



PCCS EIA Input PCCS Remediation Works Outline

Pasminco Cockle Creek Smelter

June 2006

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PCCS Remediation Works Outline

Prepared for

Pasminco Cockle Creek Smelter

Prepared by

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Executive Summary

The Pasminco Cockle Creek Smelter (PCCS) is currently the subject of a Remediation Order issued by the NSW Environment Protection Authority. The preferred remediation approach for the site is excavation and containment in an on-site cell.

The purpose of the report, in response to the Client brief, is to provide engineering input into the Part 3A Environmental Assessment for the PCCS Remediation Project, specifically:

“To more closely define engineering activities so as to be able to undertake a more definite environmental assessment of the proposed remediation works for the PCCS site. This work will serve as part of the project description and to provide a basis for noise, dust and surface water/sediment/erosion, and traffic assessments”.

In order to achieve the purpose, the report details the implementation of the remediation works including:

- Staging plans for excavation, site clean up and cell construction including indicative timeframes and dates for project execution
- Work areas for excavation and containment cell footprint. This includes layouts in plan and approximate quantification of work surface areas
- Site logistics for remediation works including potential haul routes, personnel required on site, and traffic movements specific to remedial works
- Methodologies relating to cell excavation, construction and sub surface (groundwater) control measures
- Preliminary requirements for site validation and quality assurance in so far as it relates to the remediation of the site
- The objectives for environmental management and details of specific environmental controls which are likely to be required during and after the remediation works.

Surface water management issues are addressed in an accompanying report entitled “Water Quality and Water Cycle Management”, Maunsell, 2006.

The remediation of the PCCS site will require a number of elements, with various elements occurring concurrently. In order for the contaminated areas to be suitable for redevelopment, they will require remediation and subsequent validation. The remediation works can be summarised into three general construction activities, which may occur concurrently. These are:

- Excavation and validation
- Treatment and handling
- Cell construction.

Ancillary activities will include transportation of contaminated material and importation of clean material for backfilling and capping and temporary and permanent environmental controls.

It is proposed to conduct the remediation, validation and cell construction activities over a nominal period of five years. This five year period has been divided into ten six-monthly stages. It is anticipated that the excavation of the site will be conducted by a single team, remediating and validating nominated individual site areas consecutively.

This schedule may change over time subject to changing development demands. For example, it could be possible for more than one team to work on more than one area concurrently.

To assist in the staged redevelopment of the site, the site has been divided into 11 separate development areas as shown in **Figure 1**. Of the 11 defined areas, areas 1-8, plus area 10 will require remediation in the form of excavation and subsequent validation. Areas 9 and 11 represent the anticipated final cell location.

It is proposed to remediate and validate each area to the point of certain approval (i.e. laboratory validation results indicating that the site is suitable for the proposed land use).

In parallel with the excavation, there will be a cell construction team. Prior to containment in the cell, materials will be taken to an interim storage area for holding, mixing and treatment as required. This area will be located within the anticipated final footprint of the cell. The area shall be used for material tracking, mixing and treatment to ensure that the material entering the cell meets the construction quality criteria and in addition will allow the steady supply of material to the cell for continuous cell construction.

The conceptual layout of the containment cell and the proposed 10 stages of construction are shown on **Figure 2**.

There are various methods and timing that can be used for extraction of the materials to be placed into the Cell. The report describes the general details of the site, general remediation and construction activities and general logistics. This approach allows an assessment of impacts for the noted construction activities.

The construction timetable and activity listing included in this report represents the current planning and scheduling, which is reasonably certain for the early works, but less definitive for the later works.

The described project provides a sound basis for defining activities and determining potential impacts. This approach allows an assessment of impacts for the noted construction activities and allows a prediction of an “envelope” of impacts as envisaged by the Part 3A legislation.

This approach has been taken to allow for flexibility in the order and rate of site excavation and cell construction with each further stage after the initial works being subject to review at the time. The various factors that may affect the ultimate project delivery and their possible consequences include duration of project, cell volumes and layout, order of remediation, choice of equipment, and the discovery of unusual material.

This report has addressed the relevant requirements of the Director-General’s (Department of Planning) Guidelines issued in conjunction with the Part 3A process and defined the proposed remediation works outline, setting the stage for detailed design and subsequent remediation, validation and redevelopment of the PCCS.

1.0 Introduction

The Pasminco Cockle Creek Smelter (PCCS) Remediation Works Outline Report ('the report') has been prepared by Maunsell Ltd ('Maunsell') at the request of Fitzwalter Group Pty Ltd ('the Client').

1.1 Background

The PCCS is no longer operational. The overall long term plan for the site is to remediate the smelter site, and surrounding impacted areas, so that they are suitable for a mixture of land uses including industrial, commercial, residential and open space.

A Remediation Order has been placed on the site by the NSW Environmental Protection Authority (now the Department of Environment and Conservation (DEC)) in order to prevent any off-site migration of impact prior, during, and complementary to, the implementation of remediation works across the site.

The preferred remediation approach is excavation and on-site containment. A conceptual design for this approach was prepared by Responsive Environmental Solutions (March, 2005). In order to investigate the technicalities relating to this option, and to confirm its feasibility and suitability, Maunsell prepared a Conceptual Containment Cell Design and Management Plan (CCCDMP) (September 2005).

It is intended that this report will be used in the Environmental Assessment, required for the remediation, including the construction and use of an on-site containment cell for long term entombment of contaminated materials. An Environmental Assessment for remediation is required under Part 3A of the Environmental Planning and Assessment Act 1979. General and key assessment requirements are included in the Director General Requirements (DGRs) for the Environmental Assessment, dated 22 December 2005. The Proponent is responsible for preparing the Environmental Assessment.

These DGRs and the following reports have guided and defined the proposed remediation works outline, which is the subject of this report:

- Remediation Options for the cleanup of soil and waste materials at the Pasminco Cockle Creek Smelter site, Boolaroo, NSW, January 2005, CH2M HILL Australia
- Summary of Actions Implemented to Address Significant Risk of Harm Issues at Pasminco Cockle Creek Smelter Site, Boolaroo, August 2005, Fitzwalter Group Pty Ltd
- Remediation Action Plan, Pasminco Cockle Creek Smelter Site, Boolaroo, NSW, September 2005, Fitzwalter Group Pty Ltd
- Conceptual Containment Cell Design and Management Plan (CCCDMP), September 2005, Maunsell Ltd.

1.2 Purpose

The purpose of the report, in response to the Client brief, is to provide engineering input into the Environmental Assessment for the PCCS Remediation Project, specifically:

"The Purpose is to more closely define engineering activities so as to be able to undertake a more definite environmental assessment of the proposed remediation works for the PCCS site. This work will serve as part of the project description and to provide a basis for noise, dust and surface water/sediment/erosion, and traffic assessments".

In order to achieve the purpose, the report aims to detail the implementation of the remediation works including:

- Staging plans for excavation, site clean up and cell construction including indicative timeframes and dates for project execution
- Work areas for excavation and containment cell footprint. This includes layouts in plan and approximate quantification of work surface areas
- Site logistics for remediation works including potential haul routes, personnel required on site, and traffic movements specific to remedial works
- Methodologies relating to cell excavation, construction and sub surface (groundwater) control measures
- Preliminary requirements for site validation and quality assurance in so far as it relates to the remediation of the site
- The objectives for environmental management and details of specific environmental controls which are likely to be required during and after the remediation works.

At the request of the Client, and ancillary to the remediation works, an assessment of the requirements for a new Effluent Treatment Plant (ETP) has also been provided. Surface water management issues are addressed in an accompanying report entitled "Water Quality and Water Cycle Management", Maunsell, 2006. **Figure 7** shows the surface water catchments and flow directions that are relevant to both of the Maunsell reports.

There are various methods and timings that can be used for extraction of the materials to be placed into the Cell. The report describes the general details of the site, general remediation and construction activities and general logistics. This approach allows an assessment of impacts for the noted construction activities. The Part 3A application is for a Project Approval for a staged project.

The construction timetable and activity listing included in this report represents the current planning and scheduling, which is reasonably certain for the early works, but less definitive for the later works.

The described project provides a sound basis for defining activities and determining potential impacts. This approach allows an assessment of impacts for the noted construction activities and allows a prediction of an "envelope" of impacts as envisaged by the Part 3A legislation.

This approach has been taken to allow for flexibility in the order and rate of site excavation and cell construction with each further stage after the initial works being subject to review at the time. The various factors that may affect the ultimate project delivery and their possible consequences include duration of project, cell volumes and layout, order of remediation, choice of equipment, and the discovery of unusual material.

1.3 Scope of Report

The report is limited to the examination of the staged remediation of the site which includes the following activities:

- Excavation of contaminated soils with post excavation activities sufficient to stabilise and level the excavated areas ("surface stabilisation")
- Treatment of excavated materials as required
- Emplacement of excavated materials into the containment cell as part of the construction of the containment cell
- Capping of the containment cell
- Installation of temporary and permanent environmental controls for the constructed cell.

The report is limited to the above noted activities and does not include details of operational aspects associated with the remediation, such as ongoing monitoring requirements or leachate treatment.

The report assumes that concrete breaking and removal of base slabs that were part of the smelter operations has taken place prior to the site remediation actions described within. The report also does not specify any detail associated with the removal of in-ground pipes or other services which will occur as part of the excavation activities.

The report has been prepared to supplement the preparation of the Environmental Assessment for the PCCS Remediation Project. It does not contain detail that would be sufficient for design or construction. Rather, the report provides a descriptive account of the remediation works likely to be required. It is noted in the text however where further work or additional studies are considered necessary during the design or construction phases of the project.

The report is not a Remediation Action Plan and does not specify remediation criteria. Details relating to site validation will be required both during and after remediation works, after detailed design and construction plans have been provided.

The report should only supplement additional environmental specialist studies that will be required to provide a more detailed assessment for inclusion in the Environmental Assessment and for satisfaction of the DGRs. The environmental controls relating to the remediation works are indicative only. Further analysis would be required in the Environmental Assessment for:

- Dust generation and air quality impacts
- Noise impacts
- Flora and fauna and biodiversity issues
- Traffic impacts.

Further, details on the health related impacts are also considered outside the scope of this assessment. Water related and air quality health impacts are discussed in separate reports.

Operational site management and staff requirements have not been considered in this report.

1.4 General Remediation Details

The remediation area extends from Boolaroo in the south, to Main Road in the west, the rail line and Cardiff Industrial Estate in the north, and Munibung Hill to the east as shown in **Figure 1**. It includes areas that formed part of the PCCS site or have been impacted by its activities. It is proposed to redevelop the whole area for either residential, open space, commercial or industrial use.

The remediation of the PCCS site will require a number of elements, with various elements occurring concurrently. In order for the contaminated areas to be suitable for redevelopment, they will require remediation and subsequent validation. The remediation works can be summarised into three general construction activities, which may occur concurrently. These are:

- Excavation and validation
- Treatment and handling
- Cell construction.

Ancillary activities will include transportation of contaminated material and importation of clean material for backfilling and capping and temporary and permanent environmental controls.

It is proposed to conduct the remediation, validation and cell construction activities over a nominal period of five years. This five-year period has been divided into ten, six-monthly stages. It is anticipated that the excavation of the site will be conducted by a single team, remediating and validating nominated individual site areas consecutively. This schedule may change over time subject to changing development demands. For example, it could be possible for more than one team to work on more than one area concurrently.

In parallel with the excavation, there will be a cell construction team. Prior to containment in the cell, materials will be taken to an interim storage area for holding, mixing and treatment as required. This area will be located within the anticipated final footprint of the cell. The area shall be used for material tracking, mixing and treatment to ensure that the material entering the cell meets the construction quality criteria and in addition will allow the steady supply of material to the cell for continuous cell construction.

Drying beds may be required to stabilise various materials with higher than optimal moisture contents prior to their containment. The location of the drying beds is proposed to utilise either the existing hardstand within the industrial grounds to the south west of the site, or within the containment cell anticipated final footprint itself, on top of areas yet to be remediated, so as to ensure that any impact from this drying operation can be contained and will be remediated.

To assist in the staged redevelopment of the site, the site has been divided into 11 separate development areas as shown in **Figure 1**. Of the 11 defined areas, areas 1-8, plus area 10 will require remediation in the form of excavation and subsequent validation. Areas 9 and 11 represent the anticipated final cell location.

While Area 9 is considered to be part of the anticipated final cell location, it is possible that the cell will not fully extend across or even reach Area 9. In order to consider this scenario, the upper limit of excavation will include the estimated volume of excavation for Area 9 (from Table 2-2). This is reflected in **Figure 4** where Area 9 is seen to be remediated concurrently with cell construction.

It is proposed to remediate and validate each area to the point of certain approval (i.e. laboratory validation results indicating that the site is suitable for the proposed land use).

Table 1-1 provides a description of each separate land area to be remediated (excavated). The 9 areas to be remediated and validated have been prioritised in the nominated order based on current views as to their development potential.

Table 1-1 Land area description

Land Area Number	Description
1	Cardiff West Estate (Clay pits)
2	Triangle Paddock south
3	Railway Employment Zone (including part Saltwater and Hawkes Dams)
4	Triangular Paddock north and Main Entry Precinct
5	Boolaroo Heights
6	Munibung Hill Residential (including Freshwater Dam sediments)
7	Munibung Slopes Industrial Estate

Land Area Number	Description
8	Boolaroo North
9	Cell Surrounds (including part Hawkes Dam sediments)
10	Mixed Use Zone (including part Salt Dam sediments)
11	Containment Cell

In addition, there are quantities of material to be contained that do not form part of the excavation of the areas described in Table 1-1 that are currently stored onsite or will be brought to the site and include:

- On-site slag stockpiles
- Smelter inventory material to be retained on site including dam sediments
- Cockle Creek Mix (a particular smelter by-product which is separately stockpiled)
- Demolition and Dump Wastes
- The LAS (Community Soils to be brought from off-site).

1.5 Report Structure

The report has been divided into specific work 'packages' that would be conducted in order to complete the remediation works, as follows:

- Excavation and Validation
- Treatment and Handling
- Cell construction
- Sub surface water control measures
- Staging
- Site management (environmental control requirements) during construction
- Overview of future requirements – including rationale for the placement of facilities such as the ETP in the context of future developmental opportunities for the site.

This segmented approach has been adopted so that explicit details relating to the remedial works may be reviewed as individual work tasks. It is acknowledged however, that there is likely to be overlap and synergies between the work packages.

2.0 Excavation and Validation

2.1 Excavation Activities

Excavation encompasses the following specific activities:

- Excavation of the contaminated material – This shall generally involve one or more excavators removing the material, supported by a loader, and haul trucks
- Analysis of the material – Sampling and analysis of the material shall be undertaken in accordance with the relevant construction standards in order to characterise the material being removed from a particular site area
- Transport of the material – Haul trucks shall be used to transport the material to the cell or to the mixing and treatment area
- Site Validation – Sampling and analysis of subsurface material to validate sufficient excavation and removal has occurred
- Development preparation – Preparation of the site for future development with backfilling, covering and stabilisation of the excavated area to make it safe and ready for future development activities including site shaping and levelling etc.

