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Appendix I:

Effects of transformation on soil, surface water and groundwater management

BlueSphere
ENVIRONMENTAL

Effects of Transformation on Soil, Surface Water and Groundwater Management

Nyrstar Port Pirie Smelter

Prepared for:

Nyrstar Port Pirie

Ellen Street, Port Pirie, SA

24 July 2013

Effects of Transformation on Soil, Surface Water and Groundwater Management

Nyrstar Port Pirie Smelter

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1 Introduction

Nyrstar Port Pirie Pty Ltd (Nyrstar) is seeking Major Development approval to upgrade its lead smelter and associated facilities at Port Pirie (the Site) to an advanced poly-metallic processing and recovery facility. This project is known as the Port Pirie Smelter Transformation (Transformation) and will reduce emissions and result in improved air quality within the Port Pirie community.

The approval requires the submission of a Public Environmental Report (PER). The PER is being prepared in accordance with guidelines determined by the Development Assessment Commission (DAC) to enable further assessment of the socio-economic, environmental and other implications of the Transformation Project.

BlueSphere Environmental Pty Ltd (BlueSphere) was engaged by Nyrstar to provide assistance in the preparation of the soil, groundwater and surface water management components of this PER. This report presents an assessment of the potential effects of the Transformation Project on these elements of the environment in accordance with DAC guidelines.

2 Transformation Overview

The Port Pirie Smelter Transformation involves replacing and upgrading the existing Sinter Plant, Blast Furnace, Acid Plant and associated infrastructure into an advanced poly-metallic processing and recovery facility which is designed to meet stringent environmental standards.

The project will involve the following the key components, as documented in the Development Application:

- The decommissioning and/or demolition of the existing Sinter Plants, Blast Furnace, Acid Plant and associated infrastructure;
- The construction and operation of the following facilities:
  - A new Stage 1 Enclosed Bath Smelting furnace system to replace the current Sinter Plant;
  - A new Stage 1 Oxygen Plant Facility;
  - A new Stage 2 Enclosed Bath Smelting Furnace system to replace the current Blast Furnace;
  - A new Sulphur Capture (Acid Plant) to replace the existing Acid Plant;
  - Storage areas for mineral concentrate and raw materials;
  - An upgraded seawater intake cooling system and expanded cooling water discharge system;
  - Decommissioning and/or demolition of the current Sinter Plant, Blast Furnace and Acid Plant (and associated infrastructure)

The investigation, demolition, construction and operational phases of the project all have potential implications for on-Site and adjacent soil, surface water, groundwater and contamination.

3 Current Management System

3.1 Management Context and Approach

The Site has a long and complex history of industrial use exceeding 120 years of operation. Smelting and associated practices of this period has resulted in contamination of the subsurface and contiguous environments.

Nyrstar, with guidance from BlueSphere, is following a regulatory process with respect to the assessment and remediation of the existing soil, groundwater and surface water contamination issues identified at the Site. At the time of writing, the Site is subject to a voluntary Site Contamination Audit, being conducted in accordance with the relevant provisions of the South Australian Environment Protection Policy (1993). Substantial investigation of the sub-surface environment has been undertaken under this process. Further, this process requires that certain activities (including investigation, demolition, construction and operational activities) that have the potential to impact Site groundwater conditions, be approved by the appointed Site Contamination Auditor (the Auditor) before being undertaken.

The regulatory process is stipulated in the EPA South Australia document: Site Contamination – Guidelines for the Assessment and Remediation of Groundwater Contamination, February 2009 (SA EPA, 2009) and the key milestone documents and process are summarised below in **Figure 1**.

Figure 1 EPA South Australia Regulatory Framework Summary

This process has been substantially progressed at the Site with ongoing assessment work and Auditor appointment enabling the submission of an Interim DRA in Q3 2013. A preliminary Remediation Options Assessment (ROA) has already been developed and will be finalised based on the outcomes of the DRA process.

Nyrstar has been granted approval by the EPA and the Auditor to submit an Interim DRA, (as opposed to a DRA), which will allow the major contamination issues to be addressed through a remedial response ahead of further source zone delineation that may be required in future. The

Preliminary ROA was a screening exercise to determine the likely remedial options at the Site based on the primary contaminants of concern and hydrogeological setting.

As part of the regulatory process, and subject to the outcomes of contaminant transport modelling and the DRA process, the ROA will be updated and will allow formal planning and implementation of the proposed remedial strategies.

The monitoring and management of water levels across the Site, particularly in the Fill Aquifer, is a critical aspect of groundwater management at the Site. Current and historical sources of contamination have been identified across the majority of the Site area and include both point and diffuse sources, including the widespread distribution of slag. This has led to a focus on the receiving environments rather than source zone characterisation and delineation and the establishment of a sentinel (boundary monitoring) groundwater well network.

The focus of groundwater management (and contiguous soil and surface water environments) in the medium to long term is to lower groundwater levels, particularly in the uppermost aquifer (Fill Aquifer – see **Section 4.2**). Generally, elevated water tables throughout the Fill Aquifer increase the lateral and vertical discharge of contaminants to the aquifer margins and downwards to deeper aquifers, respectively, posing environmental and health risks to receptors.

Interim remedial measures at the Site have focussed on areas of known historic groundwater contamination (e.g. groundwater interception at key sources). Site boundary areas where groundwater discharges are or are predicted to occur in future have been prioritised for the immediate implementation of groundwater management measures, due to the potential for contamination to reach nearby receptors in the short to medium term.

In the long term, the focus of groundwater management will shift from assessment and characterisation to remediation performance and compliance monitoring. It is planned that the remedial strategies will largely be passive systems, which maintain a favourable balance of groundwater inputs and outputs from the Site (e.g. construction of evaporative lakes) rather than active systems requiring ongoing operation and maintenance.

3.2 Assessment Methods

The data upon which the current understanding of Site conditions is based was collected in accordance with industry best practice and any relevant regulatory guidance. A compilation of water monitoring and related procedures used for data collection and assessment at the Site is provided in **Table 1** below and will be adopted for Transformation. All historical work presented herein and all proposed future works (including for Transformation) where relevant were/will be conducted in accordance with the following guidance documents:

- SA EPA (2010). EPA Guidelines: Guidelines for the site contamination audit system;
- SA EPA (2010). EPA Guidelines: Monitoring plan requirements;
- SA EPA (2009). Site Contamination – Guidelines for the assessment and remediation of groundwater contamination;
- SA EPA (2007). EPA Guidelines: Regulatory monitoring and testing – groundwater sampling;
- SA EPA (2007). EPA Guidelines: Regulatory monitoring and testing – water and wastewater sampling;
- SA EPA (2007). EPA Guidelines: Regulatory monitoring and testing – reporting requirements;
- SA EPA (2003). EPA Guidelines: Pollutant management for water well drilling;
- Land and Biodiversity Committee, 2012, Minimum construction requirements for water bores in Australia, Edition 3, Revised February 2012; and
- Standards Australia 1997, Australian Standard Guide to the Sampling and Investigation of Potentially Contaminated Soil: Part 1: Non-Volatile and Semi Volatile Compounds. AS4482.1-1997, Standards Australia, Sydney.

- Barnett, B, Townley, LR, Post, V, Evans, RE, Hunt, RJ, Peeter, L Richardson, S, Werner, AD, Knapton, A and Boronkay, A. (2012) Australian Groundwater Modelling Guidelines. National Water Commission

The SA EPA Publication EPA Guidelines: Regulatory monitoring and testing – groundwater sampling (2007) is considered the definitive guide to the installation, development and sampling of groundwater monitoring wells in South Australia and took precedence in the event of omissions, contradictions or errors in the other documents.

Any future potential acid sulphate soils assessment will be conducted in accordance with the following guidelines:

- SA EPA (2007). EPA Guidelines: Site Contamination – acid sulphate soil materials, November 2007.

Table 1 Groundwater Assessment and Management Procedures

Activity	Details
Permitting	The following authorities required permits or consents to be obtained prior to undertaking certain types of works, including: Department of Water, Energy, and Environment, South Australia – Bore construction licenses are required in South Australian for installation of new groundwater monitoring wells and decommissioning of old wells in accordance with the Natural Resources Management Act 2004. Refer to Section 5.1 of SA EPA (June 2007) Publication EPA Guidelines: Regulatory monitoring and testing – groundwater sampling. Utility companies – Utility companies were contacted as part of the dial before you dig and underground service clearance process, particularly in off-Site areas. Nyrstar internal excavation permits – excavation permits were obtained for all drilling locations.
Service Clearance	A Site inspection was undertaken prior to any intrusive field work for review of overhead clearances and rig access. Drilling locations (and other intrusive works locations) were cleared for underground services (i.e. sewer, storm water, electricity, gas pipelines etc) by a licensed service locator (off-site) or Nyrstar approved personnel utilising radio detection or other appropriate methodology. The first one metre (or depth of services specified in service location plans) of the drilling location was cleared using a hand auger.
Drilling and construction of monitoring wells	Monitoring wells were drilled and installed in accordance with Minimum Construction Requirements for Water Bores in Australia, Land and Biodiversity Committee, 2012,Edition 3, Revised February 2012. Refer to Section 5 of SA EPA (June 2007) Publication EPA Guidelines: Regulatory monitoring and testing – groundwater sampling. Drilling was undertaken by a licensed driller with appropriate level of qualification for the type of drilling required. All wells were installed within a single aquifer only, based on observations made during drilling at each location. Bentonite and grout seals were placed in such a way as to ensure (to the extent possible) that leakage between individual hydrostratigraphic units via the borehole or well, or infiltration of surface runoff, was prevented. Where the target aquifer is underlying the Fill Aquifer, the well installation method included the casing off all above aquifer units with a pre-collar prior to drilling the well during the most recent investigations.

Table 1 – Groundwater Assessment and Management Procedures

Activity	Details
Bore Development	Development of the wells generally occurred a minimum of 24 hours after the installation and was completed in accordance with Minimum Construction Requirements for Water Bores in Australia, Land and Biodiversity Committee, 2003,Edition 2, Revised September 2003. Refer to Section 5.3 of SA EPA (June 2007) Publication EPA Guidelines: Regulatory monitoring and testing – groundwater sampling. At the request of the Auditor, one bore volume of water was initially purged from wells installed in the UNA and Hindmarsh Aquifers within 24 hours of installation or a soon as practicable, to reduce the potential for aquifer contamination. These wells were then developed as described above.
Surveying	Monitoring wells were surveyed by a licensed surveyor to MGA and AHD (+/- 0.001 m) coordinates.
Groundwater Gauging	Groundwater gauging events were generally completed prior to groundwater sampling or any other disturbance of the water column. Where tidal effects were known or anticipated, gauging took place in a single event encompassing all affected wells as close as possible to the target tidal phase (usually low tide). This reduced the confounding effects of tidal movements on groundwater levels. The total depth of the monitoring wells and the presence of DNAPL were measured in accordance with Section 7.1 in SA EPA (June 2007). EPA Guidelines: Regulatory monitoring and testing – groundwater sampling.
Groundwater Sampling	Sampling of the monitoring wells was undertaken in accordance with Section 7 of the SA EPA (June 2007). EPA Guidelines: Regulatory monitoring and testing – groundwater sampling. Field equipment was calibrated according to the manufacturer's specifications and records kept of this process. Samples collected from each well was preserved appropriately and submitted to a National Association of Testing Authorities (NATA) accredited laboratory for the required analysis within the permitted sample holding time under Chain of Custody protocols.
Surface Water Sampling	Sampling of surface water was undertaken in accordance with SA EPA (2007). EPA Guidelines: Regulatory monitoring and testing – water and wastewater sampling. Field equipment was calibrated according to the manufacturer's specifications and records kept of this process. Samples collected from each well was preserved appropriately and submitted to a National Association of Testing Authorities (NATA) accredited laboratory for the required analysis within the permitted sample holding time under Chain of Custody protocols.
Aquifer Testing	Testing of aquifer properties was undertaken using recovery and slug tests in accordance with Section 2.8.2 of the SA EPA (2009). Site Contamination – Guidelines for the assessment and remediation of groundwater contamination.
Laboratory Analysis	Laboratory testing was undertaken by laboratories that are NATA accredited for the analytes requested. Refer to Section 8 of the SA

Table 1 Groundwater Assessment and Management Procedures

Activity	Details
	EPA (June 2007). EPA Guidelines: Regulatory monitoring and testing – groundwater sampling.
Data Assessment	The collected data has been assessed against the following water quality guidelines: The Environment Protection (Water Quality) Policy 2003 - EPP (2003) – Marine Water Ecosystems; ANZECC (2000) Ecosystems Marine Water (90%); ANZECC (2000) Ecosystems Fresh Water (90%) in the absence of a value for marine water; CRC Care (2011) HSL-D Commercial/Industrial; and Dutch Ministry of the Environment (VROM) (1994) Mineral Oil.
Decontamination	Non dedicated sampling equipment (e.g. low flow pump) was decontaminated using a non-phosphate detergent solution (i.e. Decon 90) wash followed by three distilled water rinses in accordance with Section 7.7 of the SA EPA Guidelines: Regulatory monitoring and testing – groundwater sampling.
Field Documents and Chain of Custody (COC)	Field activities and observations including data collected during sample collection and field testing were recorded in a field log book. A COC record was used by field personnel to document possession of all samples collected for chemical analysis in accordance with Section 8.2 of the SA EPA (June 2007). EPA Guidelines: Regulatory monitoring and testing – groundwater sampling.
QA/QC Procedures	In accordance with Section 9 of the SA EPA (June 2007). EPA Guidelines: Regulatory monitoring and testing – groundwater sampling, QA/QC measures that were conducted included the following : Field duplicates and triplicates were collected at 1 in 10 samples; Field blanks were collected at selected locations where cross contamination from air emissions was considered likely; Rinsate blanks were collected at the end of each sampling day at a rate of one per piece of sampling equipment; Trip blanks were included in each batch of samples containing VOC samples; and Laboratory prepared samples.
Data Validation	BlueSphere conducted a comprehensive Quality Assurance/Quality Control assessment of the data collected. BlueSphere has adopted QA/QC objectives consistent with guidance from the following sources: SA EPA (June 2007). EPA Guidelines: Regulatory monitoring and testing – groundwater sampling; EPA Victoria, 2009, Sampling and Analysis of Waters, Wastewaters, Soils and Waste, Industrial Waste Resource Guidelines (IWRG) Publication 701; NEPC (1999), National Environment Protection (Assessment of Site Contamination) Measure (NEPM), Schedule B (3) Guideline on

Table 1 Groundwater Assessment and Management Procedures

Activity	Details
	Laboratory Analysis of Potentially Contaminated Soils; Standards Australia AS/NZ, Australian/New Zealand Standard 2005, AS4482.1:2005 Guide to the Sampling and Investigation of Potentially Contaminated Soil – Non-Volatile and Semi-Volatile Compounds; Standards Australia AS/NZ, Australian/New Zealand Standard 1998, AS 5667.1:1998 Water Quality – Sampling Part 1: Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples; United States Environmental Protection Agency (USEPA) – Guidance on Systematic Planning Using the Data Quality Objectives Process; USEPA – Guidance on Environmental Data Verification and Data Validation; and USEPA – Contract Laboratory Program http://www.epa.gov/superfund/programs/clp/index.htm.
Reporting	BlueSphere has considered the following regulatory guidelines when preparing reports: SA EPA (2010). EPA Guidelines: Guidelines for the site contamination audit system; SA EPA (2009). Site Contamination – Guidelines for the assessment and remediation of groundwater contamination; SA EPA (2007). EPA Guidelines: Regulatory monitoring and testing – reporting requirements; and SA EPA (2010). EPA Guidelines: Monitoring plan requirements.
Numerical Groundwater Flow and Solute Transport Modelling	BlueSphere, in collaboration with A.D. Laase Hydrologic, have developed the numerical groundwater flow and solute transport model in accordance with the following guidance document: Barnett, B, Townley, LR, Post, V, Evans, RE, Hunt, RJ, Peeter, L Richardson, S, Werner, AD, Knapton, A and Boronkay, A. (2012) Australian Groundwater Modelling Guidelines. National Water Commission All modelling outputs to date have been reviewed and endorsed by the Auditor and his expert support team. The existing flow model, which can be used for predictive simulations of physical changes to the aquifer system, is considered to be a Class 3 model (the highest confidence level classification).

