of Pasminco, with IFL providing maintenance of Pasminco drainage easements across its property).

- Diversion, capture and treatment (as warranted) of stormwater run off across the IFL property, and discharge to approved easements.

- Separate management of leachate water derived from stockpiled material, drainage of saturated material emplaced within the containment cell, and potential ingress of groundwater seepage from excavation faces during remediation.

A Surface Water Management Plan will be prepared prior to the commencement of remediation works that provides details of the strategies and civil works required to manage the various surface water types throughout the course of the remediation program. A primary objective of the program will be to separately manage 'potentially' contaminated water, which will comprise the majority of surface run off captured across the site, from 'likely' contaminated water such as leachate drainage from excavated materials, with a view to minimising the volume of water requiring treatment (beyond sedimentation) to render it suitable for discharge to the drainage easements.

Examples of measures that will be considered to minimise the potential for water quality impacts to surface run off include:

- Minimising the area of disturbed ground that has yet to be validated.

- Diversion of water around disturbed areas, stockpiles, and the containment cell.

- Use of barrier strategies for stockpiles, excavation faces or other disturbed areas that could potentially generate contaminated run off, including:

    - Plastic sheeting

    - Sacrificial clean imported fill emplaced in a thin layer over contaminated land

    - Interim and daily cover within cell areas

- Capturing base seepage from contaminated soil stockpiles and pore water drainage from saturated fill material emplaced in the cell.

- Separate retention and management of potentially and likely contaminated water streams.

Studies are currently underway to evaluate the design criteria for the civil works and treatment plant capacity required to manage stormwater runoff across the site. The strategy will be implemented as a priority in the northern portion of the site, where the timing of the Pasminco remediation program will require that surface water run off to Pasminco land is controlled to prevent potential re-contamination of remediated areas. The studies are currently focussing on definition of sub catchments across the site, model estimates of run off volumes for various design storm events, and evaluation of stormwater run off quality. The results will comprise the basis for decisions regarding retention volumes, treatment requirements, water diversion and transfer infrastructure, and discharge locations.

10.3 Groundwater Management

A design specification for the containment cell is for the base of the cell to be constructed above the 'high-stage' seasonal fluctuation potentiometric surface associated with the 'shallow' natural aquifer (i.e. the shallowest water-bearing horizon below the remediation surface). The intent of this specification is to reduce the potential for the cell liner to be subject to hydraulic pressures from below, and isolate the contained waste material from the groundwater system to the extent practicable. Historical groundwater monitoring at the site generally indicates a downward hydraulic gradient between the perched fill aquifer and the underlying shallow and deep natural aquifers.

It is recognised that the historical groundwater monitoring data set is limited in its frequency and duration, and that there is potential for higher hydraulic head values in the shallow aquifer than is reflected in the historical monitoring data. In addition, artesian conditions have been identified in one limited area of the site, which may coincide with a portion of the containment cell footprint. The following groundwater management controls are proposed for the containment cell during construction and for long-term site management:

- In the event that groundwater ingress is encountered during construction of the base of the containment cell, the base grade will be designed to drain to one or more sumps for short-term storage of groundwater seepage or stormwater run off within the footprint of the containment cell. Any such water will be managed based on its quantity and quality in accordance with discharge criteria for the site.

- If the final cell footprint area coincides with the zone of slightly artesian conditions (i.e. BH19), a passive drainage system will be incorporated into the subgrade of the liner system to allow for depressurisation of the zone of artesian pressure. It is anticipated that this would comprise either a gravel or piped system that gravity drains to a collection sump, and the water would be managed according to its quantity and quality to conform with discharge criteria for the site.

- It is anticipated that there will be very low likelihood for significant groundwater ingress into the containment cell following installation of the basal liner system. A groundwater model developed for the site will be used to predict post-remediation equilibrated groundwater levels to aid with this assessment. Any groundwater entering the containment cell would be managed in accordance with the leachate drainage and collection system for the cell.