2.2 Contaminated Materials

The CCDMP identified 19 different material types across the site that are to be placed in containment. These materials were categorised into four separate groups based on the available chemical data of the waste materials. The destination of each material within the cell, and the required level of treatment and containment, has been determined using this material categorisation.

The four broad material categorisations for waste materials are:

- Industrial Process Wastes, including fill material containing this waste material
- Sediments from settling residue ponds
- Contaminated soil from the PCCS facility land and adjacent land impacted by stack emission deposition
- Contaminated building materials, industrial components, and hazardous building materials (such as furnace lagging etc – that can not be recovered or recycled), and material deposited in waste areas pre-1970 and between 1970 and 1995.

Descriptions of the material to be excavated or moved from current storage areas for containment are presented in **Table 2-1**. The majority of these materials are soils from areas 1 - 10. Other materials, such as industrial process wastes and building materials would require movement from their current storage positions into the containment cell.

Table 2-1 Material Types and Location

Material Group	Material Type	Description	Remediation Area as shown on Figure 1
Industrial Process Wastes	Black Sands - Imperial Smelting Furnace (ISF) Slag	Stockpiled ISF Slag material	11, HDPE covered stockpiles
	Lead Blast Furnace (LBF) Slag	Stockpile LBF Slag	11, HDPE covered eastern stockpile
	Mercury Rich Residues	Buried Mercury Rich residues	3 and/or 9, buried in pit adjacent non-recyclable dump
	Cardiff Clay Pit Material	Buried mercury contaminated clay material	1
	KI Filter Cake (In Containers)	KI Filter cake	3 and/or 9, in shipping containers
	Thallium Chloride (In Containers)	Thallium Chloride	3 and/or 9, in shipping containers
	CC Mix - Slurry Dams	Slurry Dams	11, HDPE cover stockpile to east of ISF stockpile
	Cockle Creek Mix	11, HDPE cover stockpile to east of ISF stockpile	
Dam Sediments	Freshwater Dam Sediments	Fresh water dam sediments	6
	Salt Water Dam Sediments	Salt water Dam sediments	3, 10, and/or 9, and/or 11, stockpiled to north east of non-recyclables dump
	Hawkes Dam Sediments	Hawkes 1 and 2 Sediment	3, 9, 11
Contaminated Soil from PCCS Facility Land and Surrounding Areas	General Fill and Contaminated Soil	Site Fill and Natural with ISF/LBF slag	3, 7, 8, 9, 10, 11
	Contaminated Soil - Mild/Low/Cons.	Primarily due to lead dust contamination	1, 3, 4, 6
	Cockle Creek Spit Material	Cockle Creek Spit material from LMCC	9 and/or 11, stockpiled to north east of non-recyclables dump
	Triangular Paddock Soils	Triangular Paddock remediation material	2, 4
	Boolaroo Heights Soils	Boolaroo Heights remediation material	5
	Community Residential Soil	Lead dust impacted soils from surrounding community residential properties	external
Non-Recyclables Waste and Contaminated Building Materials and Waste Areas	Waste Area 1970-1995	Waste Disposal Area - 1970-1995	9, 11, beneath ISF stockpile
	Waste Area pre -1970	Waste Disposal Area - pre 1970	11, beneath LBF stockpile
	Non-Recyclable dump wastes	Bulka Bags	9 and/or 11, Non-recyclables dump
		Cherry Drums	9 and/or 11, Non-recyclables dump
		Current dump - PVC pipe, rubber socks etc.	9 and/or 11, Non-recyclables dump
	Demolition Wastes (non recyclable)	Concrete wastes	Currently still in plant - precise nature and quantities of materials unknown until encountered during demolition
		Refractory wastes	
		Acid Plant catalyst	
		Baghouse bags	
		Mercury residues ex Acid Plant	
Acid Plant packing			
ETP underflow sludges			

2.3 Material Volumes

The volumes of material to be excavated from the 10 areas, as provided to Maunsell by Fitzwalter Group, have been determined through the estimation of the area of contaminated land, and the anticipated depth of contamination. Conservative methods have been used incorporating an additional 25% contingency. The estimated areas and calculated volumes for each area of land to be excavated are shown in **Table 2-2** below. Material volumes for *in-situ* materials or materials that will require movement from their current storage are shown in **Table 2-3**.

Table 2-2 Area Excavation Volumes

Land Area Number	Description	Area (m ²)	Excavation Volume (m ³)	Excavation Volume with 25% (m ³)
1	Cardiff West Estate (Clay pits)	160,300	20,000	25,000
2	Triangle Paddock south	72,687	75,401	94,252
3	Railway Employment Zone (including part Saltwater and Hawkes Dams)	114,800	42,010	52,513
4	Triangular Paddock north and Main Entry Precinct	132,142	49,439	61,798
5	Boolaroo Heights	101,300	20,267	25,334
6	Munibung Hill Residential (including Freshwater Dam sediments)	224,813	43,592	54,490
7	Munibung Slopes Industrial Estate	23,896	4,779	5,974
8	Boolaroo North	122,200	136,478	170,598
9	Cell Surrounds (including part Hawkes Dam sediments)	59,696	96,935	121,169
10	Mixed Use Zone (including part Saltwater Dam sediments)	89,939	111,403	139,254
Totals		1,101,773	600,304	750,380

Table 2-3 Other Volumes to be included in the Containment Cell

Description	Volume (m ³)	Volume with 25% (m ³)
Lead Blast Furnace Slag	111,000 (not to be excavated)	111,000 (known volume)
Imperial Smelting Furnace Slag	155,000 (60,000 not to be excavated, the balance of 95,000 is above ground and will be distributed across the cell)	155,000 (known volume)
LAS (Community Soils)	60,000	75,000
Inventory	1,520	1,900
Demolition and Dump Wastes	10,000	12,500
Cockle Creek Mix	30,000	37,500
Cell Volume Totals including excavated material	967,824	1,143,280
Volumes that need placing in the cell	196,520	221,900

2.4 Management of Excavation

2.4.1 Excavation Working Areas

As a general guide, it is recommended that there be no more than three hectares of exposed soil at any given time during the remediation and validation of the various areas. This will limit the potential impacts caused by runoff of sediment and the generation of dust (both contaminated and uncontaminated). The three hectares of exposed area will typically be at a single site but may be split between multiple sites if required.

2.4.2 Excavation Quality Assurance and Material Acceptance

Control of materials being excavated is crucial to the adequate performance of each of the cells. For this reason, a sampling, analysis and management plan, as well as an excavation quality assurance (QA) program, will be required to be implemented. Both documents would typically be written during the detailed engineering design phase and would specify material types, relevant QA standards, frequency of sampling, analysis for each material type and compounds / characteristics to be analysed for.

All sampling and testing shall be carried out on *in-situ* material before being excavated or otherwise removed.

Field Screening

A program of field screening would be used to support the sampling and analysis required during construction. Indicators of contamination in materials requiring emplacement within the cells may include the following:

- Unusual or distinctive colour
- Staining or residues
- Flakes, fragments or pieces of foreign substances or debris such as asbestos, metal, paint brick or wood
- Moisture content
- Consistency (i.e. viscous, dry, powdery)
- Particular characteristics (i.e. quality of odours, common characteristics of other material encountered on site).

Additionally, real-time screening instrumentation may be employed to guide the contamination identification and materials segregation activities. Types of instrumentation may include photoionisation detectors (PID) instrumentation, sorbent tubes, field olfactometer (Nasal Ranger) instruments, soil headspace vapour screening techniques and X-Ray Fluorescence (XRF) instruments.

Soil Sampling and Analysis

Sampling and analysis will be undertaken to confirm field observations and field assessments, to ensure that appropriate materials are being placed appropriately within the cell. Accordingly, a suitable sampling protocol and frequency and grid-based density will be established to statistically evaluate the consistency of field operator's assessments and categorisation decisions with actual analytical data.

A typical sampling and analysis program would look at the type and consistency of each material. The actual number of samples to be collected and analysed will depend on the homogeneity of the material and will be determined during the site works.

All samples would be analysed for known contaminants of concern related to the generation method of each of the materials (e.g. slags analysed for heavy metals). At least 10% of samples for each material will be analysed for a full suite of potential contaminants of concern as a safeguard to ensure no unexpected contaminants are encountered. This suite would include a range of analytes and may include the following:

- Arsenic
- Cadmium
- Chromium
- Copper
- Mercury
- Manganese
- Nickel
- Lead
- Zinc
- Total Petroleum Hydrocarbons (TPH)
- Polycyclic Aromatic Hydrocarbons (PAH)
- Poly Chlorinated Biphenyls (PCB)
- pH (soil/solid)
- pH (Leachable)
- Sulfates as SO_3^{2-}
- Chlorides
- Net Acidity (sulphur units)
- Net Acidity (acidity units)

Geotechnical properties (moisture content, etc) to assist with the placement and compaction of the material within the cell may also be tested for at this stage if necessary. Details of relevant standards for the construction of the Cell are given in **Section 4.3**.

Relevant Operational standards

Operational standards relevant to the excavation of waste materials shall include, but not limited to, the following:

- AS 1289.4.1.1-1997: Methods of testing soils for engineering purposes – Soil chemical tests – Determination of the organic matter content of a soil – Normal method
- AS 1289.4.2.1-1997: Methods of testing soils for engineering purposes – Soil chemical tests – Determination of the sulfate content of a natural soil and the sulfate content of the groundwater – Normal method
- AS 1289.4.3.1-1997: Methods of testing soils for engineering purposes – Soil chemical tests – Determination of the pH value of a soil – Electrometric method
- AS 2006-2001: Demolition of Structures
- AS 3798-1990: Guidelines on Earthworks for Commercial and Residential Developments
- AS 4482.1-2005: Guide to the investigation and sampling of sites with potentially contaminated soil – Non-volatile and semi-volatile compounds
- AS 4874-2000: Guide to the investigation of potentially contaminated soil and deposited dust as source of lead available to humans.

All sampling and testing methods are required to be undertaken in accordance with the methodologies outlined in the above standards.

2.5 Site Validation

2.5.1 Excavation

Site sampling, screening and analysis of waste materials during excavation have been discussed in **Section 2.4.2**. In addition, post-excavation validation of the newly-exposed subsurface will also be sampled and analysed in accordance with the Remediation Action Plan to ensure all contaminated material has been excavated and removed.

Based on the results of the various sampling and analyses, the exposed surface (and therefore the parcel of land) shall be classified as follows:

- Sufficient excavation has taken place and all contaminated material has been removed for placement in the containment cell
- Contaminated material still remains and further excavation is required. Excavation shall continue until all contaminated material has been removed to meet the required relevant Health Investigation Level (HIL) for the proposed land use and transported to the containment cell.

Once all required material has been removed and the site has been validated in accordance with the RAP, subsequent redevelopment works of the land parcel may proceed.

2.5.2 Environmental Monitoring

Environmental Monitoring will be undertaken throughout the proposed site remediation program for each remedial area, beginning with further collection of groundwater data in advance, during and following containment cell construction works. This information will be regularly compared with the modelling predictions and to help with ongoing calibration of the groundwater model developed previously and as discussed in the CCCDMP.

Additional sampling and monitoring of surface waters at required dams/ponds will also be undertaken prior, during and following excavation and construction works of the site. Locations and analytical criteria would be specified in a surface water management plan written prior to the commencement of redevelopment.

2.6 Excavation Logistics

Assumptions

The following excavation logistics have been developed to present a reasonable and representative case for impact assessment purposes. It is acknowledged that the logistics have not attempted to optimise the use and matching of equipment nor specify exactly what equipment is to be used as this will ultimately be determined during the tender and construction phase of the remediation contract. In some cases, the dimensions of the particular remediation site will also influence the choice of equipment. The accepted construction contract will use equipment and scheduling that will respond to the conditions of the Part 3A approval.

Volumes and Masses

The in-situ volume of contaminated material to be excavated is approximately 750,380m³ (as per **Table 2-2**). This excludes the Lead Blast Furnace Slag and the Imperial Smelting Furnace slag in the cell area as well as those other materials outside of the excavation areas. It is proposed to use 6 monthly staging, and therefore the 11 identified site areas (**Figure 1**) and the 10 identified cell areas (**Figure 2**), will be remediated over 10 stages (5 years in total). On this basis, each 6 monthly stage shall consist of a rounded estimate of 75,000m³ of material requiring excavation.

The CCCDMP reported the density of the in-situ general fill and contaminated material to be in the range 1.8 to 1.91T/m³ (2 samples). This is supported by the general advice of 1.8T/m³ (Pers. Comm.) from contractors for a clay based soil such as on the PCCS site. Density variations can be expected over the site. For example, the Triangular Paddock material density was reported in the CCCDMP at 2.0T/m³, the slag at 2.1-2.3T/m³, and Boolaroo Heights at 1.4-1.5T/m³ (all in-situ values). For the purposes of this report, an average of 1.85T/m³ has been used throughout.

The material will bulk once it has been excavated. Conservatively, it has been assumed that the excavated material will bulk to a maximum of 50% although lower bulking factors are more likely.

As discussed later, it is expected that once compacted in the cell construction, a final placed density of 1.85T/m³ or greater can be expected.

Working days

For convenience, it has been assumed that work will only occur on week days, although the contractor can use Saturday mornings if necessary. Each six-monthly period includes 26 weeks giving a notional 130 available working days. Allowing for public holidays (5) and wet weather delays (assumed at 25 to include wet days and drying days – roughly equivalent to four lost days per month), it is assumed on average that there is an effective 100 working days in each six-monthly period.

A typical working day for all equipment is assumed to consist of 7.5 productive hours.

Excavation Requirements

To achieve the excavation rate of 75,000m³ (rounded) per six-monthly stage within the 100 available days will require a daily excavation rate of 750m³. With the in-situ density of 1.85T/m³, there is effectively 1388T/d excavated and requiring transport to the cell area. The in-situ 750m³ could bulk up to 1125m³.

Excavation equipment and operations

The required excavator has been selected to be a 20 to 30 tonne excavator. This may change in future, subject to equipment availability of the contractor(s) working on the site however, a 20 to 30 tonne excavator is typical for this type of work and will give an appropriate indication of overall capacity.

The excavation rate for this type of excavator has been conservatively estimated at 800m³ per day. It is possible to increase this rate to 1000m³, or even 1200m³ per day once a crew is established and practiced. These extraction rates rely heavily on the physical characteristics of the material type being handled.

Excavators can load directly into trucks or alternatively, a loader can be used between the excavator and the truck. For the purposes of this assessment, it has been assumed that an excavator and a loader will be used. However, in practice, either technique may be applied depending on particular circumstances.

Typical trucks that are suitable for use on the site are bogeys, 4x2 Rigid or larger dump trucks. The remediation transport routes are primarily all on PCCS land. Because of this, trucks to be used in the remediation can take larger loads than would be permitted on public roads. Assumed on-site loads for bogeys are 12T, for 4x2 Rigid 18T, and for large dump trucks 25T. For the purposes of this assessment, 4x2 Rigid have been assumed, although a combination of bogeys and Rigid or even large dump trucks could likely occur.