4 Existing Environment

The Site is located on the north eastern edge of the township of Port Pirie, on the eastern Spencer Gulf in southern South Australia, approximately 230 km north of the City of Adelaide (**Figure F1**).

The operational Site area lies within a much larger lease area, which extends mostly to the north and northwest. The northern boundary of the lease area runs approximately parallel to the margin of the Spencer Gulf. The operational area of the Site includes both the main plant areas along the Port Pirie River and an extensive area of black sand (granulated slag) to the west. The total operational area of the Site is approximately 180 hectares.

The eastern portion of the Site adjacent to the river consists of a wharf and extensive plant areas underlain by a hard stand and is relatively flat. To the west of the plant area, the Site is dominated by 'the Pit', a large unsealed area used for the storage of a wide variety of largely in process materials (intermediate materials). This area is founded on slag material and has a history of slag deposition and re-excavation, materials storage and rehabilitation.

The natural geomorphology of the Site would have been a meandering tidal river system traversing a wide expanse of flat and low lying intertidal and supratidal flats comprised of recent alluvium, traversed by rivulets and streams derived largely from groundwater discharge, and periodic tidal inundation and drainage. These saline flats, which are still present to the north and west of the Site, are generally referred to as samphire flats, owing the dominant vegetation type that has colonised the hypersaline marine margin throughout the region.

The Site topography has been highly modified by Site development activities. Fill material consisting mainly of various types of slag has been placed to various depths across the entire Site and beyond, including parts of the Port Pirie Township and adjacent industrial facilities. Slag and other fill was also used to reclaim parts of the western bank of the Port Pirie River.

The long history of industrial activity at the Site has resulted in contamination of the subsurface environment.

4.1 Surface Water

The main operational area of the Site sits within the Port Pirie River catchment, with much of the natural drainage reporting to the River. The Site as whole (including the Black Sands Emplacement Area) straddles a drainage divide, with parts of the westernmost portion of the Site naturally draining to the Spencer Gulf.

The main operational areas of the Site are largely paved, with stormwater reporting to a surface and subsurface drainage network, which largely reports to the No.1 Drain and subsequently to the Sedimentation Pond and out the Spencer Gulf via the 1M Flume compliance point. A small portion of the southern area of the Site (mainly car parking area), reports to a stormwater drain flowing west to east from the Dead Horse Creek wetlands to the Port Pirie River mainly outside the operational area of the Site.

The Port Pirie River is a tidal estuary which drains north to the Spencer Gulf, with the river mouth located approximately 4 km north of the Site. The Port Pirie region, including the Spencer Gulf and Port Pirie River, has a semi-diurnal tidal cycle (Bureau of Meteorology, 2011), such that there are two high tides and two low tides in a typical day. The tidal range is moderate with an extreme spring tidal range of 3.44 m (AGSO, 1998). A more typical maximum daily tidal range would be of the order of 2.5 m (Bureau of Meteorology, 2011), with a mean low tide of approximately -1.3 m AHD, and a mean high tide of approximately +1.2 m AHD. Port Pirie Chart Datum (0 m CD) is equivalent to -1.933 m Australian Height Datum (AHD).

King tides are known to inundate parts of the Site, particularly when accompanied by storm surges and/or high flow in the River. King tides have been observed to reach in excess of 1.7 m AHD (up to approximately 2.0 m AHD based on recent photographic evidence for May 2011), flooding some operational areas of the Site.

4.2 Geology and Hydrogeology

4.2.1 Regional

The Site is situated in a basin of sediments overlying basement rock. The basement geology is comprised of metasediments including feldspathic quartzites and shales, interbedded with dolomitic shales and limestone (Martin *et al*., 1998). The basement rocks outcrop in the eastern Mount Lofty – Flinders Ranges and are buried by more than 150 m of sediments in the vicinity of the Site (Martin *et al*., 1998).

The Tertiary age geological sequence is reported to be composed largely of sands, sandy clays and clays (Geological Survey of South Australia, 1964). The overlying Quaternary sequence is reported to contain a basal sequence comprised of sands, gravels and calcrete up to 20 m in thickness, which is overlain by a thick sequence (~80 m) of Hindmarsh Clay (Martin *et al*., 1998).

The Hindmarsh Clay is overlain in the Port Pirie region by Holocene-aged estuarine/coastal and aeolian derived clays, silts and sands mainly of the St Kilda Formation, the upper surface of which is composed of Samphire Clay flats and marshes (Geological Survey of South Australia, 1964).

Figure F2 shows an idealised regional cross section from west to east from the Spencer Gulf, through the Site to the Mount Lofty – Flinders Ranges to the east. Groundwater systems (aquifers) exist in the basement rock and sediments with groundwater flow expected to occur predominantly within the basal sandy unit of the Quaternary age sequence and within the sandy portions of the Tertiary age sequence. Generally, groundwater flows from the ranges to the sea where groundwater discharge occurs.

4.2.2 Local

The shallow stratigraphy at the Site comprises the estuarine/coastal clays of the St Kilda Formation underlain by Hindmarsh Clay; this natural sequence is overlain across the majority of the Site area and parts of the surrounding areas by a variable thickness of anthropogenic slag and other fill (BlueSphere, 2013a). The St Kilda Formation in the vicinity of Port Pirie is mapped as potentially acid sulphate soil (CSIRO, 2013).

The typical shallow stratigraphic sequence below is based on numerous drilling logs recorded during environmental and geotechnical drilling programs conducted at the Site and can be summarised (from youngest to oldest) as follows:

- Slag (with occasional coverage of other types of fill) to depths of approximately 4 m;
- Clays of the St Kilda Formation, with typical thicknesses of between 2 and 3 m (also referred to as Samphire Clay);
- Silty and sandy clays of the St Kilda Formation, with typical thicknesses of approximately 4 m;
- Mottled clays of the Hindmarsh Clay, including interbedded sandy horizons are typically intersected below the above sequence.

The groundwater well locations used to define the shallow stratigraphy are shown on **Figure F3**. Typical cross sections showing the relationship between the various stratigraphic units are presented on **Figure F4** – **Figure F6**, with the cross section alignments shown on **Figure F3**.

The slag and other fill, the silty and sandy clays of the St Kilda Formation and the sandy portions of the Hindmarsh Clay all contain aquifers; the upper clay sequence of the St Kilda Formation forms an aquitard (substantially restricts groundwater movement). The shallow aquifer sequences have been given the following names (from shallowest to deepest):

- Fill Aquifer;
- Upper Natural Aquifer (UNA); and
- Hindmarsh Clay Aquifer.

The thickness and relatively high porosity of the slag, combined with the relatively low permeability of the underlying St Kilda Formation clay material has promoted the development of an extensive and perennial perched aquifer system in the fill (the Fill Aquifer). One of the important characteristics of the Fill Aquifer is the high infiltration rates of rainfall and/or irrigation water which results in high recharge rates to the perched water table. Water levels in the Fill Aquifer have progressively risen throughout this general Site area over several years resulting in the current water table generally varying between approximately 2.0 and 2.5 m AHD beneath much of the central Site (including the Pit) area, which equates to typical groundwater depths throughout the main Transformation area of between 1 and 3 metres below ground surface.

Fill Aquifer water levels fall to the south and southwest, to the north and northwest and particularly to the east, where the Fill Aquifer system is able to drain towards points of discharge (i.e. Dead Horse Creek Wetland and drainage, the drain below the 1M Flume or the Port Pirie River, respectively). Groundwater discharge also preferentially occurs from the northeast margin of the Site to the Port Pirie River at the northern end of the sheet pile wall (termed the North East Discharge Area). Groundwater in these areas has exhibited moderate to strong responses to tidal oscillations in the river, supporting a relatively good hydraulic connection between this portion of the Site and the Port Pirie River (BlueSphere, 2013a). These areas of off-Site discharge are being managed by Nyrstar in a prioritised fashion in accordance with the overall groundwater management strategy.

Water levels in the UNA are much less variable and typically lower than in the overlying Fill Aquifer, such that a downward hydraulic gradient typically exists between these two formations. Mounding has been observed where some of the Site's hydraulic features (e.g. the Sedimentation Pond) are shown to leak and induce elevated hydraulic heads in the UNA. Water levels in the UNA decline towards the Port Pirie River. Groundwater in the UNA is likely to discharge to the river via a number of possible mechanisms including direct discharge in areas of shoreline revetment, through breaches in and underneath the sheet pile wall or via preferential pathways, including high transmissivity sediments deposited as back fill behind the sheet pile wall, which is expected to divert groundwater north along the inside of sheet pile wall, to a discharge zone in the vicinity of monitoring well MW90 at the southern end of the northern revetment area.

A water bearing zone within the Hindmarsh Clay was reported approximately two metres below the interface with the overlying UNA on Site (BlueSphere, 2013a) and, at the adjacent site, SX Holdings (URS, 2006). It is possible that these sand lenses represent a continuous aquifer unit. The limited available data on Site indicates that there is an upward gradient from the shallow water bearing zones of the Hindmarsh Clay to the UNA.

The UNA and Hindmarsh Aquifers contain hyper saline groundwater (typically greater than seawater), making it unsuitable for many uses (**Section 2.2.3**). Groundwater salinity in the Fill Aquifer is much more variable, typically ranging from 5,000 mg/L to >40,000 mg/L.

4.2.2.1 Hydraulic Features

There are a number of Site features that are considered important to the Site hydrogeology due to the likely controlling influence they have on the groundwater flow regime and contaminant transport throughout the Site. These have been compiled based on previous works, including recent extensive intrusive works conducted by BlueSphere (e.g. BlueSphere, 2013a). The key site hydraulic features have been presented on **Figure F7.** Many of these features are also shown in the cross sections (**Figure F4** – **Figure F6**). Each key hydraulic feature and the associated hydraulic influence inferred is presented in **Table 2** below.

Table 2 Key Site Hydraulic Features and Associated Hydraulic Influence

Site Feature		Hydraulic Influence	References
The Sedimentation Pond	The Sedimentation Pond extends to a depth of approximately 1.5 metres below the original natural ground surface. It is constantly maintained at a hydraulic head of about 1.7 m AHD by a weir (the 1M Flume) located at the western end of the pond.	The Sedimentation Pond effectively forms a hydraulic barrier to groundwater flow within the Fill Aquifer and to some degree in the Upper Natural Aquifer. It is expected to act as a discharge feature relative to the Fill Aquifer and probably a recharge feature to the UNA.	BlueSphere (2013a) **Figure F7** **Figure F6**
The No. 1 Drain	The No.1 Drain is the main drain carrying waste cooling and other process water to the Sedimentation Pond from the south. It flows constantly towards the Sedimentation Pond to the north, and is therefore maintained at a head greater than 1.7 m AHD. It typically has a head of approximately 2.5 m AHD at the southern end of the wooden culvert.	This feature is expected to extend the hydraulic impact of the Sedimentation Pond significantly to the south effectively wrapping around the eastern margin of the Pit. At its southern end, it is expected to allows movement of substantial quantities of water into the Fill Aquifer, inducing a groundwater mound and radial flow away from the drain. Numerical modelling (discussed later herein) has indicated that much of the water that migrates to the west reports to the Groundwater Sump.	BlueSphere (2013a), **Figure F7** **Figure F4**
The Western Levee & Neighbouring Dam Bunds to the west	The western levee is a historical feature which was constructed as part of a network of levees throughout the area for flood mitigation and now buried beneath several metres of slag. The western levee is reportedly constructed of low permeability earthen material to an approximate elevation of 1.7 m AHD running from the 1M Weir to the southwest then south to the southern margin of the Site. Similarly, the neighbouring dam bunds are constructed of low permeability material to elevations between 2.5 and 3.0 mAHD.	Both are expected to behave as hydraulic barriers to groundwater flow within the Fill Aquifer towards the northwest and west from the Pit and site areas to south.	BlueSphere (2013a), **Figure F7** **Figure F5**

Table 2 Key Site Hydraulic Features and Associated Hydraulic Influence

Site Feature		Hydraulic Influence	References
Leahey Road Bund	Historical earthen levee constructed along the alignment of present day Leahey Road and used to elevate the roadway above the low lying Samphire Clay surface	Acts as a hydraulic barrier to groundwater flow within the Fill Aquifer, preventing migration to the south from the southwestern corner of the Site towards Dead Horse Creek wetland	BlueSphere (2013a)
The Sheet Pile Wall Port Pirie River	The Sheet Pile Wall extends along much of the Site's eastern margin with the Port Pirie River. The sheet piling stops south of the Slag Fumer where the river bank consists of rock revetment in the northern portion of the plant area.	In general, the Sheet Pile Wall is a substantial impediment to groundwater discharge to the river, substantially diverting groundwater flow in the Fill Aquifer to the north, towards the north east and south.	BlueSphere (2013a) **Figure F7**
The Groundwater Sump	The Groundwater Sump is located on the north eastern margin of the Pit and is periodically pumped to the Process Effluent Treatment System (PETS). Recent refurbishment of the sump and the creation of a surrounding pondage has improved connectivity with the Fill Aquifer and substantially increased groundwater yields.	The sump has a dewatering effect on the Fill Aquifer locally, with the sump likely to be located on the southern margin of the former Pit Creek, thus having a potential large groundwater catchment through the connectivity facilitated by this feature. The preliminary numerical modelling supports that extractions from the sump may play a significant role in controlling hydraulic heads broadly in this portion of the Site. The modelling also suggests that a large proportion of groundwater extracted at the sump is ultimately sourced from the hydraulic connection of the No.1 Drain.	BlueSphere (2013a) **Figure F7** **Figure F6**
The Paragoethite Product (PGP) Dewatering system	The PGP storage facility was constructed with an underdrainage system connected to a sump to prevent groundwater in the Fill Aquifer from saturating the base of the PGP. The drainage lines run approximately south to north towards a sump and pump station location on the southern bank of the Sedimentation Pond.	The Fill Aquifer is dewatered by this drainage system intermittently at variable rates where this water is pumped to PETS and, following treatment, it is ultimately discharged to the No. 1 Drain and flows to the Sedimentation Pond.	BlueSphere (2013a) **Figure F7**