- In the unlikely event of a leachate release from the containment cell to the underlying groundwater system (i.e. through a defect in the liner system), it is anticipated that this would be identified through an ongoing groundwater monitoring program along the hydraulically down gradient boundary of the containment cell. The implications of a leachate release with regards to groundwater quality would be evaluated and managed according to a contingency strategy to be specified in a long-term site management plan. Further details will be provided in the relevant Detailed RAP for the cell construction Stage.

10.4 Traffic

Traffic movements will be carefully managed during remediation with regards to safety issues on site and upon entering and exiting the former Pasminco smelter complex onto Boolaroo surface roads. Coordination of on-site traffic flow will be especially important during the overlap period between the commencement of the remediation program and ongoing IFL commercial activities, which involve a significant number of truck movements to and from the site. Finally, coordination with the former Pasminco remediation program will be required, as heavy plant commonly crosses the primary access road through the Pasminco property to the IFL facility.

For each stage of remediation, primary haul roads will be established to provide access to the active development areas of the site, and speed limits, right-of-way protocols and safe work methods for working around moving plant will be developed as part of the remediation safety management system. As remediation progresses, traffic flow through remediated and validated portions of the site will be restricted to permit a staged audit process of the remediation works, and minimise the potential for re-contamination of remediated portions of the site.

10.5 Air Quality and Dust Management

The activities associated with decommissioning and remediation of the IFL facility have the potential for significant dust generation, which is both a nuisance and health risk to the surrounding community. Features of primary concern with regards to dust generation include soil stockpiles, open excavation faces and areas of stripped vegetation, particularly following periods of limited rainfall. As such, an Air Quality Management Plan will be developed that will provide details of a dust monitoring program (locations, frequency, type of monitoring), regulatory compliance criteria based on NEPM standards, reporting requirements for monitoring results and site management practices to minimise dust generation.

10.6 Asbestos Management

The initial stage of the demolition program will include the removal of a large quantity of asbestos-cement sheeting from most of the buildings and structures planned for demolition. A survey of the IFL property and facilities for the presence of asbestos materials was conducted by Indec Consulting Pty Ltd in December 2007, and their report estimated that over 56,000 m^2 of asbestos-cement materials are present on the Site. The removal of these materials will be a major activity, undertaken by an appropriately licensed contractor, and in accordance with specific regulatory requirements, work practices, personal protective equipment and handling procedures (as dictated by NSW WorkCover Authority).

At any time, areas or buildings which are actively undergoing asbestos removal work will be identified and segregated from other work activities by physical barriers and warning signs, and all personnel other than those involved in asbestos removal will be excluded from entry.

Handling and removal of asbestos-containing materials will also be carried out in accordance with WorkCover requirements, whether the material is to be placed in the on-Site containment cell, as currently proposed, or trucked off-Site to an approved landfill facility.

Any asbestos or other waste that is proposed to be trucked off-site will be transported and tracked in accordance with the requirements under the *Protection of the Environment (Waste) Regulation 2005* and any licence condition imposed by DECC under the POEO Act.

10.7 Noise and Vibration

Demolition and remediation works at the Site will naturally cause the generation of noise and, to a lesser degree, vibration effects. Noise will be produced by the movement of machinery (mostly mobile plant, trucks and other vehicles), the cutting of steel, breaking and removal of concrete etc, the impact noise associated with loading, dumping and dropping of materials and general earthworks noise. The main sensitive noise receivers include the residential areas to the south-west and east of the IFL site.

It is proposed that a noise assessment will be carried out and, based on that assessment, a Noise & Vibration Management Plan will be prepared covering the following issues:

- Fitting of residential standard silencers on stationary and mobile equipment, where possible.
- Restrictions on working hours, as dictated by the Director-General's requirements.
- Notifying local residents of scheduled works and providing Site contact names and telephone numbers.
- Undertaking noise monitoring where required.
- Erecting temporary noise barriers if required.