Based on assessments of the haul route distances, it has been estimated that on average, a turnaround time for truck movements (i.e. load from the excavation area, drive to the cell area, unload and return for the next load, including waiting time) would be 20 minutes for the longer hauls and 15 minutes for the shorter hauls. If any particular haulage route is longer, or slowed due to unsealed routes or other reasons, the turnaround time will increase and additional trucks may be required.

The above assumptions result in the following truck requirements:

- At 18T per load, there will be a need for 77.1 truck movements per day
 - With three movements per hour (20 minute turnaround) and 7.5 hours per day, this translates into 3.43 trucks per day

- With four movements per hour (15 minute turnaround), this translates into 2.57 trucks per day
- Accordingly, on average 3 trucks will suffice.

Post Excavation Site Stabilisation

After excavation is finished and the site validated, some other small equipment will be used to stabilise the site, making it safe and stable (i.e. controls applied for dust and run-off management and to avoid water collection). This may require the importation of some clean fill. The importation quantities involved are expected to be relatively limited.

Based on the above, the nominal "excavation" team will require the following equipment:

- One Excavator – rated to excavate the soil material at 800m³ (in-situ) but only needs to produce 750 m³/day leaving spare capacity
- One Loader to load trucks – after initial site clearance, the stockpiled material can be loaded into the haulage trucks
- Three (4x2) Rigid Dump Trucks – to transport the contaminated material to the mixing area.

In addition to this earthmoving equipment, each "team" will require access to the following equipment, either as dedicated plant to that area of excavation, or shared with other areas being concurrently excavated:

- One water cart for dust suppression
- One grader for site maintenance, clearing of access roads etc
- One refuelling / maintenance vehicle for equipment maintenance.

In a limited number of instances, such as the remediation of Area 2, a dozer may be more effective at remediating the site. Instead of discrete excavation, the entirety of Area 2 could be evenly scraped and this may be followed by some discrete excavation.

The effect of these assumptions on the rate of remediation of site areas is illustrated in the example below. Note that the excavation times provided do not include the time required for sampling, validation and auditor sign-off.

For example, it is estimated that area 1 requires the removal of approximately 20,000m³ of material from former brick pits. As the excavation capacity is in excess of the trucking capacity, the trucking rate will determine the completion time. At the rates indicated above (i.e. excavation and trucking of 750m³/day of in-situ material per day, this take 27 days or the approximate equivalent of 5.4 working weeks. Additional time would be required for any works necessary to temporarily stabilise the site after the excavation was complete.

2.7 Imported Material for Backfilling Excavation

Backfilling will occur within a number of areas such as in portions of the Triangle Paddock and also in the Hawkes Dam where the surface profile requires raising to surrounding levels. Backfilling for redevelopment may also occur at number of other areas to be remediated where excavation has significantly reduced the level of the site. This will be determined during detailed design on a site by site basis in conjunction with cut and fill calculations and the redevelopment plan levels.

Clean material (either Virgin Excavated Natural Material (VENM) or soils appropriately validated as suitable for the intended land-use) will be imported to the site for the purposes of backfilling soil removed during remediation.

Validation of imported material will be required to ensure it meets the suitability for land-use criteria.

Validation of material for backfilling would be undertaken for the duration of the proposed remediation activities. Due to the staged nature of the works, validation of the material would be carried out on an area by area basis ensuring that future redevelopment of the individual areas can be undertaken with minimal risk to human health and the environment.

Imported material will be analysed at frequency of at least 1 sample per 1000m³ if sole sourced VENM, otherwise a frequency will be determined based upon the source of material, typically on a load by load basis, if multiple small sources are imported from off site.

3.0 Treatment and Handling

3.1 Materials Management

Additional revisions of current designated material categorisations may be required during waste material placement in the containment cell/s based on observations during actual excavation and placement activities. Any further investigations required would be undertaken to assess the chemical and physical characteristics of the materials during the detailed design and placement stages. This is in order to obtain a higher level of certainty on the suitability of the proposed containment measures and structures and determine whether some chemical, physical or physio-chemical pre-treatment may be required for the higher contaminated material (Category C materials – see **Section 3.1.1** below) prior to being placed in the cell.

A materials management strategy will be developed as part of the detailed design in response to the specific design of the containment cell. Specific field identification procedures and material placement and tracking protocols will be developed as appropriate for the various proposed remediation activities, including specific checklist protocols and procedures.

The following sections describe the procedures recommended for the management of all materials prior to emplacement in the containment cells.

3.1.1 Material Categorisation

The CCCDMP outlined a material categorisation system. Material categorisation will occur during excavation to ensure the appropriate handling and placement of different materials within the containment cell. A material categorisation system was outlined in the CCCDMP, with materials to be categorised throughout excavation to determine whether they fall into one of the following:

- **Category A (General Fill)** – Material where leachability, aggressivity, hardness, reactivity and flammability parameters (including for leachate) are within the specified acceptance criteria and will be placed in the general containment area without treatment
- **Category B (Stabilised Material)** – Material which exceeds the acceptance criteria for Category A material but can be stabilised through chemical, physical or physio-chemical methods to provide for the long-term stabilisation of the material to a level meeting the Category A acceptance criteria will be placed in the Cell
- **Category C (Material Requiring Additional Controls)** – Material which cannot be stabilised to a level meeting the Category A acceptance criteria due to cost or technical reasons will require more conservative controls at the time of containment. Treatment or specific containment of such materials will be conducted as outlined within the CCCDMP.

The CCCDMP identified material types and material categories. Volumes were also calculated which in turn delineated the size of the containment cell required. This has been summarised in **Table 3-1**.

Table 3-1 Material Type and Categorisation

Material Type	Material Category	Level of Certainty of Material Category	Category A & B Volume	Category C Volume
Process Wastes				
Lead Blast Furnace (LBF) Slag stockpile (monolith)	A	High	111,000m ³	-
Black Sands - Imperial Smelting Furnace (ISF) Slag	A	High	155,000m ³	-
Mercury Rich Residues	C Reclassification to B possible	Low to Moderate	-	500m ³
Cardiff Clay Pit Material	A and C	Low to Moderate	15,000m ³	5,000m ³
KI Filter Cake	C Reclassification to A or B possible	Low to Moderate	-	1,000m ³
Thallium Chloride	C Reclassification to B possible	Low to Moderate	-	20m ³
Dam Sediments				
Salt Water Dam Sediments	A Subject to acid generating potential being adequately addressed	High	5,000m ³	-
Freshwater Dam Sediments	A	Low to Moderate	1,000m ³	-
CC Mix - Slurry Dams	C Reclassification to B possible	Low to Moderate	-	30,000m ³
Hawkes Dam Sediments	C Reclassification to B or A possible	Low to Moderate	-	45,000m ³
Contaminated Soil from PCCS Facility Land and Surrounding Areas				
General Fill and Contaminated Soil	A	Moderate to High	302,579m ³	-
Contaminated Soil - Mild/Low/Cons.	A	High	inc in General Fill and Contaminated Soils	-
Cockle Creek Spit Material	A Subject to acid generating potential being adequately addressed	High	inc in General Fill and Contaminated Soils	-

Material Type	Material Category	Level of Certainty of Material Category	Category A & B Volume	Category C Volume
Triangular Paddock Soils	A Subject to acid generating potential being adequately addressed	Moderate to High	100,000m ³	-
Boolaroo Heights Remediation Material	A	High	13,6260m ³ Vol.	-
Lead Abatement Strategy	A	Low to Moderate	60,000m ³	-
Waste Areas, Non-Recyclables Wastes and Contaminated Building Materials				
Waste Area 1970-1995	A	Moderate	(Below surface)	-
Waste Area pre -1970	A	Low to Moderate	(Below Surface)	-
Non-Recyclable dump wastes	A or C	Low	5000m ³	-
Demolition Wastes (non recyclable)	A, B or C Most likely A	Low	5000m ³	-

3.1.2 Materials Handling

Some of the materials to be contained within the cell will require a number of specific handling methodologies due to their long-term nature and characteristics. Suggested handling techniques are summarised in **Table 3-2**.

Table 3-2 Materials Handling Techniques for Various Materials

Material Type	Suggested Handling Technique
Soil Materials	The majority of these materials require no special physical treatment other than emplacement and compaction. Care should also be taken when moving soils during construction to minimise dust generation.
Material with High Moisture Content – Silts, Sediments & Slurries	These types of materials should be managed by drying on drying beds to reduce moisture content of the material to minimise the amount of free water entering the cell and also to reduce the material to an acceptable moisture content for suitable compaction.
Dusty Materials	The black sands, dry sediments or drier soil materials have potential to be dusty when handled. These materials, particularly the black sands may potentially be mixed with other clay/soils or sediments to be placed in the cell in order to achieve the optimum moisture content for handling and compaction.
Lead Blast Furnace Slag	This material will remain in-situ. As such it will not pose a handling issue. The HDPE liner currently covering the monolith may remain after construction of the containment cell. This would provide additional protection against water infiltration and a reduction in the potential for any leachate generated above or next to this monolith or in contact with it.
ISF slag (Black Sands)	It has been proposed that the out-of-spec material be processed through a jig, which will allow the extraction of high concentrate material from the stockpile, resulting in a stockpile of lower concentration material (in-spec slag). Any portions of in-spec black sands to be placed within the drainage layer at the base of the cell shall be handled in accordance with the dusty materials above.

Material Type	Suggested Handling Technique
Materials Containing Organics	The material containing organics such as grass will be required to be spread out over drying beds until the organics are sufficiently dry or decomposed such that they will not have any potential to produce leachate, gas or compromise the stability of the compacted soils.
Category B Materials	The Category B materials are materials that are categorised as C or other materials (acid sulphate soils) that can safely be placed directly into the Cell with some form and level of prior chemical stabilisation. These materials may require stabilisation by mixing with lime, cement or another pozzolanic agent to reduce the pH and/or leachability and hence corrosivity.
Category C Materials	It is proposed that the higher risk Category C materials such as the mercury residues, KI Filter Cake and Thallium Chloride undergo complete segregation and stabilisation prior to placement in the containment cell, being placed in shipping containers and then filled with concrete. These stabilised materials and the remaining Category C materials including the Hawkes Dam sediments and the CC mix may require more conservative controls.
Demolition Materials	Certain demolition materials may require placement in the containment cell. Examples include potentially any lead dust impregnated buildings materials (including timber etc).

The following options may need to be considered for the management of materials requiring more conservative controls:

- HDPE lined storage piles
- Macroencapsulation of various materials within shipping containers. This would be a process of placing the materials within centre of the containers, with custom built spacers which would allow the pumping of a 150mm to 200mm barrier layer of concrete around the material to be contained
- HDPE liners fitted within the inside of the shipping containers to minimise the potential for corrosion of the steel shipping containers and leaking of the contained materials, which may potentially compromise the integrity of the secondary cell itself
- Sulfate resistant concrete to be used for macroencapsulation
- HDPE Liners separating the CC mix and the shipping container if the CC mix proves to be reactive with the steel of the shipping container.

Any further smelting process wastes discovered as a result of the demolition will be handled as per the waste type's categorisation as described for works involving excavation.

3.1.3 Mixing and Treatment Area

The mixing and treatment area will be located within the proposed cell footprint, adjacent to the workface. This will reduce transport distances from the mixing and treatment area to the containment cell, ensure that the same area will be available until the cell is almost complete, and eliminate the need to remediate a separate area as the treatment area is already included in the remediation.

Temporary storage will also assist with material tracking as it will allow time between excavation and containment to suitably characterise and catalogue the material.

The mixing and treatment area will be used to treat materials that require it, and those requiring modification of physical characteristics to achieve an optimal degree of compaction (i.e. materials of high moisture content).

3.1.4 Stockpile Management

Stockpiling of materials will be required at interim storage and handling areas for soil segregation and placement. The mixing and treatment area will be located within the proposed cell footprint. This allows the ready supply of the cell from this area and ensures that the same area will be available until the cell is almost complete. In addition, any residual impact from the storage and/or treatment will be contained within the final cell footprint and any leachate generated will be captured within the collection system. The area will also be within the area controlled by the construction water management system and as such handle any contaminated water (ground or surface) that comes from the working of the materials in these areas. These restrictions result in the preferred location for such storage area being towards the north-western extent of the proposed cell footprint.

Alternatively, the location of treatment areas will be in an area in which the material can be adequately contained, such that run-on and run-off water does not present a problem, or seepage from the base of the material does not impact underlying soils. This type of area would typically be a part of the site that is not yet developed, the base of which will be lined and the area bunded for water control. Such areas include concrete slab areas after demolition of former smelting operations buildings, whereby the base slab would act as a barrier to underlying ground contamination. This type of area would be ideal for silt/slurry drying beds or areas in which to stabilise materials provided runoff controls and collection systems are provided.

For ease of storage, stormwater runoff control, dust control, sampling, classification and aesthetics, it is envisaged that stockpiles on areas being remediated (areas 1-10) will be limited in size. The soil from these stockpiles will be sampled and analysed to determine the extent of contamination.

3.1.5 Materials Tracking

A materials tracking system will be established that will monitor the movement of materials at the site. The system would initially identify the materials that are to be excavated through a grid reference system that is to be established during the preparation of the remediation work packages. The grid reference system will allow the extent of excavation and later placement of soil to be clearly defined and documented.

This materials tracking system will be required to ensure the existence, movement and final placement of materials is established and documented. The system will include (but not be limited to):

- Grid based coordinates for the entire site (either by established grid system, survey marks or GPS location)
- Details of soils assessments, locations and volumes
- Truck manifest reconciliation with materials movements and destinations
- Analytical results
- Quality control results
- Audit results
- Notification records
- Details of soil treatments
- Details of stratification and depths to emplaced soils.

3.2 Mixing and Treatment Areas Logistics

As described in **Section 2.6**, each 6 monthly excavation stage will consist of the removal of approximately 75,000m³ of *in-situ* material equating to approximately 112,500m³ of loose, *ex-situ* material. However, not all of the excavated material at each stage requires further treatment. Based on the data available, it is estimated that up to approximately 55,000m³ of loose *ex-situ* material of the

75,000m³ in-situ material to be excavated, may require mixing and treatment, prior to filling and compaction in the cell. These materials include those requiring chemical treatment and/or a more rigorous degree of containment, and those requiring modification of physical characteristics to achieve an optimal degree of compaction.

To enable the mixing and treatment of 55,000m³ loose *ex-situ* material per 6 monthly stage, a nominal "mixing and treatment" team will require the following equipment:

- One Front End Loader with Backhoe—capable of transporting and loading 600m³ loose *ex-situ* material per day
- One water cart for dust suppression.

Refuelling/maintenance duties will be taken care of using the cell construction team, which will be operating adjacent to the mixing and treatment area.

Contaminated material will be delivered to the mixing area directly from the excavation via the haulage trucks. Material will be unloaded at a delivery area and subject to sorting or diverted for treatment such as to the drying beds.

Material handling within the mixing area will be primarily carried out by a dedicated loader with backhoe, collecting the material from where the haulage trucks will deliver the contaminated material, moving it between stockpiles or bays and the treatment beds.