Table 2 Key Site Hydraulic Features and Associated Hydraulic Influence

Site Feature		Hydraulic Influence	References
Lake Rohrsheim and adjacent Pit Area	Low, water-filled areas of the Pit are expected to be Fill Aquifer groundwater discharge areas due to the high surplus of evaporation over rainfall at the Site. The area defined as Lake Rohrsheim covers an area of approximately 1 hectare.	On the basis of average climate data it is expected that Lake Rohrsheim may result in evaporative losses of Fill Aquifer groundwater of the order of 17.5 ML per annum.	BlueSphere (2013a)
First Creek	The Drain below the 1M Weir drains to First Creek and from there to the Spencer Gulf.	This drain is expected to be a groundwater sink relative to the Fill Aquifer locally and may also capture shallow groundwater flow in the UNA, depending on the relative hydraulic heads. During periods of high flow and/or high tide conditions it may also be a source of recharge to both aquifers.	BlueSphere (2013a)
DHC wetland and associated pipeline	Dead Horse Creek was a former drainage line that flowed into the Port Pirie River. The drainage line has largely been reticulated into a pipeline and buried within the /fill profile. The pipeline has been constructed of various materials over its length and is considered to have relative low integrity with respect to the potential for leakage to and from the pipeline. Remnants of the drainage line exist as a wetland system located immediately south west of the Site's southern boundary, which receives run off from both the town, and parts of the Site's, stormwater network. The wetland overflows to the pipeline when stormwater runoff is received by the wetland from the township.	The wetland system is expected to behave on a net basis as a groundwater discharge zone, however, post high rainfall runoff, recharge to the groundwater system could be expected to occur.	BlueSphere (2013a) **Figure F7**
Irrigation Areas	Irrigation water is made up of treated water exiting the Sewage Treatment Plant, which is topped up with potable water. Irrigation occurs in areas across the entire Site including revegetated areas to the south and west of the Pit, north and west of the Northern Lined Dams and the southern portion of the black sand	The irrigation network is a likely spatially and temporally variable source of recharge to the Fill Aquifer. Estimated to contribute as much as 50% of rainfall.	BlueSphere (2013a)

Table 2 Key Site Hydraulic Features and Associated Hydraulic Influence

Site Feature		Hydraulic Influence	References
	emplacement area.		
Paved/Sealed Surfaces	Paved areas and lined dams (e.g. the Northern Lined Dams and Sewage Treatment Plant) are expected to restrict infiltration to the Fill Aquifer at the Site. However, poor pavement surfaces are expected to channel surface water recharge to cracks creating zones of differential/preferential recharge. Excluding point sources, in general, recharge to the Fill Aquifer is expected to be less for paved surfaces compared to unpaved surfaces.	Paved surfaces beneath the Zinc Plant and some other areas are expected to represent significant local sources of recharge and groundwater contamination to the Fill Aquifer due to the poor condition of pavements and associated above ground infrastructure There are other activities and discharges that may impact the head in the Fill Aquifer periodically.	BlueSphere (2013a) **Figure F7**
Zinc-Copper Plant Drainage Network	The Zinc-Copper Plant drainage network is generally made up of glazed earthenware pipes connected with mortar seals. The integrity of the drainage network, particularly in the Zinc Plant in the vicinity of the acid storage tanks, has been determined to be in poor condition.	A potential source of recharge and partial responsible for the continuing rise of the water table in the Fill Aquifer in the vicinity of the Zinc-Copper Plant.	BlueSphere (2013a)
Pit and Power Plant Creeks	Former surface water drainage systems that discharged to the Port Pirie River through the current Pit and Slag Fumer area, and are now buried beneath several metres of fill.	Likely to represent area of elevated transmissivity through increased aquifer saturated thickness, possibly forming preferential flow paths for the migration of groundwater through the system.	BlueSphere (2013a)

4.2.3 Relevant Protected Beneficial Use of Surface Water and Groundwater

In order to assess the effects of Transformation on the groundwater and surface water environments, it is necessary to first identify the current and potential beneficial uses of these segments of the environment. This approach is a requirement of SA EPA guidelines and is used to identify risks to groundwater or surface water. Where a beneficial may be precluded due to an activity, risk mitigation and/or management measures may be implemented to ensure the relevant beneficial uses are protected.

A review of the relevant beneficial uses of the Site was undertaken with regard to Table 1 of Schedule 1 in the Water Quality EPP and the Guidelines for Assessment and Remediation of Groundwater Contamination. The review took in to account the Site setting and the relatively high background concentrations of metals found the in the Fill Aquifer due to the nature of the formation of the aquifer in slag fill.

The groundwater beneficial uses likely to be realised are summarised in **Table 3** below and are all relevant to Transformation. Other beneficial uses have been considered relevant but are unlikely to be realised at the Site. These beneficial uses are detailed in Groundwater Assessment Report: September - October 2012 (BlueSphere, 2013a).

Table 3 Groundwater Beneficial Use Realisation

Beneficial Use	Comments
Aquatic Ecosystems (Marine)	Beneficial use considered relevant. The aquatic (marine) ecosystems beneficial use applies at the point of discharge, the Port Pirie River, located adjacent to the eastern Site boundary.
Human Health in Non-Use Scenarios	Scenario considered relevant. The exposure of workers to volatile chemicals accumulated in buildings from the unsaturated zone of the subsurface.
Human Health in incidental contact scenarios (e.g. on- and off-Site workers)	Scenario considered relevant. The exposure of workers to groundwater contaminants through direct contact (e.g. trenching, excavations, pumping of groundwater).
Buildings and Structures	Scenario considered relevant. The exposure of building foundations and subsurface structures to the relatively shallow groundwater on-Site is considered likely.
Human Consumption of Fish and Crustacea	Scenario considered relevant. Recreational fishing occurs in the Port Pirie River, both up gradient and down gradient of the Site.

Schedule 1, Table 1 of the Water Quality EPP, sets out the protected beneficial uses for marine waters. A summary of the beneficial uses likely to be realised and a justification is provided in **Table 4** below. Other beneficial uses have been considered relevant but are unlikely to be realised at the Site or Port Pirie River. These beneficial uses are detailed in BlueSphere (2013a).

Table 4 Surface Water Beneficial Use Realisation

Beneficial Use	Comment
Aquatic Ecosystems (Marine)	Beneficial use considered relevant. The Port Pirie River is located adjacent to the eastern boundary of the Site.
Recreation and Aesthetics	Secondary contact recreation beneficial use is considered relevant. The secondary contact recreation beneficial use applies where water is used for recreational activities, involving some contact with the water (e.g. wading, boating, and fishing). The Port Pirie river is known to be used for fishing, jet skiing and other water sports and therefore secondary contact recreation is considered a relevant current and potential beneficial use of surface water. Aesthetics beneficial considered relevant. The aesthetics beneficial use considers the odour, salinity, pH and turbidity of surface waters. This aesthetics beneficial use is considered a current and potential future beneficial use of surface water.
Industrial	Beneficial use considered relevant. A salt water cooling system operates at the Site and the water is collected from the Port Pirie River. The industrial beneficial use is therefore considered a relevant current and potential beneficial use of surface water.

4.2.4 Summary of Contamination Sources Potentially Relevant to Transformation

Current and historical activities relevant to soil, groundwater and surface water contamination at the Site are detailed in the Site History Review (BlueSphere, 2012f) and depicted on **Figure F8** and **Figure F9**. The Site History Review was completed to determine current and particularly historic activities that may constitute sources of soil, groundwater and surface water contamination.

The key Contaminants of Potential Concern (CoPC) at the Site are generally acknowledged to include metals/metalloids which principally include arsenic, cadmium, lead , zinc, manganese, mercury, and hydrocarbons (i.e. TPH, MAH, PAH from petroleum products). Acids (including nitric and sulphuric acids) are also considered potentially problematic due to the potential to degrade critical infrastructure and for their effect on metals mobility. A summary of the key Potentially Contaminating Activities (PCAs) at the Site is provided in **Table 5** below.

Table 5 Summary of PCAs and CoPC relevant to Transformation

Potentially Contaminating Activity	Contaminants of Potential Concern
Metals smelting and refining processes and plants (e.g. Zinc Plant and Cadmium Plant)	Metals/metalloids
Filling of the Site with slag (e.g. Fill Aquifer)	Metals/metalloids
Dust/Airborne Emissions	Metals/metalloids
Sludge Dewatering	Metals/metalloids
Storage of materials and chemicals	Hydrocarbons Metals/metalloids Nitric acid

Table 5 Summary of PCAs and CoPC relevant to Transformation

Potentially Contaminating Activity	Contaminants of Potential Concern
	Sodium Sulphate, sulphide, sulphuric acid
General maintenance	Hydrocarbons Metals/metalloids
Acid treatment, production and storage	Chloride Hydrogen gas Nitric acid Sodium Sulphate, sulphide, sulphuric acid
Landfill	Ammonia, nitrate, nitrite nitrogen Hydrocarbons Metals/metalloids Sulphate, sulphide
PETs and RO plant	Carbonate Chloride Hydrocarbons Metals/metalloids Sodium Sulphate, sulphide
Laboratory	Metals/metalloids Nitric acid Sulphate, sulphide, sulphuric acid
Sewage treatment plant	Ammonia, nitrate, nitrite, nitrogen Bacteria Carbonate Chlorine Fluorine Hydrocarbons Metals/metalloids Sulphate, sulphide

4.2.5 Contamination Status

Extensive intrusive studies have confirmed that the historic and current industrial operation of the Site has resulted in contamination of Site soil and groundwater, and adjacent surface water systems. Transformation activity will largely occur in the central portions of the Site, between the Zinc Plant and current Acid Plant, with some elements extending beyond this area to include the Pit and other peripheral areas depending on final design layout. The following sections are specific to areas of the Site currently known to be directly affected by Transformation activity. Detailed Site-wide information is the subject of other reports (e.g. BlueSphere, 2013a).

Of the CoPC (**Section 4.2.4**), contaminants of concern that are reported in groundwater and surface water within the broader Transformation footprint are as follows:

- Metals/metalloids (primarily including arsenic, cadmium, lead, manganese and zinc); and
- Hydrocarbons (TPH, MAH, PAH).

Acids have also proven to be a significant concern in the subsurface where the localised presence of acid over many years of operation have likely resulted in increased metals mobilisation, but also reactions have occurred between acid, the Fill Aquifer matrix and water (groundwater and surface water) (Nyrstar, 2011) that have induced ground heave and caused geotechnical issues. This is relevant to Transformation given potential for acid/acid impacted groundwater to be present or to migrate from the existing Zinc Plant area to the north beneath new Transformation structures.

Nyrstar is actively managing the heave issues associated with the slag, acid and water on Site and is entraining management measures within Transformation project, particularly in relation to pile design.

This reaction associated with heave can also produce hydrogen gas, which has the potential to pose health and safety risks under certain conditions. These risks are currently managed under Site health and safety protocols and have been the subject of Nyrstar risk assessments to ensure safe working conditions. These will be adopted for Transformation works.

Other potential contaminant types have been identified within the Transformation project area and determined to be less significant including nutrients (from sewage treatment, irrigation and land filling) and solvents (from processing areas, workshops and laboratories).

The widespread deposition of slag and many years of atmospheric deposition of Site-derived dusts and other emissions has resulted in a local/regional background level of the primary metal contaminants, particularly lead and zinc.

Superimposed on these background concentrations for most metals, is both legacy contamination issues associated with historic practises and current activities (**Section 4.2.4**). Within the Transformation footprint, dissolved metal contaminants (including cadmium, lead, manganese and zinc) are generally most concentrated near the Zinc Plant, Lead Production Area including the Cadmium Plant and sludge dewatering dams. From these source areas, groundwater contaminant plumes typically extend down-gradient towards the Site boundaries to the south and east, or north towards the Groundwater Sump, where Fill Aquifer dewatering occurs.

4.3 Conceptual Site Model

4.3.1 Summary

Based on the geological and hydrogeological setting, including the key site hydraulic features discussed in the preceding sections, recent monitoring events and hydraulic modelling of the Site, the conceptual site model (CSM) presents the current understanding of the Site groundwater flow regime.

The Fill Aquifer within the main Site area has been divided into several hydrogeological zones based on groundwater catchments (i.e. distinct recharge and discharge areas) and flow patterns. Three major zones have been termed the “Bowl”, “Plant Area East” and “Sedimentation Pond North” with a fourth, smaller zone, termed the “First Creek Sub Area”. The Bowl hydrogeological zone has been further divided into three subareas: the Pit, the Southwest Discharge Zone, and the Southern Discharge Zone. These hydrogeological zones and sub areas are presented on (**Figure F10**).

The Transformation area is largely contained within the Bowl and Plant Area East. In general, the groundwater flow within the central Bowl area is interpreted to be radial in nature, from the vicinity of the Zinc Plant and Sewage Treatment Plant towards the extremities of the Slag (**Figure F11**). Central mounding in the Bowl can vary temporally and spatially depending on shifting conditions at hydraulic features such as changing hydraulic head levels in the No.1 Drain (due to build-up of slag from the granulation process) or variations in the extraction rates at either the Groundwater Sump or the PGP dewatering system. Historic rising water tables across the Bowl are consistent with a water balance that has a surplus of recharge as a result of restricted discharge to the aquifer margins, high rainfall infiltration rates (including from irrigation) and leakage from the stormwater system and services in plant areas, which all report to the groundwater system.

Groundwater discharge from the Bowl is interpreted to be focused on a number of key areas, namely the southern margin associated with the Dead Horse Creek stormwater pipeline and adjacent wetland, both of which receive groundwater discharges, and the eastern, particularly north eastern, margin of the operational Site with the Port Pirie River (referred to as the North East Discharge Area). These discharge areas are generally considered to lie outside where Transformation activity will take place and will not be discussed further. Detailed information of these areas is contained in other reports (e.g. BlueSphere, 2013a).