10.8 Odour

Considering the nature of the primary contamination issue at the site (i.e. smelter slag), the potential for generation of offensive odours during remediation is considered to be low. However, the following odour mitigation measures will be adopted if odour emission issues are encountered:

- Physical barriers over material stockpiles or excavation faces, which may include plastic sheeting, sacrificial clean fill covers, or other barrier methods.
- Use of spray or mist odour mitigation chemicals, applied either along the site boundary or directly onto stockpiled material or excavation faces.
- Maintenance of equipment and plant to minimise vehicle exhaust emissions.

Odour control methods will be employed at any stage that site personnel become aware of offensive odours arising from remediation activities, or an odour complaint is registered from the surrounding local community.

10.9 Demolition

Building demolition will be undertaken during some stages of the site remediation. The majority of environmental issues arising from building demolition activities are anticipated to be related to air quality (dust management), asbestos management, and noise and vibration. These topics are discussed in preceding sections of this chapter.

It is recognised that the Environmental Management Plan for any remediation stage that includes building demolition will have to address demolition-specific topics including the following:

- demolition area management – perimeter security, stockpile management.
- demolition plant- air emissions, maintenance, and spill management.

- waste management – asbestos containing materials, concrete crushing, waste classification, recycling, waste transport to licensed disposal sites.

- noise and vibration – plant, explosives use, work hours, complaints register.

- air quality- dust and asbestos impacts relating to demolition activities.

Building demolition activities will comply with the relevant portions of current legislation for environmental and safety management including the NSW *Occupational Health and Safety Act* 2000 and *Regulation* (2001) as well as relevant NSW Codes of Practice such as asbestos removal. All demolition work will be required to be carried out in general accordance with AS 2601-2001 *The Demolition of Structures.*

11. POST-REMEDIATION ENVIRONMENT MANAGEMENT PLAN

11.1 Requirement

The containment cell will be retained at the site and will provide a long term, although manageable, risk to the environment. Consequently a post-remediation Environment Management Plan (EMP) will be established and implemented to ensure that the risks to the environment associated with the remediation of the site are effectively managed so as to minimise any risk to the environment and ensure that such risks are acceptable.

The EMP must be a legally enforceable document to ensure that the risks to the environment are appropriately managed in the long term and are linked to the land Title such that the responsibility for the implementation rests with an identifiable party. The existence of the EMP must be notified on the S149 certificate and also under Section 88b of the Conveyancing Act. The EMP will be implemented by a single entity.

The EMP must be reviewed and approved by the site Auditor and the EMP will form part of the Site Audit Report as its implementation will be required to suitably manage the ongoing environmental risks associated with the site.

11.2 Responsibility

IFL will retain responsibility for the implementation of the EMP and to undertake the required monitoring and any contingency actions required to mitigate the environmental risks associated with the containment cell.

11.3 Containment Cell Design Environmental Controls

Post-remediation management of the containment cell will primarily comprise leachate system management and surface maintenance/inspection. These activities would be specified in a cell operation and maintenance plan, a component of the EMP.

Post-remediation leachate system management would generally require the following activities at varying frequencies as appropriate:

- Leachate collection volume monitoring at the leachate sumps. With respect to leachate production, it is anticipated that the majority of leachate generation will occur in the early stages of contaminated soil placement and compaction as pore water drains from potentially saturated fill material emplaced in the cell. Considering the fully encapsulated cell design specification, it is expected that the volume of leachate generated will decrease with time.

- Pump out, testing and disposal of leachate to licensed off site disposal facilities.

- Flushing of leachate collection pipes through perimeter clean out ports.

Post-remediation cell landform surface maintenance / inspection would generally require the following activities at varying frequencies as appropriate:

- Vegetation maintenance and rehabilitation of stressed areas.
- Site inspection for subsidence and erosion features and repair of any damaged areas.
- Surface water monitoring.
- Groundwater monitoring and management.

The extent to which these need to be undertaken will in part depend on the outcome of the remediation program, particularly with regard to surface water and groundwater management. Any additional issues identified as requiring management will be included in the final EMP for the site.