Two separate areas of approximately 4,000m² are required, with each area having the capacity to accommodate two week's volume of excavated loose material. Only one 4,000m² area shall be in operation at any time to accommodate delays in the construction program. Should excavation works become stagnant, the material already within the storage area shall allow cell construction to continue for a further two weeks. Conversely, should construction works become stagnant, the unused second storage area shall allow excavation to continue for a further two weeks. This methodology shall assist with maintaining a smooth construction program.

4.0 Cell Construction

The containment cell design and its construction methodology have been outlined within the CCCDMP. The layout of the cell has been amended from the CCCDMP as a result of further investigations.

In this report, the cell has been located using the following approximate boundaries:

- The existing on-site PCCS road to the south-west
- The Incitec-Pivot boundary to the south-east
- The railway easement to the east and north-east.

The height of the cell is notionally 10m (including a 2m capping layer) above the existing ground level (on average at RL 18.5). This is equivalent to the top height of the existing south-eastern slag mound plus the 2m for capping. The north-western boundary of the cell will be determined by the volume of material to be contained in the cell, but will not extend beyond a line approximately 100m from the PCCS western boundary. Based on the estimated volumes provided above, the cell will have an approximately rectangular footprint of 440m by 485m equivalent to an area of about 21ha (rounded).

The final size of the cell and the final footprint of the cell will be subject to the volume of material excavated from the surrounding areas. These volumes have been estimated on the basis of various surveys conducted by a number of different consultants, all of whom have applied factors of safety. As with all such remediation work, there is some uncertainty related to the final volume of material required to be excavated to permit the areas to be redeveloped for their proposed use. In order to cater for this uncertainty, it has been resolved that the footprint of the cell will not be finalised until the cell is almost complete.

Material is to be placed within the cell only after the following conditions have been met:

- Material is physically suitable for construction (post mixing and treatment as required)
- Material source has been tracked
- Material has been categorised.

Cell construction shall generally progress in a north western direction (refer **Figure 2**) which will have the flexibility to deal with any changes in material volumes requiring containment as work progresses. The construction of the cell is to be completed in stages over a nominal period of 5 years. Construction shall progress continuously with each stage following on from the preceding stage. A boundary adjustment to the west of the cell would address volume changes should initial volume estimations result in an over or underestimation of actual contaminated material.

4.1 Cell Layout

The Cell position is described in this report as remediation Area 11. Principles for the containment cell layout are based on the following:

- Constraints (cost and logistics) related to the stockpile of the lead blast furnace slag 'monolith'. The current location of this mound sets the basis of where the containment cell is to be generally located, as the cell must totally encompass this monolith
- The existence of easements across the PCCS land
- Suitability of the general cell area from a geotechnical basis and hydrogeological suitability
- Cell volume requirements

- Whether the neighbouring Incitec site was to be remediated concurrently with the PCCS site
- Landform optimisation visual appearance
- Surface grades sufficient to minimise infiltration by shedding surface water
- The pattern of drainage for the preferred drainage scheme
- Site constraints such as operational infrastructure
- Compatibility with redevelopment, including constraints on railway levels, grades and access
- Cell access requirements.

Additional operational constraints include:

- The rail line to the North east and East
- The extent of the LBF and Mixed Use Employment Zone to the South West

The Cell will be able to extend to the Northwest if required.

The conceptual layout of the containment cell is shown on **Figure 2** and some typical cell cross-sections are shown on **Figure 9**.

4.2 Cell Construction Methodology

The construction methodology will generally be in accordance with the CCCDMP and will be finalised during detailed design.

4.2.1 Material Placement and Compaction

To ensure stability of the Containment Cell for ultimate development on top of the Cell and for Occupational Health and Safety reasons, material must be placed within the cells under controlled conditions.

A dedicated loader will collect the material from the mixing area and deliver it to the tipping face of the cell. At this point a dozer or grader will be used to spread the material evenly before it is compacted using a padfoot compactor / roller.

It is expected that, after compaction in the cell, the *ex-situ* material may achieve controlled compaction possibly greater than its original 'natural' compaction, and will be reduced back to a volume of 75,000m³ or less in the cell.

Each material will be placed in the appropriate containment cell (as determined by its categorisation as discussed in **Section 3.1.1**) and cover the entire surface of the current area of construction. Material will be placed in layers and compacted in accordance with the design requirements.

Construction of the Cell is likely to follow the following sequential steps:

- a) A drainage layer and leachate collection and conveyance system ('LCCS') is to be placed at the base of the Cell
- b) Materials placement
- c) The conceptual design for the proposed capping for the roof and side walls of the Cell consists of the following layers in sequential order from the contained material upwards:
 - Seal Bearing Layer

- Natural Material Sealing Layer
- Infiltration Drainage Layer
- Revegetation Layer (where required– typically side batters of Cell)
- Hardstand Layer (where required – typically top of Cell) or landscaping.

Contaminated material requiring more conservative controls may require a base liner consisting of the following layers in sequential order from the contained material downwards:

- Leachate drainage layer
- Flexible membrane layer (FML)
- Intermediate bedding layer such as a Geosynthetic clay liner (GCL)
- Natural material sealing layer.

A LCCS will also be placed in the leachate drainage layer for leachate collection of this part of the Cell.

The conceptual design for the proposed capping of this part of the Cell would consist of the following layers in sequential order from the contained material upwards:

- Seal bearing layer
- Flexible membrane layer
- Intermediate bedding layer
- Natural material sealing layer
- Infiltration drainage layer
- Revegetation layer.

No gas collection layer is proposed, as the materials to be confined within both cells will be of an inorganic, non reactive nature, and inorganic gas generation is not expected in either cell.

4.2.2 Potential Acid Generating Materials

Management procedures will be in place during the placement of any potential acid sulphate soil (PASS) which reduces the risk of the acid generating potential of these materials being realised. These management procedures will include minimising exposure to air and water through the use of temporary covers in addition to the implementation of adequate surface water runoff controls.

Where possible, the potential acid generating materials will be placed above the base of the containment cell to minimise the potential for these materials to be saturated following construction of the containment cell.

4.2.3 Construction Working Areas

Exposed working areas are to be limited due to the potential for dust generation and erosion. These areas shall include any mixing and treatment areas, any interim stockpiles, and the construction tipping face. Reducing the area will assist in reducing the capacity requirements for instruments for sediment control and reduce potential dust impacts (both contaminated and uncontaminated). It is anticipated that the construction tipping face will be the larger off the exposed areas.

To reduce the areas exposed during construction works, progressive capping shall be employed. Where possible, as soon as an area of the containment cell has been filled in, capping shall be placed upon the material without waiting for the entire construction stage to be completed before capping of

that stage commences. Staged capping has also been utilised within the CCCDMP and shown in Figure 6.2 of that document.

4.2.4 Imported Materials for Capping

Clean material (either Virgin Excavated Natural Material (VENM) or soils appropriately validated as suitable for capping) will be imported to the site for the purposes of capping the cell.

Due to the overall volume of capping materials required, it is expected that a large volume of these materials will consist of materials imported to site. As such, validation of imported material will be required to ensure it meets the suitability for land-use criteria.

Validation of capping material would be undertaken for the duration of the proposed remediation activities. Due to the staged nature of the works, validation would be carried out on an area by area basis and then as future demand requires on the remainder of the containment cell area, ensuring that future redevelopment of the containment cell area can be undertaken with minimal risk to human health and the environment.

Imported material will be analysed at frequency of at least 1 sample per 1000m³ if sole sourced VENM, otherwise a frequency will be determined based upon the source of material, typically on a load by load basis, if multiple small sources are imported from off site.

4.2.5 Capping Placement

The procedure required to maintain the integrity of the containment cell capping system and validation process requires:

- A survey of each area upon completion of the re-contouring of the site but prior to capping
- Sampling and analysis of placed compacted capping material as per the relevant standards (see **Section 4.3**)
- Cross-referencing truck movements and carrying out visual inspections to ensure that no foreign or contaminated materials are being used for capping (should capping material be imported)
- A subsequent survey of the finished levels to ensure that the capping specification has been met.

As the Cell is to be constructed in stages, in order to minimise water infiltration and run-off, capping will also be performed in stages. This staging is discussed in **Section 6**.

4.3 Cell Construction Quality Assurance

A quality control program will be prepared for construction of the cell, and liner and capping layers, including any placement and compaction trials. All testing will be carried out by a NATA registered laboratory that has current registration for the nominated test procedures.

Construction standards relevant to the construction of the Containment Cell and liner and capping layers shall include, but not limited to, the following:

- AS 1141.11-1996: Methods for sampling and testing aggregates – Particle Size Distribution/Dry Sieve
- AS 1141.12-1996: Methods for sampling and testing aggregates – Materials finer than 75 micrometer in aggregates
- AS 1141.13-1995: Methods for sampling and testing aggregates – Material finer than 2 micrometer

- AS 1141.11-1996: Methods for sampling and testing aggregates – Wet/dry strength variation
- AS 1289.2.1.1-2005: Soil moisture content tests – Determination of the moisture content of a soil - Oven drying method (standard method)
- AS 1289.3.1.2-1995: Soil classification tests – Determination of the liquid limit of a soil - One point Casagrande method (subsidiary method)
- AS 1289.3.2.1-1995: Soil classification tests – Determination of the plastic limit of a soil - Standard method
- AS 1289.3.3.1-1995: Soil classification tests – Calculation of the plasticity index of a soil
- AS 1289.3.4.1-1995: Soil classification tests - Determination of the linear shrinkage of a soil - Standard method
- AS 1289.3.6.1-1995: Soil classification tests – Determination of the particle size distribution of a soil – standard method of analysis by sieving
- AS 1289.3.6.3-2003: Soil classification tests – Determination of the particle size distribution of a soil - Standard method of analysis by sieving
- AS 1289.5.1.1-2003: Soil compaction and density tests – Determination of the dry density/moisture content relation of a soil using standard compactive effort
- AS 1289.5.3.1-2004: Soil compaction and density tests – Determination of the field density of a soil - Sand replacement method using a sand-cone pouring apparatus
- AS 1289.5.4.1-1993: Soil compaction and density tests – Compaction Control Test – dry density ratio, moisture variation and moisture ratio
- AS 1289.5.6.1-1998 : Soil compaction and density tests – Compaction control test – Density index method for a cohesionless material
- AS 1289.5.7.1-1993: Soil compaction and density tests – Compaction Control Test – Hilf density ratio and Hilf Moisture variation (Rapid Method)
- AS 1289.5.8.1-1995: Soil compaction and density tests – Determination of field density and field moisture content of a soil using a nuclear surface moisture-density gauge - Direct transmission mode
- AS 1289.6.1.1-1998: Soil strength and consolidation tests – Determination of the California Bearing Ratio of a soil – Standard laboratory method for a remoulded specimen
- AS 1289.6.7.2-2001: Soil strength and consolidation tests - Determination of permeability of a soil - Falling head method for a remoulded specimen
- AS 1289.7.1.1-2003: Soil reactivity tests - Determination of the shrinkage index of a soil
- AS 2566.1-1998: Buried flexible pipelines, Part 1: Structural Design
- AS 2566.2-2002: Buried flexible pipelines, Part 2: Installation
- AS 3978-1996: Guidelines on earthworks for commercial and residential developments
- AS 5065-2005: Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications.

4.4 Cell Construction Logistics

Each 6 monthly cell construction stage will consist of placing within the cell approximately 112,500m³ of ex-situ excavated material requiring containment, resulting in 75,000m³ (or less, depending on compaction achievements) plus 22,200m³ (rounded) of other existing material (as per Table 2-3).

A dedicated loader will collect the material from the mixing area and deliver it to the tipping face of the cell. At this point a dozer or grader will be used to spread the material evenly before it is compacted using padfoot rollers.

In order to construct the cell using the noted volumes per stage, the following team and equipment will be required:

- One Loader – the loader will be used to transport material between the mixing area and the tipping face of the cell
- One dozer or grader – a dozer or grader will be used to distribute the material evenly at the tipping face, in preparation of final compaction
- Two padfoot compactors / rollers – two padfoots will be required in order to compact the 134,700m³ of loose material over the nominated time period.

In addition to this earthmoving equipment, each “team” will require access to the following equipment, dedicated to that area of cell construction, or shared as required with the mixing and treatment area:

- One water cart for dust suppression
- One refuelling / maintenance vehicle for equipment maintenance.

5.0 Subsurface Water Control Measures

Groundwater flow direction within the vicinity of the site is similar to topographic gradient directions and generally towards the north-west. Contaminant screening has indicated that both the shallow and deep aquifers are impacted by a variety of contaminants produced by smelter operations, with the highest contaminant concentrations reported in the shallow aquifer. Subsurface water control measures have been focused into three areas:

- Permanent down-gradient capture and up-gradient interception of the containment cell footprint
- Interim down-gradient capture at the South West Dam
- Interim down-gradient capture at Hawkes Dam.

Interim capture of the groundwater at the down-gradient boundaries of the PCCS site (i.e. at the South West and Hawkes Dams) provides assurance that the likelihood of contaminated groundwater migrating off site is reduced during the remediation works. These groundwater capture locations are proposed to provide contingency measures for groundwater leaving site until the site is remediated and the cell subsurface water control measures are installed. The following sections outline the methodologies proposed to be undertaken for each of the sub-surface water control measures.

5.1 Containment Cell Subsurface Water Control Measures

Sub surface water control measures surrounding the containment cell structure have been proposed with the aim of:

- Preventing water groundwater ingress from up-gradient, hence minimising the generation of leachate within the containment cell
- Cutting off and collecting water generated from within the containment cell mass and underlying soils, to prevent this from further migration on site and ultimately off-site.

The proposed water control measures are grouped into two types:

- Up-gradient Measures – a cut-off wall keyed into bedrock along the eastern boundary of the cell complex accompanied by a drainage trench to direct the groundwater away from building up against the wall. A runoff diversion bund is also to be located immediately up topographic gradient of the cut-off wall / interception drain for the surface water
- Down-gradient Measures – a drainage trench excavated to the top of bedrock along the downstream perimeter of the cell complex and an internal perimeter drain.

The following sections detail the outline of the works program for the installation of sub surface controls as part of site remediation works.

5.1.1 Up-gradient

Based upon groundwater modelling performed by Access-UTS, (July 2005), an up-gradient groundwater cut-off barrier and interception drain is proposed to intersect the shallow aquifer. The cut-off wall is currently proposed to key into bedrock or go to a depth of approximately 6m below the ground surface.

It may be necessary for the wall to extend below the top of bedrock to restrict potential for groundwater seepage under the wall through the upper level of the sedimentary rock into the contaminated material

through this zone. The need for this will be considered in the detail design taking into account the currently anticipated very low groundwater flows.

Subject to water quality testing, the captured groundwater will be either directed to the effluent treatment plant or diverted for reuse or off-site discharge.

The proposed layout and extent of the up-gradient cut-off barrier is shown in **Figure 8**. This would require modification during detailed design and/or construction phases to reflect the actual volume and footprint of the containment cell.

A cross section of a typical design for a cut-off wall that may be used with this type of application is shown in **Figure 8**.