Hydraulic heads in the Fill Aquifer are generally shown to be higher than that in the UNA, such that a downward hydraulic gradient, potentially inducing groundwater movement from the Fill downwards to the UNA, prevails across most of the Site, including the majority of the Transformation area. In the easternmost portions of Plant Area East the hydraulic regime is less straightforward due to groundwater levels in the respective aquifers being similar, with the dominant control on groundwater levels in both aquifers being tidal elevations in the river in this area. In parts of Plant Area East, an upward hydraulic gradient can be inferred from the UNA to the Fill Aquifer in some cases, due to movement of groundwater out of the fill sequence during low tide.

Within the UNA the hydraulic head is shown to be highest in the vicinity of the Sedimentation Pond due to the hydraulic connectivity of this feature with the UNA, which has created a mounding effect in the UNA in the immediate vicinity of the pond (**Figure F12**). Elsewhere, including within the Transformation area, horizontal hydraulic gradients within the UNA are relatively flat, consistent with the broader area being a regional groundwater discharge zone, where vertical gradients are likely to dominate. In the Transformation area lateral flow in the UNA is broadly inferred to occur from the Sedimentation Pond, in a south east direction through the Pit, ultimately reporting to the Port Pirie River.

A water bearing zone within the Hindmarsh Clay was reported approximately two metres below the interface with the overlying UNA on Site and at adjoining land parcels, and it is possible that these sand lenses represent a continuous aquifer unit. On Site, the vertical gradient is shown to be upwards from the Hindmarsh Clay to the UNA. Hydraulic head data for the Hindmarsh Clay is limited but, on a regional basis, lateral flow may be inferred broadly in the direction of the Spencer Gulf.

Many of the metals/metalloid contaminants, within groundwater at the Site, have a pronounced background concentration, with these contaminants being detected, at relatively low concentrations, at most peripheral locations sampled. This can be attributed to diffuse sources such as dust/particulate deposition as a result of broader Site activities, the entrainment of seawater (which contains detectable concentrations of contamination) into deposits of granulated slag, broad leaching of the slag profile and/or the generally widespread and overlapping nature of materials handling at the Site. Background groundwater monitoring wells located southwest and upgradient of the Site (**Figure F3**) and screened within the samphire and UNA reported detectable concentrations of metals/metalloids (cobalt, copper, lead, mercury, nickel, and zinc) which are also considered likely to be related to dust deposition.

The distribution of groundwater contamination is generally consistent with the locations of the various known current and historic contaminant sources and the current interpretation of the groundwater flow regime. In some cases, an historic flow regime can be inferred to have contributed to the distribution of a contaminant plume, within the confines of what is understood to have been the changes in hydraulic conditions of the Site with time, particularly in the Fill Aquifer.

Of the key metal/metalloid contaminants in groundwater (arsenic, cadmium, manganese, lead and zinc), cadmium, manganese, lead and zinc have distributions that are consistent with the locations of the known source areas and the expected migration patterns in groundwater. With respect to these dissolved metals in groundwater, the main footprint of Transformation (i.e. that area between the Zinc Plant and current Acid Plant) would be considered among the more contaminated parts of the Site.

The plumes of lead, zinc and manganese contamination in groundwater are spatially similar due to common sources for these metals, with relatively high contaminant concentrations or inferred source areas generally located in the vicinity of key plant/activity areas which are within or adjacent to the Transformation area, such as the Zinc plant, Lead Production Plant, Cadmium Plant and sludge dewatering dams.

These contaminant plumes are generally focused at the eastern end of the Zinc Plant extending down hydraulic gradient - southward to the Southern Discharge Area, northward to the southern edge of the Acid Plant and eastward towards the Port Pirie River. Cadmium also has a similar plume orientation with the highest cadmium concentrations located in the vicinity of the Lead Production Plant (east of the Zinc Plant) which incorporates the Cadmium Plant.

Other contaminant plumes exist at the Site, but are considered to be of relatively low significance to Transformation. These are detailed in other reports (BlueSphere, 2013a).

The distribution of arsenic is less consistent with the conceptual model in that a number of potential sources of arsenic do not appear to result in prominent areas of arsenic contamination in groundwater. . This may be due in part to differences in metal/metalloid mobility in the groundwater geochemical environment. In the Transformation area, relatively elevated concentrations of arsenic have been reported beneath the Zinc and Copper Plants, extending north towards the Groundwater Sump.

The distribution of both free and dissolved phase hydrocarbon contamination is the subject of ongoing investigations at the Site. However, source areas relevant to Transformation include the fuel storage and bowser area north of the Zinc Plant and a former oil and drum disposal area in the north west corner of the Pit, all which have reported free product at the water table historically. As such, it is noted that the Transformation Project Area is likely to be impacted to some extent by these contaminants.

The distribution of acid is not well characterised; however, it is inferred that acidic liquids are primarily beneath the Acid Plant, and to a lesser extent, the Zinc Plant, have resulted in the discharge of acid to the subsurface and induced the associated contaminant and geotechnical issues. Similarly, the Transformation Project Area, a considerable portion of which is located between the Zinc Plant and current Acid Plant is therefore potentially impacted, or may be impacted in future, by issues related to the migration of acid in the subsurface.

In most cases, particularly with the metals/metalloids, these contaminants have been shown to have migrated downwards from the Fill Aquifer to the UNA. While this is consistent with the prevailing downward hydraulic gradient between these aquifers across the majority of the Site area, the diffusion of contaminant mass through the intervening Samphire Clay (**Section 4.2.2**) under the concentration gradients may also be a significant, if not the dominant, process. The occurrences of relatively high contaminant concentrations in the UNA for the key metal/metalloid contaminants, is generally consistent with the presence of these in the overlying Fill Aquifer. A small number of outliers to this trend exist, in some cases where no fill profile/aquifer exists. These occurrences may be due to adjacent land parcels, build-up of atmospheric dust deposition over the samphire flats or may partly reflect background conditions.

As determined based on groundwater flow paths, contamination present in the Fill Aquifer in the Bowl is likely to migrate radially to the margins of the aquifer where discharge to wider environment occurs to a lesser or greater extent depending the hydrogeology and hydrodynamics of the particular discharge boundary. To a lesser extent, discharge is also expected to occur downwards into the UNA, which in turn discharges to the wider environment, either upwards to the ground surface or directly into the Port Pirie River. Dominant discharge pathways relevant to Transformation are considered to include the southern discharge area, the north east discharge area, and to at least some extent the sheet pile wall to the east. The pathway to the north west, including flow occurring over the Western Levee and reporting to the First Creek Drain below the 1M Weir and ultimately to the Spencer Gulf is also considered as a groundwater discharge boundary, but is considered to be of less significance owing to the controlling influence of both the western levee and tidal First Creek Drain. These discharge boundary areas are a key focus for monitoring and remedial activities..

4.3.2 Pathway Analysis

Based on the current and historical sources of soil, groundwater and surface water contamination at the Site the potential risks to human health and the environmental were assessed for groundwater. This analysis addresses the DAC requirement to describe the likely routes of all emissions, including via water and soil and the likely exposure scenarios.

As per **Section 2.3** above, metals/metalloids, petroleum hydrocarbons and acids are considered key CoPC at the Site. A qualitative source-pathway-receptor analysis has been completed for the Site based on the CSM and is summarised in **Table T1** (attached).

Where complete pathways have been identified, these are being managed through a combination of existing Site health and safety protocols, project specific Environmental Management Plans (EMPs) and Health and Safety Plans (HASPs) and the Audit and Groundwater Management Plan process. Transformation-specific management measures are identified and **Section 6** and described in detail in **Section 7**.

5 Impact Assessment

In general, the Transformation is expected to deliver a net environmental benefit with respect to the soil, groundwater and on Site surface water environments. While some risks exist throughout the design, construction and operational phases of Transformation, these can be readily eliminated, mitigated or managed by adopting established environmental protocols.

5.1 Risks Identified

The identified human health and environmental risks associated with Transformation have been summarised for soil and groundwater and surface water in **Table 6** and **Table 7**, respectively. The contaminant linkage assessment in **Section 4.3.2** was used to identify the risks associated with each activity. These issues have been entrained in the overall site risk assessment conducted by COOE for the Site and presented in the PER.

5.1.1 Soil and Groundwater

Table 6 Summary of Transformation Activities, Potential Soil and/or Groundwater Impact and Assessment/Mitigation Measures

Activity	Task	Potential Soil and/or Groundwater Impact	Assessment / Mitigation Measures
Decommissioning and Demolition of Existing Plant			
Demolition	Stockpiling of building rubble/waste materials	Stored materials may be contaminated and form a soil and groundwater contamination source	• EMP (including stockpile management procedures)
		Excessive dust generation may lead to increased entrainment of metals and other contaminants in recharging groundwater	• EMP (including dust management)
	Creation of open sealed and/or unsealed space	Increased runoff of potentially contaminated water could enter aquifers through unsealed surfaces or degraded drainage infrastructure increasing contaminant loads and/or hydraulic head in the groundwater system.	• EMP
Construction of New Plant			
Feasibility Investigations	Geotechnical Drilling and Test Pitting	Potential breach of aquitard could lead to cross contamination of aquifers	• EMP (including management of

Table 6 Summary of Transformation Activities, Potential Soil and/or Groundwater Impact and Assessment/Mitigation Measures

Activity	Task	Potential Soil and/or Groundwater Impact	Assessment / Mitigation Measures
			geotechnical Scopes of Work)
Excavation	Excavation	Potential breach of aquitard could lead to cross contamination of aquifers	• EMP (including excavation procedures)
	Stockpiling and disposal of contaminated spoil	Stored materials may be contaminated and form a groundwater contamination source	• EMP (including stockpile management procedures)
		Excavated spoil, particularly natural materials may be acid generating under oxidising conditions (i.e. Acid Sulphate Soils)	• EMP (including Acid Sulphate Soils management procedures)
	Dewatering	Could temporarily alter groundwater and contaminant flow paths	• EMP
		Stored water could form a groundwater contaminant source if not appropriately managed	• EMP
	Emplacement of underground cooling water pipeline	Pipeline could interfere with contaminated groundwater flow paths, modifying the location or concentrations of discharge to boundaries	• EMP • Modelling
Piling	Drilling	Potential breach of aquitard could lead to cross contamination of aquifers	• EMP (including management of geotechnical Scopes of Work and specific piling design)
	Stockpiling/storage	Stored materials may be	• EMP

Table 6 Summary of Transformation Activities, Potential Soil and/or Groundwater Impact and Assessment/Mitigation Measures

Activity	Task	Potential Soil and/or Groundwater Impact	Assessment / Mitigation Measures
	and disposal of contaminated spoil and water	contaminated and form a groundwater contamination source	
	Piling Emplacement	Piles ay reduce aquifer transmissivity and alter groundwater and contaminant flow paths	• Modelling • Groundwater Monitoring and Management Plan (GMMP) • Piling design
Caisson and Diffuser emplacement and associated pipelines	Excavation	See above	• EMP
	Caisson, Diffuser and Pipelines Emplacement	Caisson may affect aquifer transmissivity and alter groundwater and contaminant flow paths locally	• EMP • GMMP
Ongoing Operation			
Increased Cooling Water Disposal	Additional water input to Sedimentation Pond and/or First Creek Drain	Increased head in the Sedimentation Pond and/or First Creek Drain could alter groundwater and contaminant flow paths and lead to flooding of low lying areas of the Site through groundwater level increases	• Modelling • GMMP
Rationalisation of Intermediate Materials	Possible disposal of unused feedstocks	Stored materials may form a groundwater contamination source	• EMP (including waste management)
	Creation of open unsealed space	Increases in evaporation from the shallow watertable may alter water balance and groundwater/contaminant flow paths	• Modelling • GMMP
Storage of New Feedstocks	Storage of new, potentially contaminant-bearing feedstocks	Stored materials may form a groundwater contamination source	• Nyrstar Operating Procedure • GMMP

Table 6 Summary of Transformation Activities, Potential Soil and/or Groundwater Impact and Assessment/Mitigation Measures

Activity	Task	Potential Soil and/or Groundwater Impact	Assessment / Mitigation Measures
Acid Management	Monitoring and prevention of acid ingress from historical releases entering the Transformation Site	Groundwater barriers may alter groundwater and contaminant flow paths	• Modelling • GMMP
		Groundwater barriers may fail or be circum-vented requiring contingency measures to be implemented	• GMMP

5.1.2 Surface Water

Table 7 Summary of Transformation Activities, Potential Surface Water Impact and Assessment/Mitigation Measures

Activity	Task	Potential Surface Water Impact	Assessment / Mitigation Measures
Decommissioning and Demolition of Existing Plant			
Demolition	Stockpiling/Disposal of building rubble/waste materials	Stockpiles may leach contamination and run-off into surface or water systems, including the Port Pirie River.	• EMP (including stockpile management procedures)
	Creation of open sealed and/or unsealed space	Increased runoff of potentially contaminated water could enter stormwater or surface water systems, including the Port Pirie River.	• EMP
Construction of New Plant			
Feasibility Investigations	Geotechnical Drilling and Test Pitting	See Excavation Tasks below	
Excavation	Stockpiling and disposal of contaminated spoil	Stockpiled spoil may leach contamination and run-off into stormwater or surface water systems, including the Port Pirie River.	• EMP(including stockpile management procedures)
		Excavated spoil, particularly natural materials may be acid generating under oxidising	• EMP (including Acid Sulphate

Table 7 Summary of Transformation Activities, Potential Surface Water Impact and Assessment/Mitigation Measures

Activity	Task	Potential Surface Water Impact	Assessment / Mitigation Measures
		conditions (i.e. Acid Sulphate Soils) and may leach acid and metals into adjacent stormwater or surface water systems.	Soil Management)
	Dewatering	Stored water could form a stormwater and/or surface water contaminant source if not appropriately managed.	• EMP
Piling	Stockpiling/storage and disposal of contaminated spoil and water	Stored materials may be contaminated and form a stormwater/ surface water contamination source	• EMP
	Piling Emplacement	Piles may alter groundwater flow paths thereby potentially modifying the discharges of groundwater and contaminants to contiguous surface water systems such as the No.1 Drain, Sedimentation Pond and the Port Pirie River	• Modelling • GMMP • Pile Design
Caisson and Diffuser emplacement and associated pipelines	Excavation	See Excavation Impacts above	
		Excavation at the river margin and/or within the intertidal/subtidal zones may lead to sediment mobilisation and unacceptable turbidity and visual impacts	• EMP (including silt management procedures)
	Caisson, Diffuser and Pipeline Emplacement	Caisson may affect aquifer transmissivity, altering groundwater and contaminant flow paths locally thus potentially altering the flux of contaminants to the Port Pirie River	• Modelling • GMMP
Ongoing Operation			
Increased Cooling Water Disposal	Additional water discharges to the Sedimentation Pond, First Creek	Increased flow in the Sedimentation Pond and/or First Creek Drain could increase hydraulic heads in	• Hydrological Modelling conducted by

Table 7 Summary of Transformation Activities, Potential Surface Water Impact and Assessment/Mitigation Measures

Activity	Task	Potential Surface Water Impact	Assessment / Mitigation Measures
	Drain and/or the Port Pirie River	these systems, restricting groundwater drainage and potentially alter dissolved and particulate contaminant loads reporting to the Spencer Gulf	others • Nyrstar Operating Procedure
		The volume, temperature and other physical properties of discharging cooling water may alter the physical environment of the receiving water potentially impacting aquatic flora and fauna	• Hydrodynamic Modelling conducted by others
Rationalisation of Intermediate Materials	Possible movement and/or disposal of unused feedstocks	Stored materials may generate leachate or particulate-bearing run-off to stormwater and/or surface water systems	• EMP (including waste management as appropriate)
Storage of New Feedstocks	Storage of new, potentially contaminant-bearing feedstocks	Stored materials may generate leachate or particulate-bearing run-off to stormwater and/or surface water systems	• Nyrstar Operating Procedure • GMMP
Acid Management	Monitoring and prevention of acid ingress from historical releases entering the Transformation Site	Groundwater barriers may alter rates of discharges of groundwater, acid and/or contaminants to contiguous surface water systems such as the No.1 Drain and Sedimentation Pond, altering contaminant loads at compliance points	• Modelling • GMMP

5.2 Potential Benefits and Opportunities

Provided the potential risks (**Section 5.1**) can be appropriately managed, mitigated or eliminated, the Port Pirie Transformation Project is expected to provide substantial net environmental benefits to the soil, groundwater and surface water systems of the Site and surrounding area. This will be facilitated by four primary mechanisms:

- Reduction of metal-bearing airborne and dust emissions;
- Discontinuation of the use of the sludge dewatering dams and the subsequent recovery of metals-bearing materials;
- Decommissioning and demolition of the existing Acid Plant (and cessation of associated acid ingress to subsurface); and
- Reduction in storage of metal-bearing intermediate materials in the Pit.