11.4 Monitoring and Verification

Monitoring of all identified elements of the containment cell and the environment which require management will be undertaken. Suitable assessment criteria will be developed for each parameter to identify acceptable and unacceptable conditions. The detail of the monitoring program will be developed following the completion of the remediation program. This will include the QA / QC requirements to verify the integrity of the data.

A variable frequency monitoring program is expected to be developed with the frequency and extent of subsequent monitoring rounds dependent on the risk posed as determined by the existing data set. Where possible, monitoring end points will be established as part of this plan.

11.5 Triggers and Contingencies

Appropriate triggers and contingency options will be developed for each of the elements of the monitoring program. The triggers for actions will be developed using a risk based framework. The detail of the trigger levels and the contingency actions will be developed following the completion of the remediation program, assuming this program has been completed and meets the remediation objectives.

Where the remediation objectives cannot be met by the proposed remediation system, then a contingency approach should be developed and implemented where practicable to ensure compliance with the remediation objectives. The potential for the soil management approach not to achieve the remediation objectives is considered to be low as the extent of contamination is well defined and the management approach of isolation provides a robust management solution. The response of the groundwater system to remediation efforts and in response to the removal of the primary source is less certain due to the complexity of the issues associated with groundwater contamination and migration. Contingency measures for the groundwater remediation approach would be appropriate. These will be addressed as part of the detailed RAP documents.

A series of level responses will be developed for each element monitored, with successive levels resulting in a greater degree of investigation and / or remedial action to mitigate any risk posed by the identified contamination. The initial response level(s) will ensure that appropriate data is collected to support and define any required intervention actions.

11.6 Groundwater Quality Management Plan

Once the materials are contained within the cell, the greatest risk for off site migration of contamination is expected to be via the groundwater system as a result of seepage from the containment cell. Although the lined cell will be designed to minimise seepage losses, a small volume may be lost from the cell. This seepage is expected to be diluted and dispersed within the natural groundwater system and the design will verify that this seepage rate acceptable and does not restrict applicable environment values of the groundwater.

To verify that this is the case, a groundwater quality management plan (GQMP) will be developed for the site. This plan will form a subset of the EMP document. The detail of the GQMP will be developed following the completion of the remediation. This document will detail the monitoring well network required, the frequency of sampling and extent of the analytical program, QA/ QC measures to be adopted, revision and assessment of the data, and reporting of results to stakeholders.

12. REPORTING & MEETINGS

Data will be collected at the site throughout the remediation program and it is important that relevant information is provided to the Principal, Auditor and stakeholders in a timely manner throughout the project. This will be done through periodic reports and scheduled meetings.

12.1 Reporting

A progress report will be prepared at the end of each calendar month following the commencement of Stage 1 remedial activities. This will follow a set format and provide a brief synopsis of the works completed for the month, any significant results obtained, and a summary of works intended for the following month. The report will be circulated to the Principal and the Auditor. Any comments received will be addressed in the first week of the following month.

Formal reports will be prepared at milestone events and on an annual basis. Milestone reports will include completion of various major phases of the soil remediation program and if required, completion of the groundwater remediation program. These reports will provide a comprehensive documentation of the works conducted, the results obtained and the outcomes of the remediation program. The report will include the results of all relevant monitoring conducted during the period relevant to the report.

RAPs will be developed for Stages 2 to 4 (three RAPs) and a summary report produced for each stage comparing the RAP to the actual remediation undertaken in order to facilitate Audit sign off.

At the conclusion of the soil and if required, groundwater remediation programs, an EMP will be developed for the site. This document will detail the nature of works undertaken at the site, the location of residual contamination including the location of stabilised contaminated soils, allowed and disallowed actions at the site, the methods required to manage the containment cell to protect human health and the environment, trigger levels and contingency actions, the safety precautions to be undertaken and the need for referral to experienced environmental practitioners and regulatory authorities should interaction with contaminated materials be required. Reporting on the results of the EMP implementation will be undertaken routinely.

A validation report will be completed at the conclusion of the remediation (both soil and groundwater) in order to facilitate final Audit sign off.

A detailed reporting program will be developed following the final staging of the remediation work programs.