5.1.2 Down-gradient

The potential sources of water for the groundwater-sourced leachate would generally be:

- Lateral groundwater flow through the shallow aquifer
- Rainfall infiltration through the completed cap
- Release from storage inside the containment cell (either through compaction or reduced recharge, according to transient conditions).

It is therefore proposed to install a down-gradient seepage water collection trench to collect all seepage water flowing beneath the containment cell. The trench will be of high permeability, which will then allow all collected water to be extracted, pumped and treated by the ETP in operation.

The collection trench is still subject to detailed design and construction. The layout of the collection trench will be finalised and constructed when cell construction has been completed and the footprint of the cell is finalised. The preliminary layout and extent of this collection trench is shown in **Figure 8**.

A cross section of a typical cut-off trench that may be used in this type of application is also shown in **Figure 8**.

5.2 South West Dam Subsurface Water Control Measures

For the South West Dam, strong capture of groundwater is achievable with a system comprising three wells, approximately 30-40m apart, screened in the shallow aquifer. The three wells are proposed to be located in a linear structure immediately down hydraulic-gradient to the dam.

5.3 Hawkes Dam Subsurface Water Control Measures

For Hawkes Dam, strong groundwater capture is achievable with a network of three wells screened in the shallow aquifer, spaced evenly and aligned linearly, down-gradient of Hawkes Dam. As low permeability materials occur in this area, significant drawdown is required to achieve sufficient groundwater capture and prevent potential groundwater migration off site between the wells.

6.0 Staging

6.1 Outline of Staging Plan

The site has been divided into 11 different areas, with the areas designated or titled typically by its future use. Of the 11 areas, nine will be subject to excavation and validation in order to make the sites suitable for development as either residential or industrial land with the remaining area hosting the containment cell (Area 11) (**Figure 1**). The nine areas to be excavated and validated have been prioritised in the nominated order based on current views as to their development potential (see Section 1.4, Table 1-1).

For the purpose of this report, it is proposed to excavate and validate each area sequentially in a predetermined order. Cell construction will occur concurrently with the remediation, with some of the excavated material subject to an intermediate mixing or treatment process, before being deposited in the Cell. A number of existing internal roads will be used as haul routes and a number of temporary haul routes will be established to cater for the future use of the site. Ancillary activities including backfilling, importation of capping material and preparation of a remediated site for development will also be conducted concurrently with the remediation and cell construction.

While it is proposed to remediate each site individually in order of priority, it may become necessary to remediate and validate the area in a different order or to remediate multiple sites at a single time. In this event, the potential impacts resulting from the remediation activities, including dust, noise, use of haul routes and the impact on adjacent sites may need to be reassessed.

6.2 Staging Excavation and Validation

It is proposed to remediate each area of the site individually, and in order of priority over a nominal period of 5 years as per **Figures 3 and 4**. This program allows for a number of factors including:

- Allowing sufficient time for excavation of the “approximate volumes” from each given site with flexibility and some contingency
- The remediation of materials outside of the allotted areas, where the material is dispersed such as the community soils
- The time required for regulatory and planning approval process
- Allowing surrounding areas to become available and be included in the remediation and redevelopment program.

Given that each of the site areas contain different volumes of contaminated material, the timeframe to remediate each area will vary. The areas will be remediated successively as per their remediation order, resulting in several areas being remediated both during, and between, the six monthly stages. That is, the stage(s) during which the remediation of a site area shall occur depends upon the rate of excavation/treatment/construction, rather than their nominated order of remediation.

Site Area 1, for example, will require approximately 5.4 weeks to remediate (plus time for validation, auditor sign off, temporary site stabilisation etc) and Site Area 2 will require approximately 27 weeks (plus time for validation, auditor sign off, temporary site stabilisation etc). This timing results in Site Area 1 being remediated within Stage 1 (months 1-6) and Site Area 2 being remediated partially within Stage 1 and completely over Stage 2 (months 7-12).

Presently, the timeframe for remediation is shown in **Table 6-1**.

Table 6-1 Timeframe for remediation of areas

Area	Title	Timeframe for Remediation (Months from Approval)
1	Cardiff West Estate	1 – 4
2	Triangular Paddock South	4 – 11
3	Railway Employment Zone	13 – 18
4	Triangular Paddock North & Main Entry Precinct (formerly Superlot 5A)	19 – 26
5	Boolaroo Heights	25 – 30
6	Munibung Hill Residential	25 – 36
7	Munibung Hill Industrial	33 – 37
8	Boolaroo North (formerly Superlot 5B)	33 – 42
9	Cell Surrounds	37 – 48
10	Mixed Use Zone	43 – 48

As previously discussed (**Section 2.4.1**), it is recommended that the exposed area for excavation be limited to 3ha to allow control of dust generation and erosion. This area will include all exposed areas across both single and/or multiple sites, and will allow the extent of exposed area to be predicted using the proposed staging plan.

Brief details of each Site Area as to their order of remediation are as follows:

- Area 1 – The Cardiff West Estate is an outlying site with its proposed use as an industrial site to complement the neighbouring industrial estate. As this area is on the edge of the remainder of the site and has a different catchment, it is unlikely to be contaminated by future remediation activities and it is anticipated that little contaminated material will be encountered
- Area 2 – The Triangular Paddock “South” is an outlying area, with the division of the area to allow the building a new road to divert traffic around the site property
- Area 3 – The Railway Employment Zone, Munibung Hill Residential and Munibung Hill Industrial are outlying areas, and will have no significant infrastructure onsite
- Area 4 – The Triangular Paddock North & Main Entry Precinct will complete remediation along the northern and western extents of the site
- Area 5 – The Boolaroo Heights area will continue the concentric remediation direction towards the proposed cell layout in accordance with the proposed future site development plan
- Area 6 – The Munibung Hill Residential area will continue the concentric remediation direction
- Area 7 – The Munibung Hill Industrial area will continue the concentric remediation direction
- Area 8 – The Boolaroo North area contains the existing effluent treatment (ETP) plant, which is required to remain in use until the future ETP located in Cell Surrounds (Site Area 9), is operational. The existing ETP will be decommissioned once the new ETP is built and commissioned for use
- Area 9 – The Cell Surrounds area will contain the future ETP and is required to succeed the Boolaroo North area to enable the future ETP to be operational and the completion of Boolaroo North
- Area 10 – Mixed Use Zone is the last remaining site area with its close proximity to the final cell layout allowing short transport distances.

6.3 Cell Construction Staging

As described earlier, the final footprint of the cell will not be determined until the cell is almost complete.

The staging for construction has been modelled using the current estimated volumes. However this may be subject to amendment throughout the detailed design phase, as the ongoing excavation provides an up to date indication of the accuracy of these volumes.

The rate of construction shall be directly dictated by the rate of excavation and mixing/treatment. The cell will need to be completed and validated as an appropriate containment solution as the final area is being validated and deemed suitable for redevelopment.

The cell will be constructed over five years (in accordance with the methodologies outlined within the CCCDMP). Filling will commence around the existing LSF monolith and will progress as per the construction staging plans in **Figures 5 and 6**.

The mixing and treatment of material will be conducted within the cell footprint to minimise the area requiring remediation and to allow the mixing and treatment to be conducted until the end of cell construction. The area used for mixing will consist of a mobile stockpile, with contingency to allow construction to continue for a week in the event that excavation ceases. In addition, the stockpile will have contingency to allow for an additional week of storage in the event that construction ceases. Therefore, there will be a storage area suitable for containing two weeks of material but generally 50% full.

The initial placement of materials will essentially surround the blast furnace slag monolith. This is seen as an immovable feature of any cell configuration and, as such, commencing with the placement of materials around this feature will provide the greatest flexibility for the final layout of the cell. It is also expected that any screening of the Black Sands will be carried out and completed during this stage such that any ISF slag to be contained within the cell may be used in the drainage layer of the LCCS of the Cell (subject to leaching tests).

The subsequent stages of the construction of the Cell would commence working in a north-west direction away from the blast furnace slag monolith. While staging of cell has been based upon the current material volumes, should these volumes be found to change during excavation processes the actual timing of construction stages, and the north-western Cell boundary, could be altered quite readily due to the proposed construction methodology.

The batters of the Cell have been designed with a slope of 1:5 to allow for stability and access. This slope will still ensure the LBF monolith is contained within the cell. Intermediate batters between stages can be steeper than this, subject to stability assessment during construction.

6.4 Subsurface Water Control Measures

6.4.1 Containment Cell

To ensure their effectiveness, the location and design of sub-surface water control measures cannot be finalised until the final cell footprint is determined. Construction of the groundwater cut-off wall and collection trench shall be undertaken in conjunction with the completion of the final segment of the containment cell. This will allow for alignment adjustments of the wall/trench should the final containment cell layout change during the project's construction lifetime. Groundwater characteristics and movements will be reassessed post-construction and the wall/trench alignment adjusted accordingly.

6.4.2 Hawkes and South West Dams

The groundwater collection wells associated with Hawkes Dam and the Southwest Dam boundaries have already been installed in advance of the site remediation commencement.

6.5 Constraints and Assumptions

There are a number of constraints and assumptions related to the staging plan in its current form including:

- The rate of construction will be dependent on the rate of excavation and the rate of processing at the mixing/treatment area
- The rate of handling at the mixing point is dependent on the space available and the condition of the material when it arrives there
- The operational rates and availability of personnel, various plant, machinery, vehicles and equipment
- The order of staging is dependent on having access to the various areas
- The space in which construction is possible as it may place a limit on the amount of equipment in use during construction
- The allowable exposed operational area for excavation, and mixing and treatment (to be determined), which is dependent on the degree of dust generation and will be influenced by the efficiency of dust mitigation measures and weather and seasonal conditions
- Haul routes will be free of public traffic where possible, minimising the risk to the public and to allow the most efficient use of the roads
- The area exposed during excavation, mixing and construction will be limited by the resultant impacts at the relevant sensitive receptors.

6.6 Site Logistics and Vehicle Movement

Vehicle movements around the site will consist of:

- Haulage of contaminated material
- Transportation of plant and equipment between sites
- Haulage of backfill / capping material
- Water carts
- Staff vehicles.

Site access is to be in accordance with the site's safety policy and NSW Occupational Health and Safety Act (2001) and associated Regulations.

Once on the site, it should be possible to use the many internal roads and access points and avoid using public roads unless absolutely necessary. A number of internal routes have been nominated on the Staging Plans (**Figures 3 and 4**). These are nominal and have been based on apparent accessibility from an aerial photograph. The use of internal routes would also minimise the impact on surrounding sensitive receptors.

In a number of instances, specifically the remediation of Cardiff West and the Munibung Hill Residential Estate, access can be made directly to the containment cell by crossing the rail line (branch line).

Where public roads are to be used, such as for staff access or the importation of material, site access points and thoroughfares for construction machinery will be located as far away as possible from sensitive receivers.

All drivers entering a remediation area will be required to be inducted. This induction will include site traffic procedures.

Flexibility of construction is also an important design aspect of the material excavation and cell construction. Working of multiple areas simultaneously can allow adverse potential impacts (e.g. excess dusty or wet conditions) to be successfully managed. This will allow provide a greater flexibility in the timing of works and accordingly assist in meeting the proposed staging plan.

7.0 Site Management During Construction

7.1 Objectives for Environmental Management

The objectives for environmental management during construction are to:

- Contain sediments on site, particularly the control of contaminated sediments
- Prevent the occurrence of cross contamination of sediments by overland movements, which may potentially impede site remediation efforts
- Reduce the release of potential pollutants, which may result in risks to human and ecological health.

Reference documents to be consulted for the management of environmental issues include:

- NSW State Legislation:
 - Protection of the Environment Operations Act 1997
 - Soil Conservation Act 1938
- Other:
 - NSW Department of Land and Water Conservation (DLWC) – Urban Erosion and Sediment Control
 - ANZECC Guidelines for Fresh and Marine Water Quality, 2000
 - Landcom – Managing Urban Stormwater, Soils and Construction, 4th Edition, March 2004.

The sections below define environmental controls which may be implemented during the excavation and cell construction phases of the remediation clean up program. It should be noted that groundwater control measures are discussed in **Section 5**.

7.2 Erosion and Sediment Controls

Prior to construction of each stage a detailed erosion and sedimentation control plan (ESCP) will be prepared and implemented. The plan may be developed with input from the construction contractor in order to ensure it meets the dual objective of construction and environmental protection.

The following sections detail erosion and sediment control practices which may be used to implement erosion and sediment management across the site for differing remediation activities.

7.2.1 During Excavation

The following lists some erosion and sediment control practices which may be implemented during excavation works:

- Provision of silt fencing, as appropriate, along site boundaries
- Sediment socks within drainage lines to capture sediment entrained within site runoff prior to entering the stormwater system
- Temporary erosion and sediment control structures to be retained until the land has been successfully stabilised
- Clean upstream runoff to be directed towards the existing drainage system via the use of diversion banks and catch drains
- Construction of perimeter V-drains along site boundaries, where feasible

- Temporary (or possibly permanent) sediment basins where required designed in accordance with DEC's "Managing Urban Stormwater" manual
- Topsoil to be placed and revegetated as early as possible at the completion of earthworks.

7.2.2 Cell Construction

The surface water control measures will be designed to:

- Separate clean up-gradient surface waters from coming into contact with the capping cover material in the containment area
- Reduce water infiltration within the containment cell area.

Surface water will be managed throughout construction is proposed to consist of the following control measures.

Up-gradient Surface Water Control Measures

The following lists erosion and sediment control devices and practices which may be implemented upstream of the cell construction works:

- Construction of a runoff diversion bund located immediately up topographic gradient of the ground water cut-off wall. The height of the bund will be sufficient to divert the flow from a peak storm event and drainage measures will be in place to prevent ponding of water against the bund for extended periods (say for greater than one hour after the end of a rainfall event). The extent of the bund will be sufficient to prevent ingress of surface water from outside the containment facility and will be capped with low permeability material to prevent infiltration of surface water into the groundwater being collected in the drain
- Diverted water to flow to existing dams for retention and sedimentation into the existing site stormwater handling system
- During detailed design, alternative dams may be constructed and channels diverted accordingly
- As remediation of the site progresses, revegetation of sections of the upstream catchment will be undertaken. Sections where runoff water is retained within these revegetated drains and is kept separate from waters having come in contact with the containment cell may be treated as clean water catchment. This will allow this clean runoff water to be released from site without requiring treatment.

Down-gradient Surface Water Control Measures

The following lists erosion and sediment control devices and practices which may be implemented downstream of the cell construction works:

- All surface water runoff from the cell area, both capped and uncapped, will be collected with leachate and directed to a collection pond
- Construction of an internal perimeter surface water drain to collect all surface water running off the capping and uncapped working surfaces during the construction of the cell. The perimeter drain will cover the entire perimeter of the containment facility and be graded to allow collection of surface water without significant ponding at the northern corner of the facility
- Channelling of the surface water to a collection pond along with contaminated groundwater. The water collected in this pond will then be directed to the existing treatment plant. The existing system caters for all surface water that falls on the PCCS site and as such is adequate to handle the volumes expected during construction. Throughout the construction of the cell, the existing effluent treatment plant will be utilised to treat any such water prior to discharge off-site under the existing EPA Licence

- Areas of uncapped materials will be kept to a minimum by progressive capping of the cell in stages. The areas that are not capped will consist of materials that have been compacted into place and as such will minimise the potential passage of rainwater infiltration. Other measures to counter infiltration can be used, such as flat drum rolling of the surface to create a smooth top which will shed water, rather than have it penetrate into the materials and having this surface graded to a re-workable slope to assist with water runoff. Any water that seeps from emplaced materials or comes into contact with uncapped emplaced materials or remedial working areas will be regarded as contaminated leachate
- Management techniques to reduce runoff velocity and sediment movement. For example the use of a spiral type pattern for the drains around the cell to reduce slope steepness and increase slope length.