The likely significance of these changes for the local groundwater and surface water systems is outlined in the following sections.

5.2.1 Soil and Groundwater

A reduction in metal-bearing airborne and dust emissions would result in reduced entrainment of particulates and gases into recharging rainfall, potentially lowering contaminant concentrations in groundwater proportionately. While these types of emissions are not considered to form key point sources of contamination, they are likely to contribute to the diffuse background contamination conditions that pervade the Site and surrounding groundwater environment.

Discontinuing the use of the sludge dewatering dams, and subsequently recovering the metals-bearing sludges will result in the removal of a substantial and ongoing groundwater (and indirectly surface water) contamination source.

A reduction in the storage of metal-bearing intermediate materials would result in considerable direct and potential indirect beneficial outcomes for groundwater. Direct benefits would include a reduction in contaminant source materials, including leachable oxides, mattes, sinter and other materials and residues, which directly impact the shallow groundwater system, particularly within the Pit Amphitheatre (the Pit).

Decommissioning of the acid plant will remove a significant source of acid to the subsurface environment, improving contamination issues associated with enhanced mobilisation of metals and commensurate decrease in the risks associated with ongoing heave and hydrogen generation.

The removal of stockpiled intermediate materials from the Pit would also increase the evaporative losses from groundwater in this area, where groundwater levels are typically at or near the surface. This would result in less storage of groundwater in the aquifer, reducing hydraulic head and potentially lowering the flux of contaminants towards the Site boundaries. Locally, and in conjunction with Lake Rohrsheim, this could further induce an inward draining hydraulic regime within the Pit area, potentially helping to contain the contaminated groundwater present in this part of the Site, including residual contamination associated with the current sludge dams.

Indirectly, the potential redundancy of the Pit for the storage of intermediate materials may liberate space which could be used for passive remedial systems, such as evaporative lakes. The passive management of groundwater at the Site, including the management of contamination is a key long term objective of the groundwater management program (see **Section 3.1**), with evaporative lakes one of the preferred candidate options.

5.2.2 Surface Water

The deposition of metal-bearing dust and other emissions across the broader Port Pirie township currently results in metals, primarily lead and zinc, reporting to the town stormwater network. Ultimately, this stormwater reports to the Port Pirie River, thus contributing to the relatively poor background water quality within this system.

Reductions in dust and other airborne emissions will result in lower metals loads in stormwater and subsequently improve conditions in downstream surface water systems.

Similarly, the reduction in storage of metal-bearing intermediate materials is likely to measurably improve dust emissions from the Site, delivering commensurate improvements in local surface water quality.

6 Impact Management

The issues identification process highlights some potential direct (and in many cases indirect) human health and environmental risks, which require further assessment, mitigation or control to appropriately manage.

These will be managed by assessment of likely impacts through numerical modelling prior to construction, and by the documentation of appropriate management and monitoring protocols in Construction Environmental Management Plans, Operational Environmental Management Plans (EMPs) and the Site Groundwater Monitoring and Management Plan (GMMP).

6.1 Environmental Management Plans (EMPs)

The EMPs will provide a framework to manage human health and environmental risks associated with transformation activities at the Site. The key objective of the EMP is to ensure that the activities are conducted in a way that minimises the risk of contamination exposure to construction workers and minimises environmental impacts to the Site and the surrounding areas.

An EMP defines the responsibilities of the Project Manager in protecting the environment at the Site and the implementation of appropriate control techniques and practices to achieve 'Environmental Best Management Practices' for the duration of the project.

The EMPs address the following:

- Background and site summary information including site identification, scope of the proposed activity and CoPC;
- Roles and responsibilities of parties involved;
- Health and safety requirements including management options and controls to mitigate occupational health and safety hazards;
- Regulatory, licensing and legislative requirements;
- Identification of potential environmental impacts associated with each activity, including dust, noise, vapour, soil contamination, groundwater contamination, surface water runoff, soil runoff and waste generation;
- Relevant environmental management quality control measures to minimise potential impacts associated with the each activity including operational objectives, performance criteria, management strategies, monitoring, reporting and corrective actions; and
- Emergency procedures and environmental incident response.

The EMP will be subject to review and approval by the appointed Auditor.

6.2 Groundwater Monitoring and Management Plan (GMMP)

A GMMP will be implemented to assess and monitor; temporal and spatial changes in groundwater quality and therefore any downstream impacts on adjacent surface water systems, the impacts of Transformation activities at the Site (as part of regular Site-wide monitoring), and the adequacy of remedial measures (where implemented).

The objectives of the GMMP are:

- Outline groundwater and associated surface water management and monitoring requirements at the Site.
- Document appropriate groundwater quality objectives for monitoring purposes.
- Determine contaminant trigger levels and contingency actions.
- Detail reporting requirements and responsibilities.

The GMMP comprises the following:

- Definition of roles and responsibilities.
- Identification of groundwater and surface water CoPC.
- Identification of relevant groundwater and surface water beneficial uses and permitted beneficial uses at and surrounding the Site.
- Definition of groundwater quality management objectives.
- Summary of groundwater management approach including health and safety protocols.
- Groundwater and surface water monitoring requirements including the rationale for sampling, location of sampling points, sampling methodologies and frequency of sampling.
- Definition of contaminant trigger levels to assess if relevant groundwater quality management objectives have been met.
- Contingency actions to be implemented where trigger levels are exceeded.

The GMMP will be subject to review and approval by the Auditor.

6.3 Groundwater Numerical Modelling

The existing numerical groundwater flow model, developed by BlueSphere (BlueSphere, 2013b), is a computerised mathematical representation of the groundwater environment of the Site and surrounding area. The input parameters, which determine model behaviour, can be infinitely modified to represent future physical changes to the groundwater system (e.g. those induced by new subsurface infrastructure), and the model used to predict the likely groundwater system response. This can be coupled with contaminant data to predict any changes in contaminant fate and transport.

As determined in the preceding sections (**Table 6** and **Table 7**), the Transformation Project presents a number of potential risks to soil, groundwater and surface water. Where these risks are related to potential physical changes induced by new subsurface infrastructure intercepting the groundwater system (e.g. piles and other deep foundations), it is proposed to input the relevant parameters to represent these changes into the model and use the model to predict the likely changes to the groundwater flow regime and any subsequent impact to any downstream surface water system.

It should be noted that the current calibration of the numerical model for the site effectively allows for any existing piles and other low permeability structures in the subsurface. The interactions between proposed and existing structures will not be explicitly simulated by the model. Rather, zones of reduced permeability will generally be implemented to represent the proposed structures within an essentially homogenous aquifer, the bulk permeability of which reflects the distributed impacts of any existing features.

The model may be utilised during the options assessment phase or following the determination of final design criteria. Current modelling scenarios or input parameters related to Transformation are expected to include the following at a minimum:

- The effects of the distribution of new piles throughout the Transformation project area;
- The effects of the distribution of any foundations or other sub-surface infrastructure expected to be constructed below water table;
- The effects of any remedial measures or groundwater interception/management infrastructure related to acid risk mitigation and management (i.e. groundwater/acid barriers);
- The effects of caisson (new seawater intake) emplacement on local groundwater system;
- The effects of removing intermediate materials stockpiles from areas of shallow water table; and
- The effects of any additional evaporative lakes proposed in redundant areas of the Pit Amphitheatre.

Due to the relative scale of the Site (and therefore model domain) compared to the anticipated subsurface features, including the cumulative impact where several such features may be present in any given area, the detrimental impacts to groundwater flow and contaminant fate are expected to be minimal. Where a potential risk is identified by the modelling, a risk assessment may be required to determine appropriate elimination, mitigation or management approaches.

7 Conclusions

The surface water, soil and groundwater environments are well understood at the Site. Thus, the effects of Transformation can be confidently predicted and managed.

The Transformation Project is expected to deliver a net benefit to the environment, including the soil, groundwater and surface water systems of the Site and local surrounding environment.

Where potentially detrimental effects on soil, surface water and groundwater have been identified, these can be effectively and readily managed through the use of a combination of standard environmental best practice procedures and protocols, which Nyrstar commits to implementing.

This process comprises the following elements in the soil, surface water and groundwater context:

- Development of Environmental Management Plans (EMPs);
- Development of Groundwater Monitoring and Management Plans (GMMPs);
- Further assessment and risk quantification and management planning through numerical modelling; and
- Review and approval of documents, work plans and procedures and implementation by an independent EPA-appointed Auditor (while the Site remains subject to a Site Contamination Audit).

Development and implementation of, and adherence to, these processes by appropriately qualified persons will ensure that the potential detrimental environmental effects to soil, surface water and groundwater are eliminated or appropriately managed in accordance with regulatory requirements.

8 Limitations

This report was prepared for the sole use of the **Nyrstar Port Pirie Pty Ltd** and should not be relied upon by any other person. None of BlueSphere Environmental Pty Ltd or any of its related entities, employees or directors (each a **BlueSphere Person**) owes a duty of care (whether in contract, tort, statute or otherwise) to any third party with respect to or in connection with this report and no BlueSphere Person accepts any liability for any loss or damage suffered or costs incurred arising out of or in connection with the use this report by any third party.

The work was carried out in accordance with the Nyrstar Port Pirie Consultancy Agreement ZC-02408.

The conclusions and recommendations provided in this report are based on available information and it is possible that different conclusions and recommendations could be made should new information become available, or with changing site conditions over time. These opinions, conclusions and recommendations are subject to uncertainty given the potentially complex nature of any subsurface environment. Variation in soil and groundwater conditions may vary significantly between the specific sampling and testing locations and other locations at the site.

The report will not be updated if anything occurs after the date of this report and BlueSphere Environmental Pty Ltd will not be obliged to inform any person of any matter arising or coming to its attention after that date.

9 References

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Tables

Table T1 Exposure Pathway Analysis

Source(s)	CoPC	Pathway	Receptor	Complete Pathway
Metals smelting plant and processes (Zinc and Cadmium Plants) Fill Aquifer Materials storage General maintenance PETs and RO plant Sewage treatment Dams and ponds Acid Sulphate Soils	Metals/metalloids	Dermal contact	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducting construction and maintenance works.
		Ingestion	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducting construction and maintenance works.
		Inhalation	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducting construction and maintenance works.
		Migration via groundwater	Surface water bodies (Port Pirie River)	Yes – groundwater known to discharge to Port Pirie River.
Acid treatment, production and storage	Hydrogen	Dermal contact	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducting construction and maintenance works.
		Ingestion	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducting construction and maintenance works.
		Inhalation	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	Yes – short term exposure via migration of hydrogen gas through buildings.

Source(s)	CoPC	Pathway	Receptor	Complete Pathway
		Migration via groundwater	Surface water bodies (Port Pirie River)	Yes – groundwater known to discharge to Port Pirie River.
	Acid/s (including those generated by Acid Sulphate Soils)	Dermal Contact	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducting construction and maintenance works.
		Ingestion	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducting construction and maintenance works.
		Inhalation	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducted contraction and maintenance works.
		Migration via groundwater	Surface water bodies (Port Pirie River)	Yes – groundwater known to discharge to Port Pirie River.
Storage of hydrocarbons Free phase hydrocarbons in groundwater PETs and RO Plant Water treatment Laboratory	Hydrocarbons (TPH C_6-C_{36})	Dermal contact	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducting construction and maintenance works.
		Ingestion	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducting construction and maintenance works.
		Inhalation	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building	Yes – short term exposure via migration

Source(s)	CoPC	Pathway	Receptor	Complete Pathway
			occupants	of hydrogen through buildings.
		Migration via groundwater	Surface water bodies (Port Pirie River)	Yes – groundwater known to discharge to Port Pirie River.
Landfill Sewage treatment plant	Ammonia and nitrate	Dermal contact	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	Yes – short term exposure via migration of hydrogen through buildings.
		Ingestion	Construction and maintenance workers	Yes – short term exposure
			On-Site workers/building occupants	No – exposure unlikely unless conducting construction and maintenance works.