12.2 Meetings

Informal and formal meetings will be held throughout the remediation program. Informal meetings between the consultants and the Principal and Auditor will be held when relevant information is available and the consultants determine the routine update of these stakeholders is beneficial. Formal progress meetings will be held with the Principal and the Auditor on a monthly basis.

It is expected that meetings with relevant stakeholders will be held on a three-monthly basis to provide an update on progress and proposed works to be completed during the next period.

A formal meeting will be held between the nominated stakeholders prior to the commencement of the remediation program to confirm the final details of the Stage 2 RAP (following reviews and comment) and to provide the opportunity for any discussion of issues prior to commencement. A formal meeting is not proposed at the commencement of the Stage 1 as the scope of works is relatively minor, being limited to the interim groundwater remediation program and the demolition of the trestle structures. A formal meeting will be held between nominated stakeholders at the completion of the soil remediation program.

Public meetings will be held only if required and there is sufficient public interest in the project. The public will be notified routinely of the progress of the project via the media or by other means deemed appropriate. Issues raised by the public are expected to be dealt with on an individual basis via the nominated Community Liaison Officer.

13. TIMING

The estimated timing of each stage of the remediation process is presented below:

Stage 1 –	Establishment of initial groundwater hotspot remediation:	Sept 2008 – April 2011
Stage 2 –	Cell construction / northern area soil remediation:	Dec 2008 – June 2011
Stage 3 –	Decommissioning / demolition and soil remediation of central portion:	Sept 2010 – June 2013
Stage 4 –	Remediation of the filled gully on the southern portion of the site:	Sept 2012 – June 2015

14. CONCLUSIONS

Following detailed soil and groundwater investigations across the site over a number of years, a contamination extent in soil and groundwater has been identified and delineated. An assessment of a significant number of remedial options has been undertaken. It is considered the most appropriate management approach at the site would be to consolidate and contain all the soil and other materials unsuitable for use within a residential setting in isolation within a lined containment cell located on the northern portion of the site within the site boundaries. The removal of the metal impacted soils, which are the primary source of the identified groundwater contamination, to a fully lined and sealed engineered containment cell will also remove the primary ongoing source of groundwater contamination at the site. The remainder of the site is expected to be developed for residential use.

Some targeted and short term groundwater remediation is proposed for the northern area (within the proposed containment cell area) to reduce the contaminant mass present in the groundwater system prior to the installation of the containment cell. Due to the low permeability of the shallow aquifer it is likely that groundwater recovery for the initial remediation program will occur via a series of extraction trenches. Extracted water will be passed through the treatment system and will most likely be returned to the aquifer via an infiltration trench located up gradient or between extraction locations to further facilitate the recovery of impacted groundwater. The detailed design of the initial groundwater system will be developed following the finalisation of the treatment options investigations.

To ensure ongoing environmental management of the area of the site incorporating the containment cell and a suitable buffer zone, IFL will retain the ownership and responsibility for this area, including the groundwater environment. This will ensure accessibility to the area for any future management requirements and will provide a viable entity for the implementation of the environment management plan into the future.

The remainder of the site is to be divested for development purposes with the expectation that the area will be suitable for residential use as a result of the soil remediation works conducted. The groundwater beneath various parts of this divested area may contain contaminant concentrations that preclude various environmental values of the groundwater, particularly those associated with extraction and use. Due to the difficulty in remediating groundwater across the entire site, the low potential for use in the residential setting and the presence of a reticulated potable water supply system, it is anticipated that a condition may be imposed as part of the environmental audit outcome that restricts use of the shallow groundwater at the site to minimise any potential risk to site users.

The most relevant environmental value of groundwater at the site is that of aquatic ecosystems and it is expected that any residual site groundwater contamination will be demonstrated not to preclude this environmental value. If this cannot be achieved then it is anticipated that appropriate remediation or management measures will be put in place to ensure this environmental value is protected and the outcome of the audit with respect to this matter is suitably assured.

The estimated timing of each stage of the remediation process is presented below:

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