7.2.3 Stockpile Management

The following lists some erosion and sediment control practices which may be implemented in the vicinity of stockpiled materials:

- Any movement or disturbance of the geomembrane cover from the ISF slag stockpile must have appropriate measures in place to ensure the minimisation of dust generation from the stockpiles, limit potential rainfall infiltration and minimise the potential for erosion and transport of slag and other material from this area
- Bunds around stockpiles which direct water flow away from stockpiles
- Stockpiles will not be established on slopes greater than 2:1 (horizontal to vertical)
- Care will be taken to ensure that stockpiles do not exceed the quantities and requirements specified for “extractive industries” as outlined in Schedule 1 of the POEO Act, otherwise an Environmental Protection Licence from the DEC may need to be sought
- The stockpiling of surplus material will not be undertaken during heavy periods of rainfall
- Stockpiles will be located away from natural flow paths and a minimum of 40m from a watercourse
- Stockpiles will not be located within 5m or under the canopy of a tree that is to be retained
- Temporary erosion and sediments control structures will be placed around stockpiles to reduce erosion.

7.2.4 Haul Roads

Haul roads will be nominated and/or established and designed to minimise surface disturbance and movement of sediments across the site.

Further, a stabilised site exit point for vehicles will be built to prevent the tracking of mud and loose sediment onto sealed roads. Wheel cleaning facilities and daily sweeping activities may also be implemented to remove any materials deposited on public roadways.

7.3 Dust Management

The following sections detail control practices which may be used to minimise dust emissions and limit impacts to local air quality during remediation activities.

Guidance on the management of fugitive lead dust particles has been considered from the National Pollutant Inventory (NPI) guidance documentation, Emission Estimation Technique Manual for Lead Concentrating, Smelting and Refining. This Manual describes the procedures and recommended approaches for estimating emissions from facilities engaged in lead concentrating, smelting and refining (Environment Australia, 1999).

Within the scope of the Manual is management of dusts from the movement of materials processed. Dust management techniques proposed are consistent with guidance as detailed in the Manual.

Reference should also be made to site specific controls and monitoring requirements as detailed in the **Specialist Environment Reports** (separately reported).

7.3.1 Extent of Potential Dust Generation

During dry conditions, on-site activities associated with the PCCS remediation works have the potential to generate dust. The following activities are those identified as a specific potential source of dust generation:

- Earthmoving activities and excavation. This will include the activities associated with loading, tipping and scraping
- Movement of vehicles and construction machinery, both within and off the construction site
- Stockpiling of materials
- Transportation and movement of slag into the containment cells
- Build-up of material around erosion and sedimentation controls
- Mixing of excavated materials prior to emplacement into the containment cells
- Compaction during cell construction and material placement.

7.3.2 Dust Controls

Particular care must be taken to address the release of lead particles in fugitive dust emissions, particularly from excavation, transportation and deposition of slag stockpiles into the containment cells as part of the PCCS site remediation works. There are potential significant risk to human health issues associated with the release of lead particles due to inhalation, ingestion and absorption of lead from the dust fall out into the air.

The following points identify specific controls and approaches that may be implemented to minimise impacts from excavation, transportation, wind erosion, stockpiles and vehicle emissions:

- Water-carts made available at short notice for use during periods of high dust generation
- If dust cannot be adequately controlled then activities generating dust are to cease until appropriate controls can be implemented
- Areas stabilised progressively during construction
- All plant maintained regularly to ensure its optimum operating levels and minimise pollutant emissions. Exhaust systems of construction plant vehicles and machinery to be properly maintained in accordance with manufactures specifications to ensure exhaust emissions comply with the POEO Act and any associated regulations
- Minimising the number of working faces on stockpiles
- Stockpiles may be temporarily covered or sprayed with water / crusting agent (example Polo Dust Bind) to keep dust to a minimum. The covering of stockpiles is particularly relevant for lead contaminated soils. A polyethylene geomembrane or HDPE liner may be used
- All vehicles on site be confined to designated roads with designated speed limits where possible
- Prevent mud tracking onto public roads that may ultimately generate dust (with stabilised site access, cattle grids, wheel wash-downs etc)
- Trucks immediately covered after being loaded and tailgates be effectively sealed prior to leaving site
- Trucks will be thoroughly dry-brushed prior to exiting the site to remove any excess dust/material that may be deposited on external roads

- Use of scalpings, crushed concrete or coarse aggregate for construction haul roads, use of spray seal where practical.

It is also noted that there are proposals to develop a remediation buffer zone “along any boundary of a development area that is adjacent to an unremediated area of the PCCS site” (Fitzwalter Group (b), 2005).

7.4 Noise Management

Ancillary to the required PCCS remediation works will be noise generated from plant and equipment. Reference should also be made to site specific controls and monitoring requirements as detailed in **Specialist Environment Reports** (separately reported).

The following outline specific controls and approaches that may be implemented to minimise noise impacts:

- Limitation of working hours, for example, adherence to the construction hours as specified in the EPA Noise Control Guidelines
- Site access points and thoroughfares for construction machinery routed as far as possible away from sensitive receivers (residential areas of Boolaroo, Macquarie Park)
- Whenever practical, at the end of shifts, excavation plant may be taken from their work areas and left overnight away from the immediate vicinity of sensitive receivers. Warming up of the plant in the morning would then be conducted away from such receivers
- Mobile plant such as excavators, front-end loaders and other diesel-engine equipment may be fitted with residential class mufflers where necessary
- Plant and machinery will be regularly maintained
- Where feasible and reasonable, plant layouts and equipment movements will be designed to minimise the need for reversing alarms. Other mitigation measures will also be considered, including the use of “smart reversing” alarms, which adjust the volume according to the background noise, “white-noise” alarms whose noise emissions decay quicker than normal tonal alarms, or their outright replacement with strobe lighting. In considering these possible measures, the safety of workers on the project will not be compromised.

7.5 Other Environmental Controls

7.5.1 Potential Other Pollutants

There is potential for pollutants other than sediments to enter local waterways. These include:

- Gross litter
- Oil, grease and fuel from motor vehicle use within the work area
- Nutrients from fertilisers, herbicides and pesticides used in landscaping during site reinstatement
- Previously undiscovered contaminated materials.

Controls for other pollutants might incorporate the following:

- Separate construction waste, general rubbish and recycling bins provided and workers encouraged to separate construction waste from general rubbish and recyclable material. Rubbish and recyclable material will be collected on a regular basis and disposed to an appropriately licensed authorised waste management facility

- All spills to be cleaned up immediately using a spill response kit and absorbent material and disposed of in accordance with EPA guidelines
- Routine inspections will be carried out to ensure that all wastes are being disposed correctly and the site is kept clean at the end of each day
- Should liquid chemicals be used, then storage will be minimised onsite as far as possible. Any liquid chemicals required onsite are to be stored within bunded areas capable of containing 120% of the largest container and 25% of the total volume of all combined containers. Storage areas are also to comply with any WorkCover OHS licensing requirements
- In order to prevent materials leaking from static plant, such as pumps and generators, contaminating the ground and being washed into the drainage system, static plant will be placed on drip trays
- All maintenance on equipment will be undertaken in a designated area specifically designed to contain all chemical, fuel, and oil spills.

7.5.2 Unanticipated Materials

Contaminated Soils

During remediation excavation works, should any materials of a suspect nature be encountered by visual, olfactory or field screening techniques, these materials will be excavated, stockpiled in a separate area and appropriate measures taken to avoid/minimise cross contamination e.g. washing equipment, stockpiled and covered, water/dust control measures. These materials will then be analysed for suspect contaminants of concern, and the appropriateness of the control measures confirmed.

Hydrocarbons

Other contaminants, such as Total Petroleum Hydrocarbons of greater than C10 chain length, Polycyclic Aromatic Hydrocarbons or other compounds potentially incompatible with existing emplaced materials or with capping/liner materials will require isolation and treatment analysis for compatibility with materials contained within the cells. If they are found to be unsuitable for cell emplacement, options for treatment and/or disposal will be investigated. The first preference would be to investigate on-site treatment options to allow for these materials to be rendered compatible with containment cell materials and then be emplaced within the cell. If this is not found to be possible, then off-site treatment and/or disposal options will be investigated.

Volatile Organic Compounds

If significant volatile organic compounds (VOCs) are encountered during excavations on-site, these may have the potential to affect the integrity of the containment cell lining materials and as such are required to be handled separately. Initial soil treatment strategy would comprise an in-situ investigation of the extent of proposed excavation locations in an attempt to delineate and quantify the volume of material. Depending upon the type and concentration of VOCs, this material can then either be landfarmed / bioremediated to reduce VOC levels, or off-site treatment and/or disposal options could be investigated.

7.6 Management Plans

7.6.1 Occupational Health and Safety

A detailed site Occupational Health and Safety Plan (OHSP) will be prepared for remedial works at the site in order to protect workers at, and visitors to, the site as well as people in surrounding areas.

The site-specific OHSP, to be written after the completion of the detailed design or during the remediation planning activities will include at least the following:

- Hazard identification and control
- Risk Management
- Safe Work Method Statements
- OHS monitoring for impacts of concern
- Chemical hazard control
- Materials handling and decontamination procedures
- Personal protective equipment requirements
- Work zones
- Incident reporting
- Induction and site specific training
- Emergency contact numbers.

The OHSP for the remedial works will comply with all relevant safety regulations.

Where it is demonstrated that there is potential for site workers to be exposed to potentially harmful materials, all practicable steps will be taken immediately to control exposure:

- Areas of high risk will be isolated and secured from general worker access
- Activities resulting in the release of any airborne contamination will cease
- A temporary soil cover can be placed on asbestos containing material in soil that presents a high risk of airborne fibre release and that cannot be immediately removed or is considered more appropriate to remain in-situ
- A temporary soil cover can be placed on odorous material in soil that cannot be immediately removed or is considered more appropriate to remain in-situ
- Warning signs will be provided at access points to high-risk areas.

The OHSP is also to recommend that all site employees participate and comply with the health surveillance program of the PCCS site for possible health issues such as lead in blood risks. Details of the surveillance program will be outlined during the planning of the detailed design phase of the project.

7.6.2 Construction Environmental Management Plans

A Construction Environmental Management Plan (CEMP) will be a contractual requirement for any contractors employed on site during the earthworks and cell construction phases of the project. The CEMP will detail site-specific measures aimed at controlling and minimising soil movements and pollution incidences on the site.

Environmental Monitoring

All discharges from the site must conform to the Environment Protection Licence issued to PCCS. As such, an environmental monitoring regime will be established in the CEMP for the construction phase. The following provides some considerations in relation to environmental monitoring requirements during remediation works:

- Relevant water quality objectives will be confirmed

- Dust monitoring will need to be conducted to assess whether dust levels associated with construction works are kept below dust guidelines. Issues regarding dust generation are two fold, as the first is the standard level of dust generation permitted, with the second regarding the presence of lead levels in the contaminated materials
- Sensitive receivers will need to be identified to enable noise monitoring to be conducted. Noise levels will be in accordance with appropriate noise management requirements
- Validation will be undertaken throughout the proposed site remediation program for each remediation area.

8.0 Overview of Future Requirements

8.1 Effluent Treatment Plant

The timing for the new treatment plant will be dependent upon the timing for the remediation of the area of the Site that the existing effluent treatment plant (ETP) is located on, thus requiring its decommissioning.

It is proposed that the effluent stream from the new treatment plant eventually be disposed of to a new sewer connection, under a trade waste agreement with Hunter Water. Up until this time, the treated effluent may be used for dust suppression or a source of water during macro encapsulation or to ensure optimum moisture content during compaction of material. When water is no longer required for these purposes, effluent will be discharged into sewer. Hunter Water will set the discharge criteria for the effluent at this point in time as well as a required sampling regime.

Sludge produced by the plant will eventually need to be disposed of at a licensed disposal facility. However, during the construction of the cell, the sludge may be included in the material to be contained within the cell. The quantities of sludge to be produced by the new treatment plant will be determined by its design and the concentrations of the water it treats. As a guide the existing ETP on the PCCS site produces approximately 1,500m³/month of sludge in treating approx 1,500m³ of effluent/day from the un-remediated site. The new containment system is estimated to capture a maximum of 230m³/day predominantly from upstream of the cell, but including downstream leachate. Additionally, the levels of contaminants in the combined water and leachate to be treated are expected to be significantly less than those for the existing site since the Site will be progressively remediated. When the cell is completed, it would be expected that the combined effluent concentrations will continue to reduce over time.

When the effluent treatment plant has been decommissioned, a smaller, dedicated plant would be required to be constructed near the base of the cell system. By this stage, only fairly small volumes of leachate from within the containment cell are anticipated based upon the low moisture content of the emplaced materials and the sealing by capping layer from rainwater infiltration. This dedicated plant however, shall be required to handle leachate from the Cell, as well as from groundwater controls (such as boreholes used for monitoring) around the site. The plant would be designed and constructed based upon leachate quality data gathered during construction of the cell by the pumpout and monitoring for the existing smelter surface water plant. It is expected that any leachate generated at this stage, would require fairly simple treatment, such as by pH adjustment, flocculation, settlement and filtration which are fairly widely used technologies and relatively easy to install and manage.

8.2 Ongoing Management Overview

Post Construction Management (PCM) of the site will also consider the possibility for future development post remediation. In particular, PCM is required to consider:

- Groundwater monitoring
- Leachate management
- Surface and stormwater management
- Management of capping
- Revegetation management
- Corrective actions as necessary.

Groundwater monitoring

Baseline groundwater data will be established with a network of piezometers and sampling wells prior to the commencement of various site area remediation works. Validation will be undertaken throughout the proposed site remediation program for each remedial area, beginning with further collection of groundwater data in advance, during and following containment cell construction works. This information will be regularly compared with the modelling predictions and to help with ongoing calibration of the groundwater model. Ongoing groundwater monitoring will be undertaken in accordance with the groundwater monitoring plan.

As the quantity and contamination levels of the leachate are expected to decrease over time, it is expected that long term trends in groundwater quality will be established which demonstrate that the containment area has no impact on groundwater quality. Once this is demonstrated, it would be proposed that a reduced frequency of groundwater sampling and a reduced suite of contaminants analysed during monitoring be undertaken.

Leachate Management

Leachate management will involve pumping leachate from sumps within the collection trench of the containment Cell. Initially, the leachate will then be pumped directly to the ETP for treatment in operation at the point in time. The capacity of both the existing and proposed future ETPs is far in excess of the orders of magnitude of leachate estimated to be generated. The effluent quality from the ETP will be acceptable for discharge under the current EPL, with the possibility of a future discharge criteria update during the EPL's annual renewal.