Figures

PROJECT ID 30143.01
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BlueSphere ENVIRONMENTAL

Legend

- Audit Area Boundary
- SX Holdings
- Site Operating Boundary

N

0 60 120 180 240 300
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SITE LOCALITY PLAN

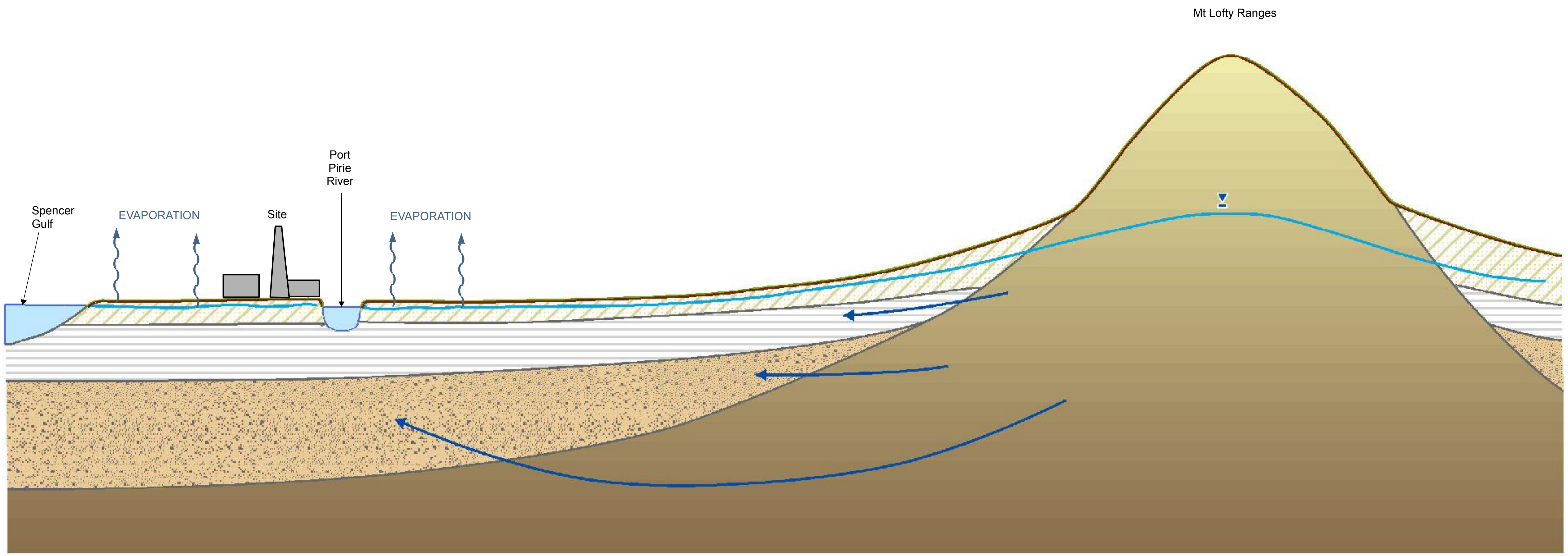
Effects of Transformation on Soil, Surface Water and Groundwater Management

Nyrstar Port Pirie Smelter,
Ellen St, Port Pirie

Nyrstar Port Pirie Pty Ltd

Figure
F1

30143_01_FigF1_SiteLocality_Rev00.mxd



LEGEND

- Ground surface
- Evaporation
- Water Table
- Groundwater Flow Direction
- Water Body
- Quaternary Sediments - St. Kilda Formation and Other Deposits
- Quaternary Sediments - Hindmarsh Clay
- Tertiary Sediments
- Proterozoic Basement

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REGIONAL CONCEPTUAL HYDROGEOLOGICAL SECTION

Effects of Transformation on Soil, Surface Water and Groundwater Management

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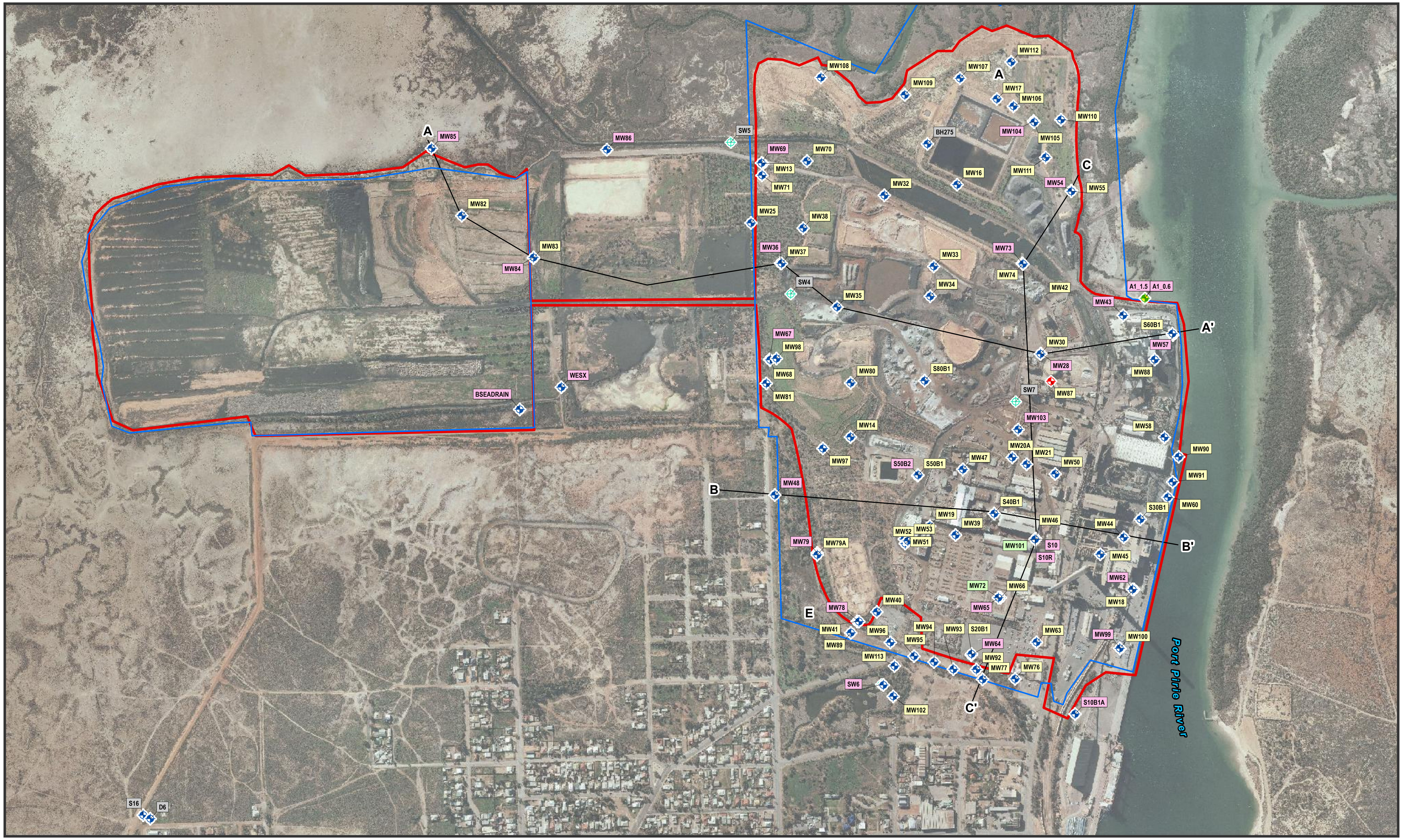
Figure
F2

30143_01_FigF2_Regional_HydroGeo_Section_Rev00.mxd



LEGEND

- Site Operating Boundary
- Groundwater Well
- Extraction Bore Location
- MW65 Fill Aquifer Monitoring Well
- MW66 UNA Aquifer Monitoring Well
- MW72 Hindmarsh Aquifer Monitoring Well
- Surface Water Sampling Location
- Seepage Sample Location
- Intertidal Array
- A—A' Cross Section Alignment
- Audit Area Boundary

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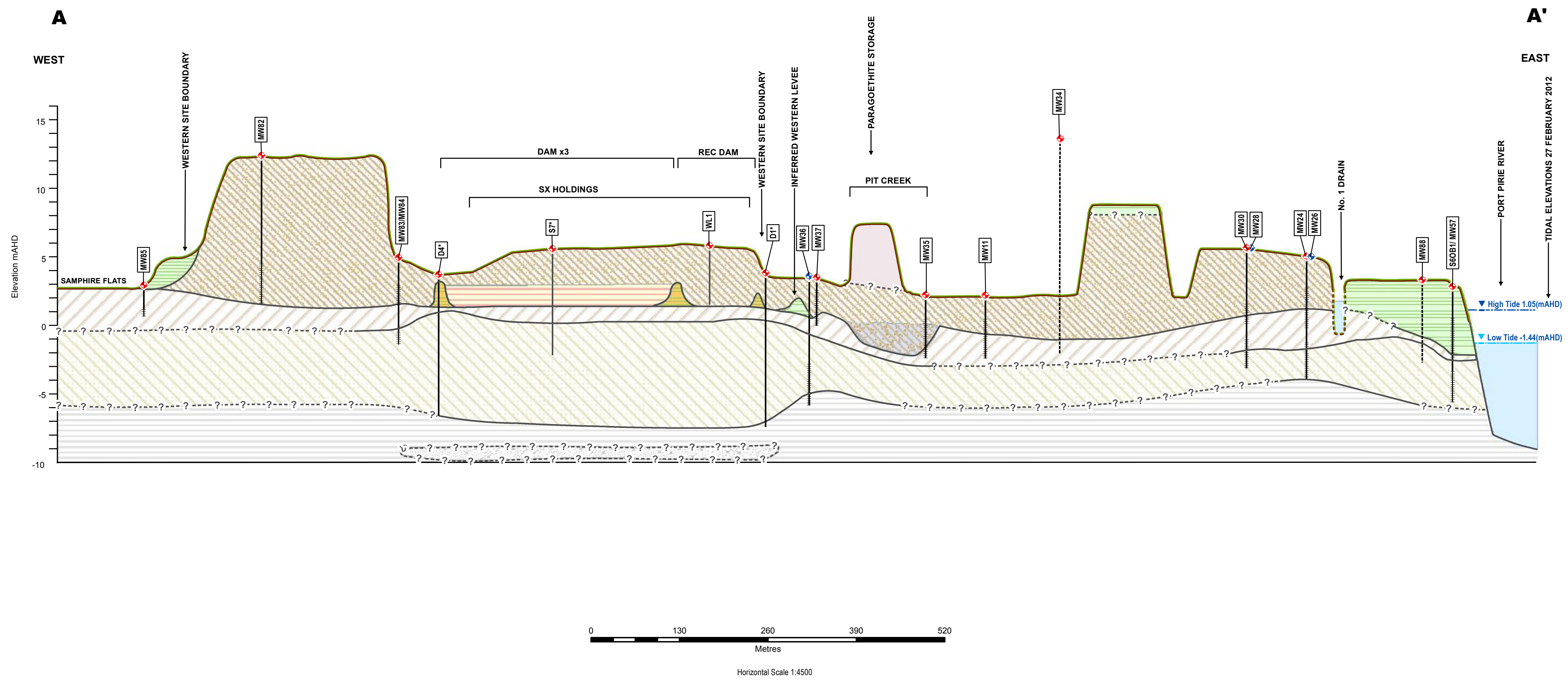
SITE LAYOUT, MONITORING WELL NETWORK AND CROSS SECTION ALIGNMENTS

Effects of Transformation on Soil, Surface Water and Groundwater Management

Nyrstar Port Pirie Smelter,
Ellen St, Port Pirie
Nyrstar Port Pirie Pty Ltd

Figure
F3

30143_01_FigF3_GW_Bores_and_XSect_Lines_PlantArea_Rev00.mxd



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LEGEND

Groundwater Monitoring Wells

- Slag Aquifer
- Quaternary / Natural Aquifer
- Decommissioned

Note: *Inferred from URS (2006)

- Monitoring Well
- Bore (Transposed)
- Screen
- Ground surface
- Interpreted Geological Boundary
- Inferred Geological Boundary
- High Tide Level (mAHD)
- Low Tide Level (mAHD)
- Water Body
- Creek Bed filled with Slag
- Tailings
- PGP
- Miscellaneous Fill
- SX Holdings Tailings Dam Bunds
- Type 1 - Granulated Slag
- Type 2 - Poured/ Glassy Slag
- Type 3 - Poured/ Glassy Slag Low Permeability

Saint Kilda Formation
- Samphire Clay
- Silty / Sandy Clay (Upper Natural Aquifer)

- Hindmarsh Clay
- Hindmarsh Sands

GEOLOGICAL CROSS SECTION A - A' (WEST - EAST)

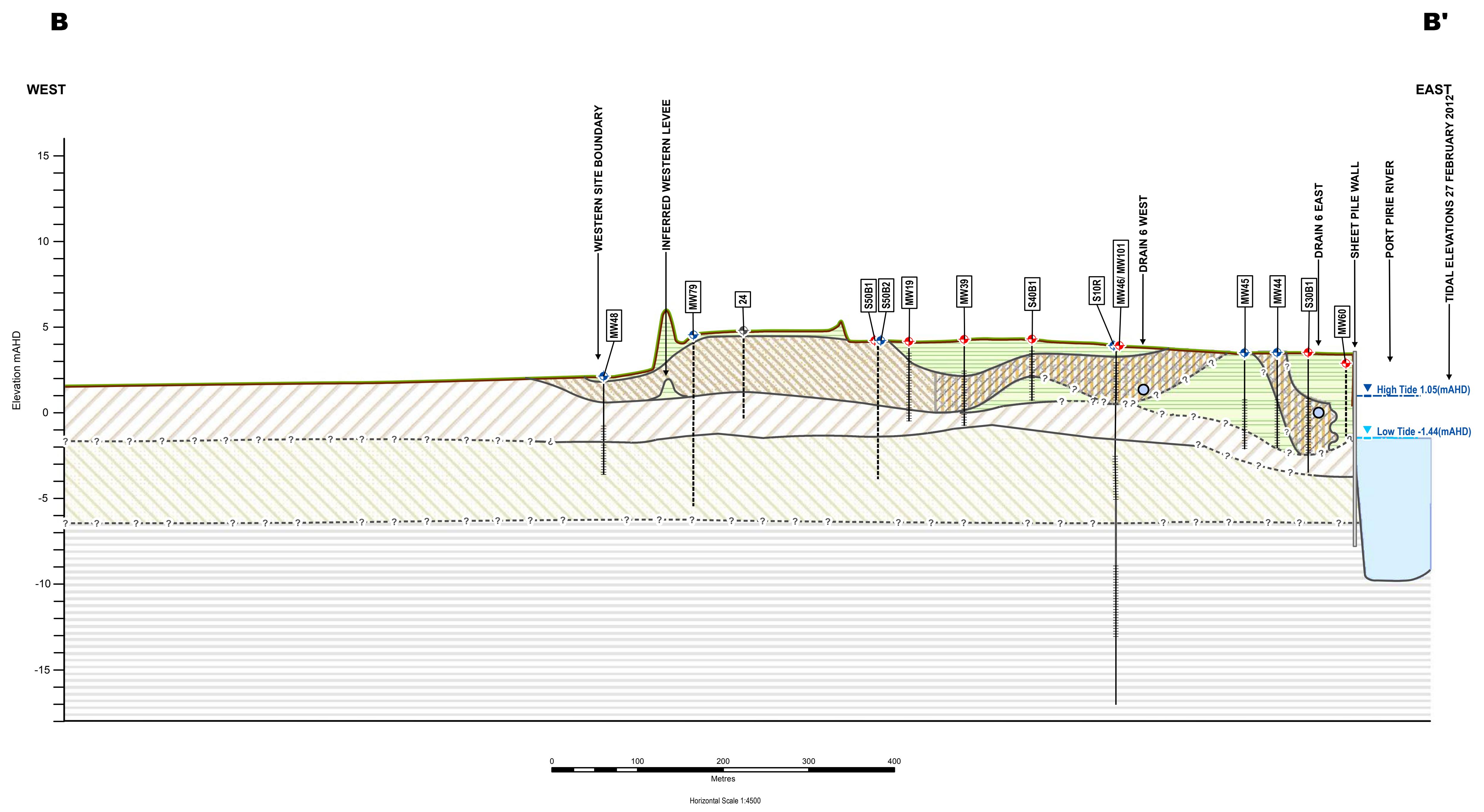
Effects of Transformation on Soil, Surface Water and Groundwater Management