The leachate treatment system will be designed with spare capacity (as necessary) to cater for other contaminated groundwater emanating from other parts of the site.

Pipework in the cell and leachate system has been oversized for a conservative approach to allow for potential fouling, and consequently it is anticipated that inspection should only be required on a 2-5 year frequency. This frequency may be altered when a reliable history of leachate flows is established. The system will still be designed to allow easy access for inspection by CCTV on a regular basis if required. The pipe network would be installed to allow cleanout of leachate pipes via electric eel or high pressure water blasting. The LCCS will extend to the sides of the containment cell to enable easy access for the collection system maintenance equipment. All pits required for maintenance should be designed in accordance with OH&S requirements to allow access for inspection.

Surface Water Management

Surface and stormwater management will continue to focus on isolating contaminated (or potentially contaminated) runoff from clean water runoff. Diversion drains will be constructed diverting clean water runoff around the cells. Runoff from capping material will be diverted in to the clean water diversion channels. These channels will be directed either to sumps where it will be pumped to a stormwater holding pond, or directly to the holding pond itself. The water will then be taken to the existing treatment plant on site for treatment after which it will then be ready for further uses or disposal.

Revegetation and Surface Management

During the conceptual design of the site, issues of future maintenance were taken into account. The size and slopes of drainage lines and bunds were designed for both aesthetics as well as practicality of future maintenance work. Such current design features generally include:

- Internal drainage lines at 2.5m width. This will allow vehicular access (i.e. slasher) along the drainage lines

- Bund batter slopes at 1:4 to allow grass slashing latitudinally along the bund
- Top of bund at 5m width to allow vehicular access to avoid using a drainage line as access road to travel around site. A 3% grade sloping towards the internal drain also assists with managing surface stormwater runoff.

A further possible long term solution may be to create a bench-step layout for the for the revegetation layer of the cell. This is thought to provide a more natural looking view of the site. The width of the benches would be approximately 5m to allow access for grass and tree maintenance vehicles to ensure the site can be easily maintained.

Once works are complete and the site is in post construction stage, it is important that the site be revegetated properly. Any suitable topsoil valuated to the DEC open parkland health investigation criteria removed during construction phases will be placed over the area, along with any available vegetative matter. Local native trees and shrubs will be planted at appropriate spacings over the revegetation area. Revegetation will be selected based upon the requirement of having shallow root systems so as to not penetrate past the revegetation later of the capping.

Revegetation will commence as soon as practicable after completion of construction, with the works being undertaken by qualified and/or experienced bush regenerators.

In addition to the revegetation plan addressing aesthetical aspects of the site remediation, the plan will also focus on a long term stability to ensure the regular maintenance required is kept to a minimum. The native flora to be chosen will aid in attaining this goal.

9.0 Conclusions

The Pasmaico Cockle Creek Smelter (PCCS) is currently the subject of a Remediation Order by the NSW Environmental Protection Authority, with the preferred remediation approach being excavation and containment.

A conceptual design for this approach was prepared by Responsive Environmental Solutions (March, 2005). In order to investigate the technicalities relating to this option, and to confirm its feasibility and suitability, Maunsell were commissioned to prepare a Conceptual Containment Cell Design and Management Plan (CCCDMP) (September 2005).

It is intended that the content of this report will be used in the Environmental Assessment, which is required for the remediation (including the construction and use of a containment cell for long term entombment of contaminated materials). The preparation of the Environmental Assessment is required under Part 3A of the Environmental Planning and Assessment Act 1979. General and key assessment requirements are included in the Director General Requirements (DGRs) for the Environmental Assessment, dated 22 December 2005

This report has addressed the requirements of the DGRs and defined the proposed remediation works outline, setting the stage for detailed design and subsequent remediation, validation and redevelopment of the PCCS.

10.0 Limitations of Use

Site contamination is generally a product of man-made processes and therefore exhibits characteristics and properties which vary from place to place and can change with time. Contamination assessments involve gathering and assimilating limited facts about these characteristics and properties in order to better understand or predict the status of contamination on a particular site under certain conditions.

The facts reported and utilised in this document may have been obtained by inspection, excavation, probing, sampling, testing, and other means of investigation or from the client. They are directly relevant only to the ground at the place where and time when the investigation was carried out. Any interpretation or recommendation given in this report is based on judgement and experience and not on greater knowledge of the facts than the sources of information indicate. The interpretations and recommendations are opinions provided for the sole use by the Client identified on the cover sheet and in accordance with a specific brief. Maunsell does not represent that the information or interpretation contained in this document address completely existing features such as surface and subsurface contamination, groundwater and geotechnical conditions or ground or contamination behaviour on the subject site.

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Figures

Figure 1 – Site Plan

Figure 2 – Cell Layout

Figure 3 – Excavation Staging Plan 1

Figure 4 – Excavation Staging Plan 2

Figure 5 – Construction Staging Plan 1

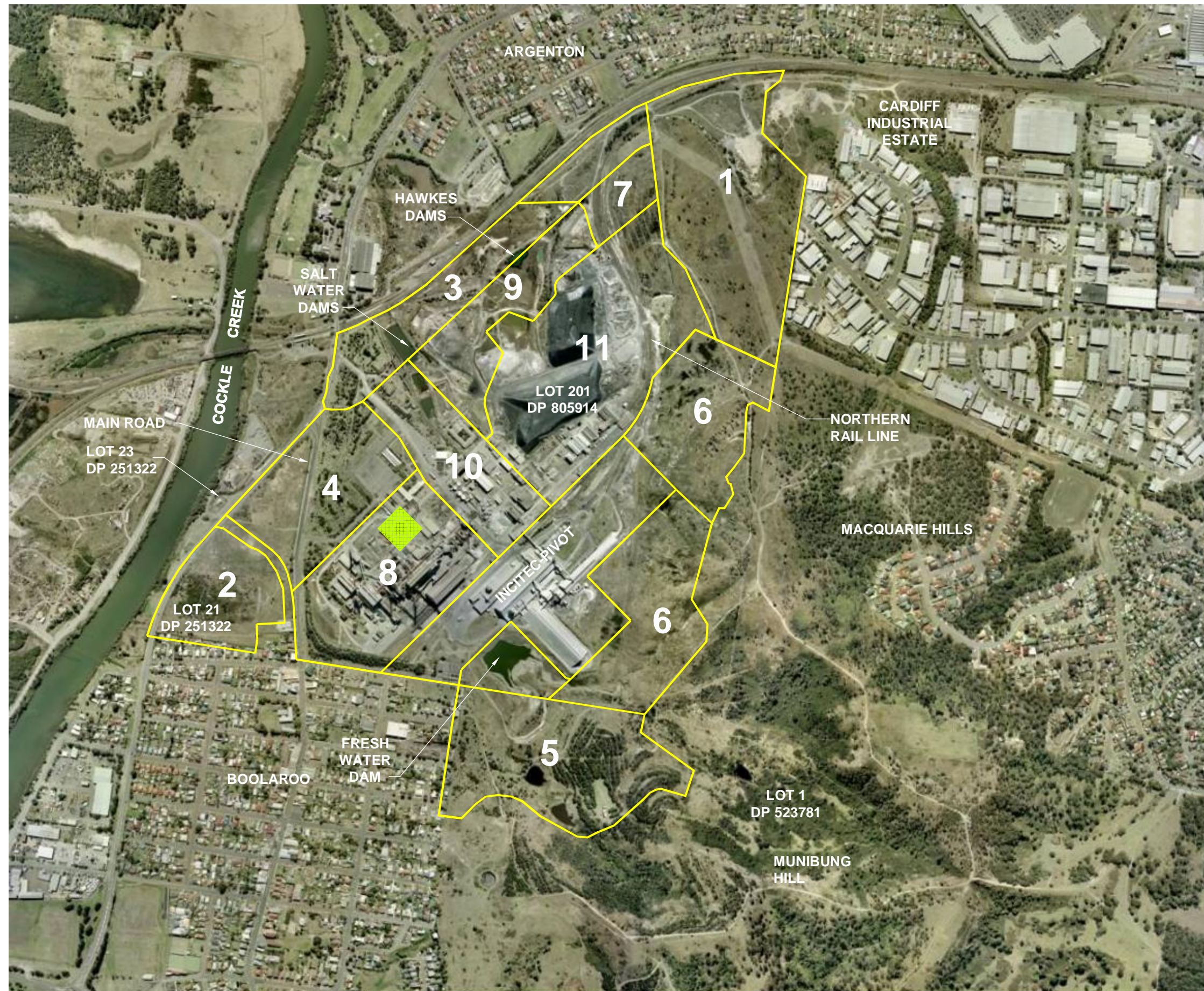
Figure 6 – Construction Staging Plan 2

Figure 7 – Surface Water Catchments and Flows

Figure 8 – Sub-Surface Water Control Measures

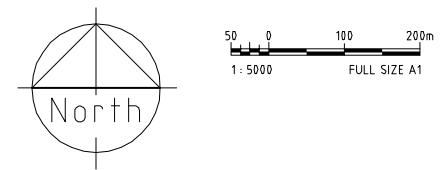
Figure 9 – Cell Details and Sections

Figure 10 – Cell Layout – Capped Final Design



- LEGEND:**
- 1 CARDIFF WEST ESTATE
 - 2 TRIANGULAR PADDOCK SOUTH
 - 3 RAILWAY EMPLOYMENT ZONE
 - 4 TRIANGULAR PADDOCK NORTH AND MAIN ENTRY PRECINCT (FORMERLY SUPERLOT 5A)
 - 5 BOOLAROO HEIGHTS
 - 6 MUNIBUNG HILL RESIDENTIAL
 - 7 MUNIBUNG HILL INDUSTRIAL
 - 8 BOOLAROO NORTH (FORMERLY SUPERLOT 5B)
 - 9 CELL SURROUNDS
 - 10 MIXED USE ZONE
 - 11 CONTAINMENT CELL
- EXISTING ETP
- PROPOSED ETP


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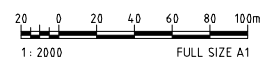
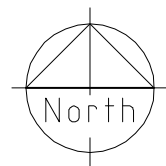


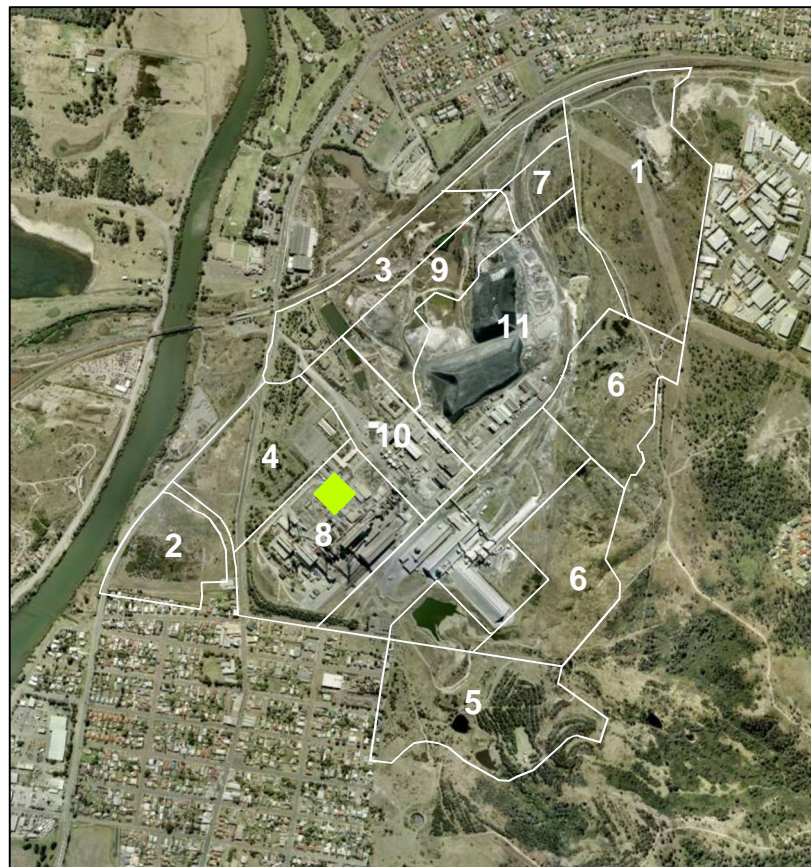


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LEGEND:

-  CAPPED CONTAINMENT CELLS
- 1 - 10** CONSTRUCTION STAGING





MONTH 0



MONTHS 1-6



MONTHS 7-12



MONTH 13-18








MONTHS 19-24





MONTHS 25-30

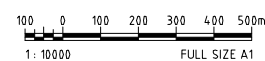
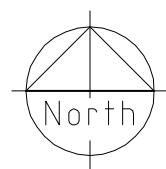
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-  UNDERGOING REMEDIATION
-  VALIDATED
-  ACTIVE FILLING
-  CAPPED CONTAINMENT CELL
-  HAUL ROUTES
- MONTHS** FROM APPROVAL

LEGEND:

- 1 CARDIFF WEST ESTATE
- 2 TRIANGULAR PADDOCK SOUTH
- 3 RAILWAY EMPLOYMENT ZONE
- 4 TRIANGULAR PADDOCK NORTH AND MAIN ENTRY PRECINCT (FORMERLY SUPERLOT 5A)
- 5 BOOLAROO HEIGHTS
- 6 MUNIBUNG HILL RESIDENTIAL
- 7 MUNIBUNG HILL INDUSTRIAL
- 8 BOOLAROO NORTH (FORMERLY SUPERLOT 5B)
- 9 CELL SURROUNDS
- 10 MIXED USE ZONE
- 11 CONTAINMENT CELL
-  EXISTING ETP
-  PROPOSED ETP