Nyrstar Port Pirie Smelter, Ellen St, Port Pirie

Nyrstar Port Pirie Pty Ltd

Figure
F4

30143_01_FigF4_Geological_XSect_AA_Rev00.mxd



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LEGEND

Groundwater Monitoring Wells

- Slag Aquifer
- Quaternary / Natural Aquifer
- Decommissioned
- Underground Drain
- Water Body
- High Tide Level (mAHD)
- Low Tide Level (mAHD)

- Monitoring Well
- Bore (Transposed)
- Screen
- Ground surface
- Interpreted Geological Boundary
- ? - - - Inferred Geological Boundary

- Miscellaneous Fill
- Type 1 - Granulated Slag
- Type 2 - Poured/ Glassy Slag
- Type 3 - Poured/ Glassy Slag Low Permeability
- Undifferentiated Sand
- Saint Kilda Formation: Samphire Clay
- Saint Kilda Formation: Silty / Sandy Clay (Upper Natural Aquifer)
- Hindmarsh Clay

GEOLOGICAL CROSS SECTION B - B' (WEST - EAST)

Effects of Transformation on Soil, Surface Water and Groundwater Management

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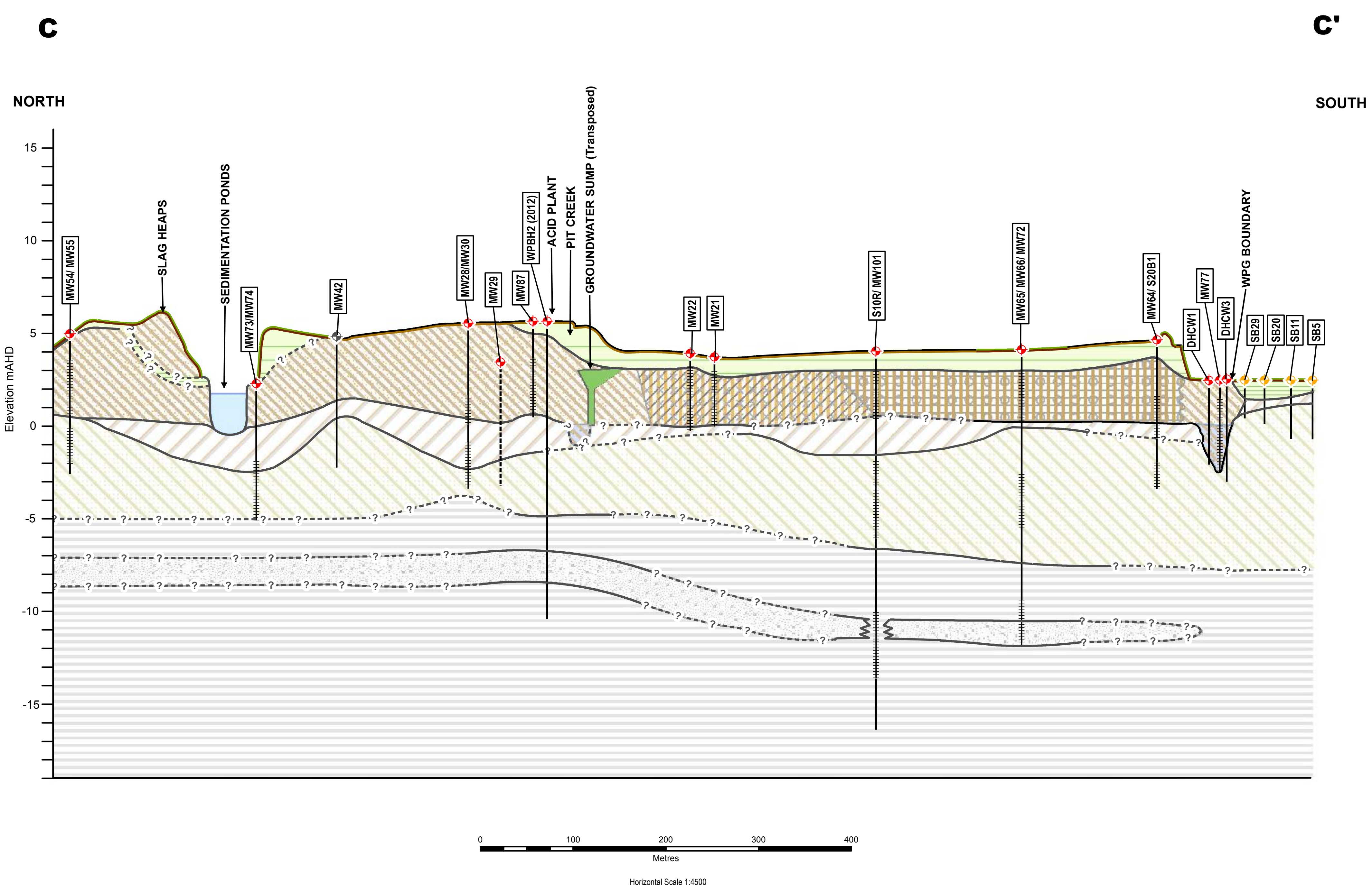
Nyrstar Port Pirie Pty Ltd

Figure F5

30143_01_FigF5_Geological_XSect_BB_Rev00.mxd



LEGEND

Groundwater Monitoring Wells

- Slag Aquifer
- Quaternary / Natural Aquifer
- Decommissioned
- SKM Bores
- Monitoring Well
- Bore (Transposed)
- Screen
- Ground surface

- Sealed Surface
- Interpreted Geological Boundary
- ? Inferred Geological Boundary
- High Tide Level (mAHD)
- Low Tide Level (mAHD)
- Water Body
- Creek Bed filled with Slag

- Miscellaneous Fill
- Type 1 - Granulated Slag
- Type 2 - Poured/ Glassy Slag
- Type 3 - Poured/ Glassy Slag Low Permeability

Saint Kilda Formation
- Samphire Clay
- Silty / Sandy Clay (Upper Natural Aquifer)

- Hindmarsh Clay
- Hindmarsh Sands

Notes:
- GW Sump elevations from survey plus SG memorandum 19/09/11 - groundwater survey and pump arrangement
- Based on GW head difference between MW46 & S10, and historical zinc plant cross sections. It has been inferred there is a confining layer at S10 not shown on borelog
- Pit Creek Assumed to have similar bank and channel elevations as dead horse creek
- Sedimentation pond elevations as built plan 27/8/92 - SR2-1148

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GEOLOGICAL CROSS SECTION C - C' (NORTH - SOUTH)

Effects of Transformation on Soil, Surface Water and Groundwater Management

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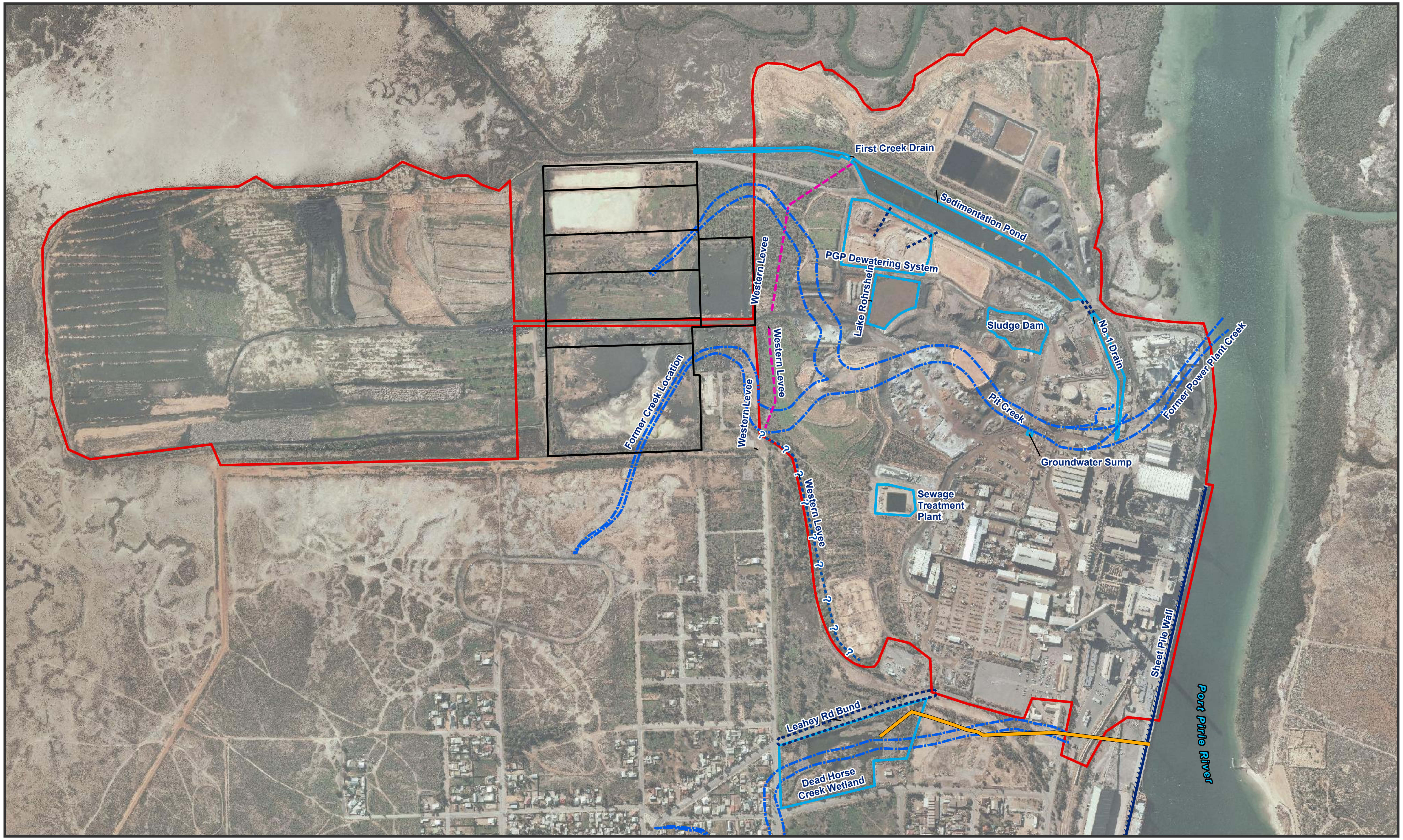
Figure **F6**

30143_01_FigF6_Geological_XSect_CC_Rev00.mxd



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LEGEND

- Site Operating Boundary
- SX Holdings Bunds
- Dead Horse Creek Pipeline

Key Site Hydraulic Features

- Surface
- Former Creek Location
- Underground
- ? Inferred Underground Location
- Wall

N

0 50 100 150 200
Metres
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KEY SITE HYDRAULIC FEATURES

Effects of Transformation on Soil, Surface Water and Groundwater Management

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Figure
F7

30143_01_FigF7_KeySiteHydraulicFeatures_Rev00.mxd

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Legend

- Site Operating Boundary
- SX Holdings
- Audit Area Boundary
- A PETS and RO Plant
- B Water Treatment Plant
- C Roast Fume Storage Plant and Pad
- D Slag Fumer
- E Acid Plant and Acid Treament Plant
- F Laundry Power Plant
- G General Maintenance
- H Blast Furnace and Mixing
- I Cadmium Plant
- J Sinter Plant
- K Precious Metal Refinery
- L Zinc Plant
- M Copper Plant
- N Storage
- O Administration and Amenities
- P Sewage Treatment Plant
- Q Baghouse and Tall Stack
- R Lead Refinery
- S Co Treatment Shed
- T Sedimentation Pond
- U Arsenic Dams
- V Material Storage - 'The Pit'
- W Landfill
- X Coke & Coal Storage
- Y USTs and Bowser
- Z Sludge Dams
- AA Iron-Arsenic Speiss
- AB Zinc Concentrate Storage
- AC Old Annexe & Workshops
- AD Wharf and Former Rail Loading Areas
- AE Paragoethite Storage
- AF Materials Storage
- AG Raw Fume Storage
- AH Biosolids/ Sludge Dam
- AI Air Separation Plant
- AJ ETSA Transformer Yard

N

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Metres
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GENERAL SITE ACTIVITY BY AREA

Effects of Transformation on Soil, Surface Water and Groundwater Management

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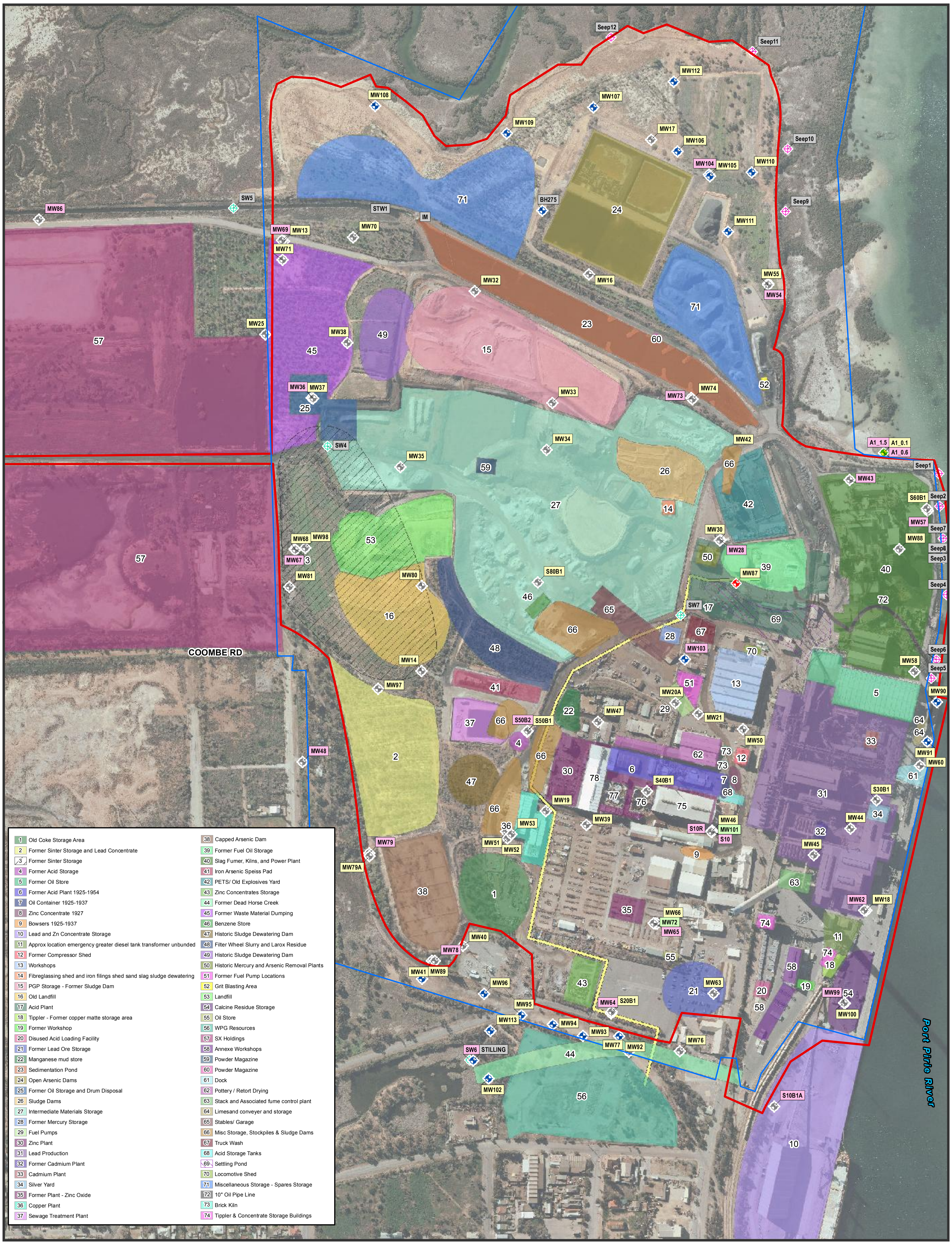
Ellen Street, Port Pirie