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MONTHS 31-36



MONTHS 37-42



MONTHS 43-48



MONTHS 49-54



MONTHS 55-60



MONTHS COMPLETE

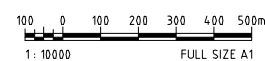
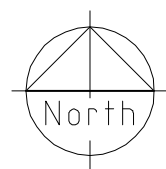
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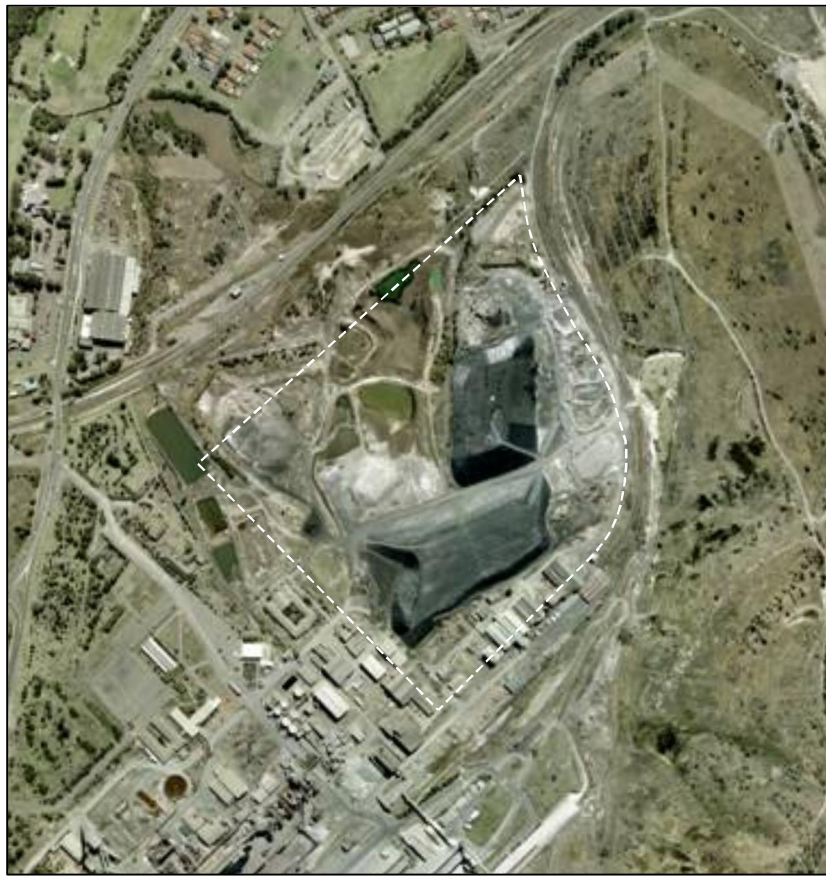
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- VALIDATED
- ACTIVE FILLING
- CAPPED CONTAINMENT CELL
- HAUL ROUTES
- MONTHS FROM APPROVAL

LEGEND:

- 1 CARDIFF WEST ESTATE
- 2 TRIANGULAR PADDOCK SOUTH
- 3 RAILWAY EMPLOYMENT ZONE
- 4 TRIANGULAR PADDOCK NORTH AND MAIN ENTRY PRECINCT (FORMERLY SUPERLOT 5A)
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- 7 MUNIBUNG HILL INDUSTRIAL
- 8 BOOLAROO NORTH (FORMERLY SUPERLOT 5B)
- 9 CELL SURROUNDS
- 10 MIXED USE ZONE
- 11 CONTAINMENT CELL
- EXISTING ETP
- PROPOSED ETP

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MONTH 0



MONTHS 1-6



MONTHS 7-12



MONTHS 13-18





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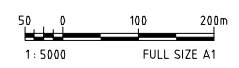
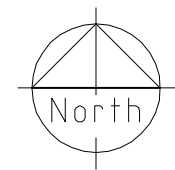


MONTHS 25-30

LEGEND:

-  ACTIVE FILLING
-  CAPPED CONTAINMENT CELL
- MONTHS FROM APPROVAL

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MONTH 31-36



MONTHS 37-42



MONTHS 43-48



MONTHS 49-54

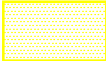



MONTHS 55-60



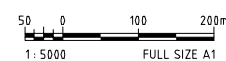
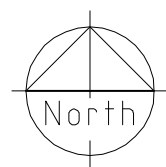
CELL COMPLETE

LEGEND:

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-  CAPPED CONTAINMENT CELL
- MONTHS

 FROM APPROVAL

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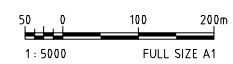
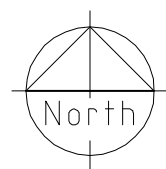
- CATCHMENT BOUNDARY
- ➔ FLOW
- PROPOSED CONTAINMENT CELL

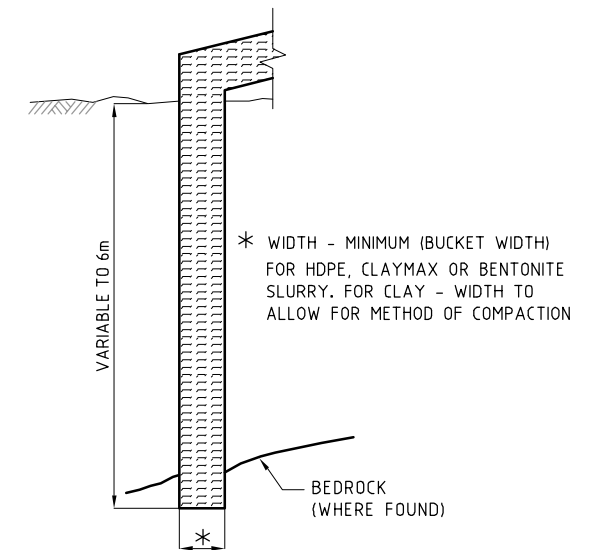
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2	SOUTH WEST	17
3	NORTH EAST	34
4	NORTHERN	25
5	OFFSITE	7.3
6	NORTHERN DUMP	34
7	CENTRAL	7.7
8	TRIANGULAR Paddock	9.6

NOTE:

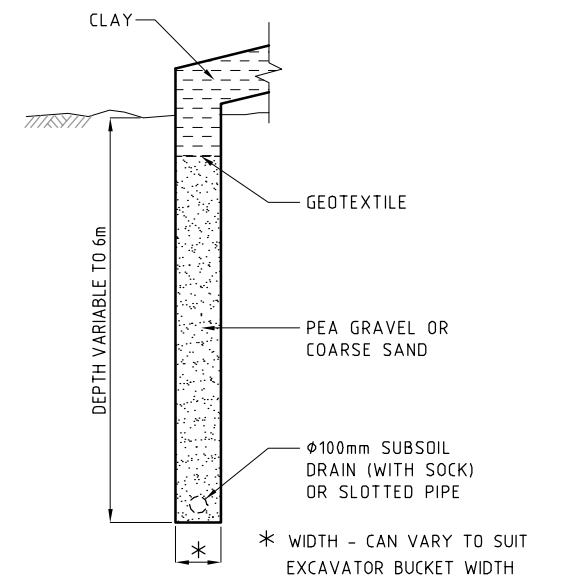
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TYPICAL CUTOFF WALL DETAIL
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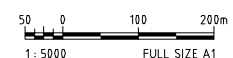
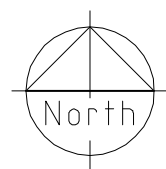


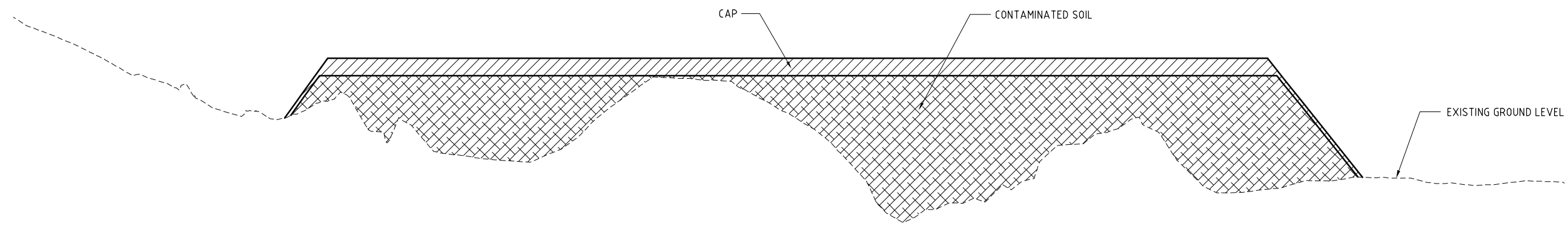
TYPICAL DRAINAGE TRENCH DETAIL
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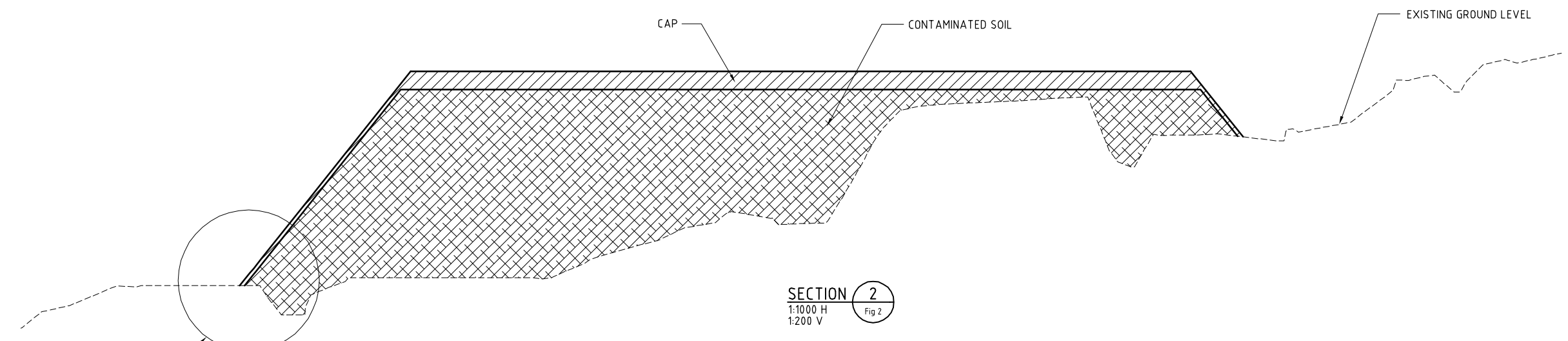
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- SOUTH WEST DAM RECOVERY WELLS
- UP GRADIENT CUT-OFF WALL
- UP GRADIENT INTERCEPTION DRAIN
- DOWN GRADIENT COLLECTION TRENCH
- PROPOSED CONTAINMENT CELL
- PROPOSED ETP

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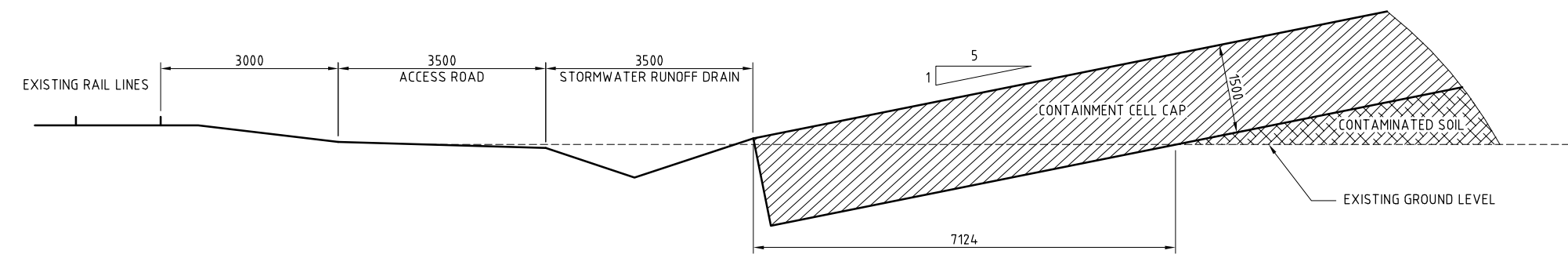




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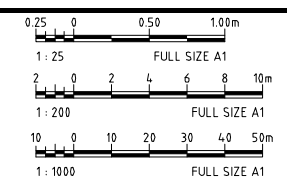


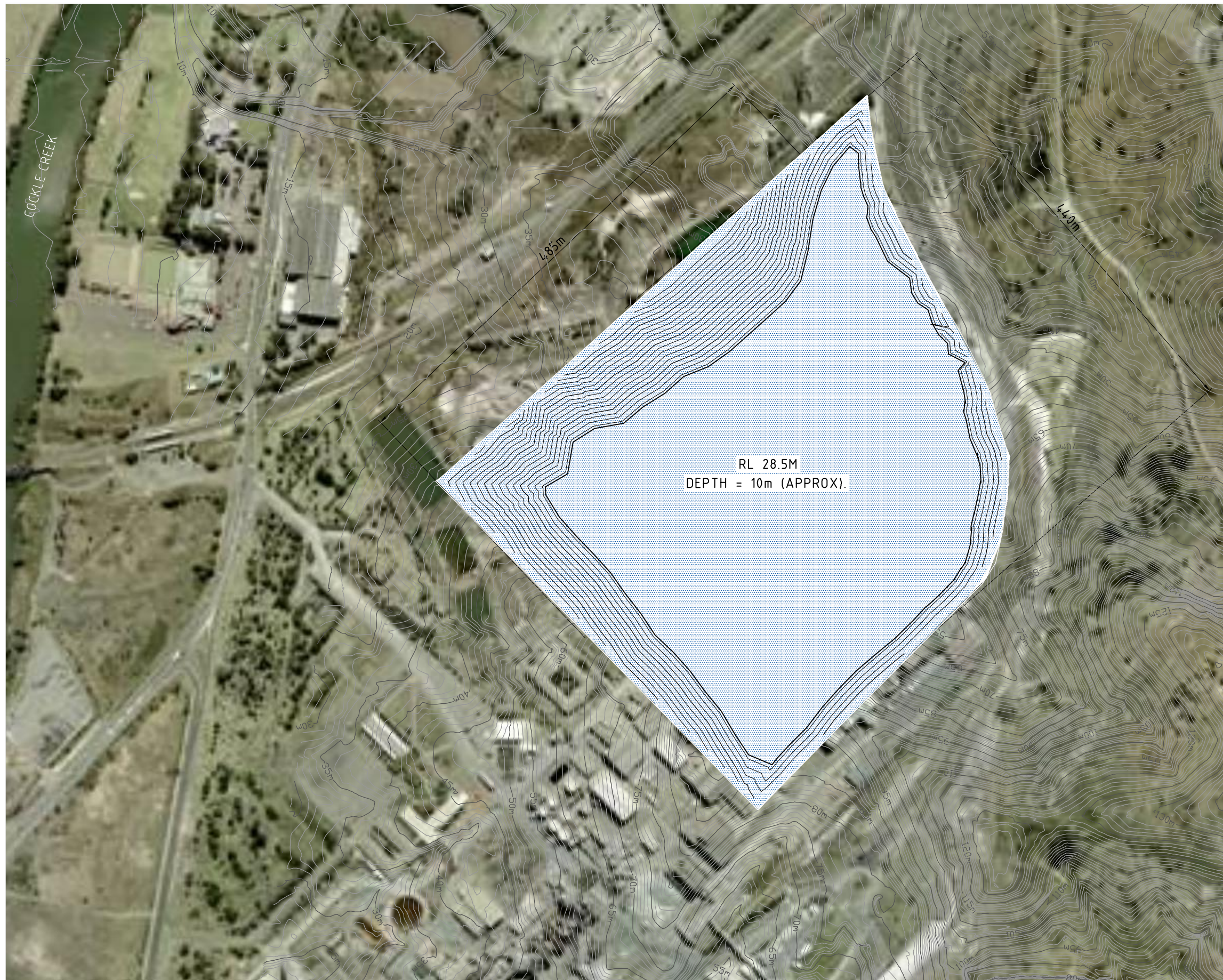
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1:1000 H
1:200 V

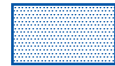


DETAIL A
1:25

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LEGEND:
 CAPPED CONTAINMENT CELLS

ASSUMPTIONS :
 1) DIMENSIONS WIDTHS ARE THE AVERAGE
 2) VERTICAL DEPTH OF CELL = 10M (APPROX).

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