Nyrstar Port Pirie Pty Ltd

Figure
F8

30143_01_FigF8_SiteActivityPlan_Rev00.mxd



BlueSphere ENVIRONMENTAL

PROJECT ID 30143.01
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Legend

- Site Operating Boundary
- Audit Area Boundary
- Monitoring Well/ Extraction Bore
- Intertidal Array
- Surface water Sample Location
- Seepage Sample Location
- Groundwater Well - New
- Groundwater Well - Existing
- The Shell Pipeline
- MW64 UNA Aquifer Bore
- MW77 Fill Aquifer Bore
- MW72 Hindmarsh Clay Aquifer Bore

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Metres
1:5,000 when printed at A3
GDA94 MGA Zone 54

SUMMARY OF SITE CONTAMINATION SOURCES

Effects of Transformation on Soil, Surface Water and Groundwater Management

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Ellen St, Port Pirie

Nyrstar Port Pirie Pty Ltd

Figure
F9

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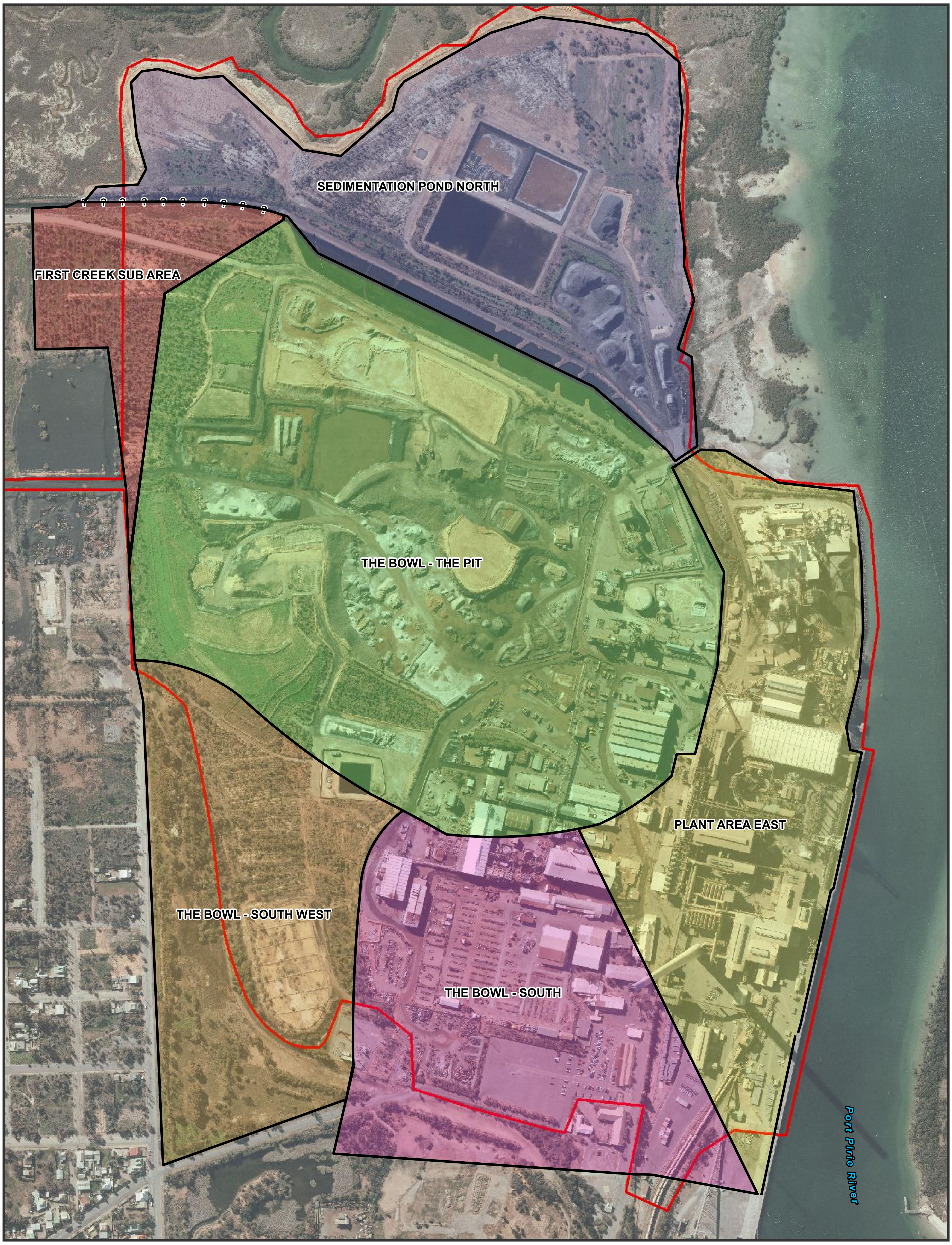
30143_01_FigF9_SiteContaminationSources_Rev00.mxd



BlueSphere ENVIRONMENTAL

PROJECT ID 30143.01
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LEGEND

- Site Operating Boundary
- ?--?- Inferred Boundary
- Interpreted Boundary

Hydrogeological Zones

- First Creek Sub Area
- Plant Area East
- Sedimentation Pond North
- The Bowl - South
- The Bowl - South West
- The Bowl - The Pit

N

0 25 50 75 100
Metres
1:4,500 when printed at A3
GDA94 MGA Zone 55

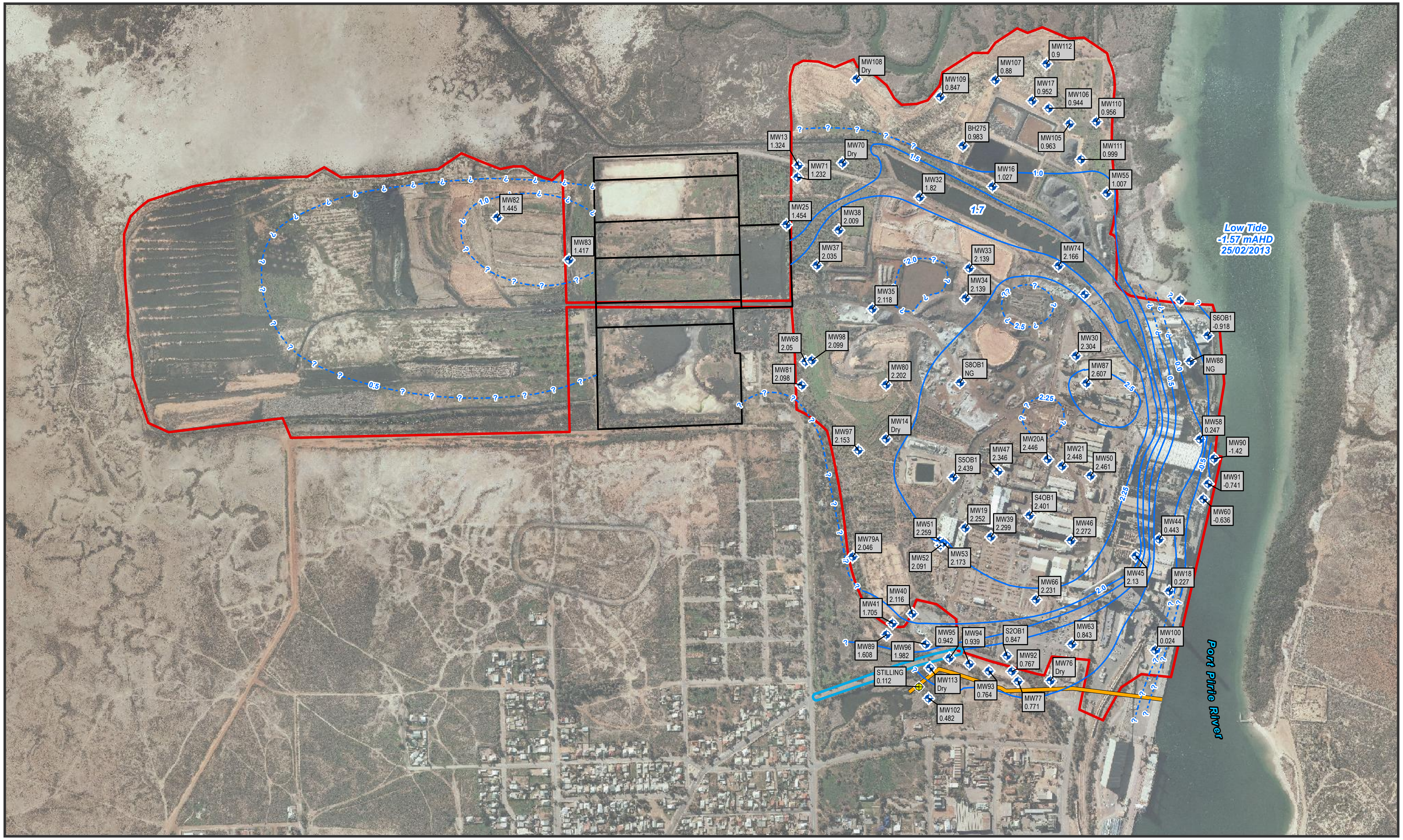
HYDROGEOLOGICAL ZONE BOUNDARIES

Effects of Transformation on Soil, Surface Water and Groundwater Management

Nyrstar Port Pirie Smelter,
Ellen St, Port Pirie
Nyrstar Port Pirie Pty Ltd

Figure
F10

30143_01_FigF10_Hydrogeological_Zone_Boundaries_Rev00.mxd



LEGEND

- Site Operating Boundary
- Groundwater Well
- Stilling Well
- MW35 NG — NG denotes Not Gauged
- Interpreted Groundwater Contours m(AHD)
- Inferred Groundwater Contours m(AHD)
- SX Holdings Bunds
- Leahey Rd Bund
- Dead Horse Creek Pipeline

BlueSphere ENVIRONMENTAL

PROJECT ID 30143.01
DATE 24 Jun 2013
CREATED BY ART

0 50 100 150 200
Metres
1:8,000 when printed at A3
GDA94 MGA Zone 54

FILL AQUIFER GROUNDWATER CONTOURS - FEBRUARY 2013

Effects of Transformation on Soil, Surface Water and Groundwater Management

Nyrstar Port Pirie Smelter,
Ellen St, Port Pirie

Nyrstar Port Pirie Pty Ltd

Figure
F11

30143_01_FigF11_Fill_RWL_Rev00.mxd

LEGEND

- Site Operating Boundary
- Groundwater Well
- Stilling Well
- Interpreted Groundwater Contours m(AHD)
- Inferred Groundwater Contours m(AHD)
- SX Holdings Bunds
- Leahey Rd Bund
- Dead Horse Creek Pipeline

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GDA94 MGA Zone 54

BlueSphere
ENVIRONMENTAL

PROJECT ID 30143.01
DATE 24 Jun 2013
CREATED BY ART

UNA AQUIFER GROUNDWATER CONTOURS - FEBRUARY 2013

Effects of Transformation on Soil, Surface Water and Groundwater Management

Nyrstar Port Pirie Smelter,
Ellen St, Port Pirie

Nyrstar Port Pirie Pty Ltd

Figure
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30143_01_FigF12_UNA_RWL_Rev00.mxd

Resources for a changing world

Appendix J:

Draft Construction Environmental Management Program

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1 Introduction

This Draft Construction Environmental Management Plan (draft CEMP) has been prepared as part of the Public Environment Report (PER) for the proposed upgrade to the Nyrstar Port Pirie Pty Ltd (Nyrstar) Smelter known as the Transformation. The Construction Phase encompasses demolition, decommissioning and construction activities.

The aim of the draft CEMP is to provide a framework of proposed environmental management and monitoring during construction activities of the Transformation, as identified from the Risk Assessment (refer to **Chapter 16** of PER). The draft CEMP is intended to be a precursor for the Construction Environmental Management Plan (CEMP) designed to ensure that the strategies and control measures identified during the PER Risk Assessment are implemented.

The draft CEMP addresses the following:

- Background and site summary information;
- Roles and responsibilities of parties involved;
- Regulatory, licensing and legislative requirements;
- Identification of potential environmental and social aspects; and
- Identification of quality control measures to manage impacts and achieve risk levels ALARP for each aspect.

Note that health and safety requirements for employees and organisational risks will be addressed by upgrading the current operations Nyrstar Management System.

1.1 Background to the Transformation

The Transformation will replace the existing outdated smelting facilities with new more environmentally friendly technology. The Project will transform the current lead smelting plant to an advanced poly-metallic processing and recovery facility, which is expected to improve emissions and associated air quality within the Port Pirie community.

The Transformation will involve the construction and operation of:

- an Enclosed Bath Smelting (EBS) Oxidation Furnace that replaces the Sinter Plant;
- a larger Oxygen Plant;
- an EBS Reduction Furnace that replaces the existing Blast Furnace should it be approved during the feasibility stage;
- a Sulphuric Acid Plant that replaces the existing Acid Plant;
- storage areas for mineral concentrate and raw materials;
- an upgraded Cooling Water System;
- infrastructure including workshop and upgrading of roads; and
- decommissioning and/or demolition of the existing Sintering Plant, Blast Furnace (should it be required) and Acid Making operations and associated infrastructure.

1.2 Site information

The Transformation will be located within the existing Port Pirie Smelter property. The development site layout, including the proposed Project infrastructure is shown in Figure 1-1.

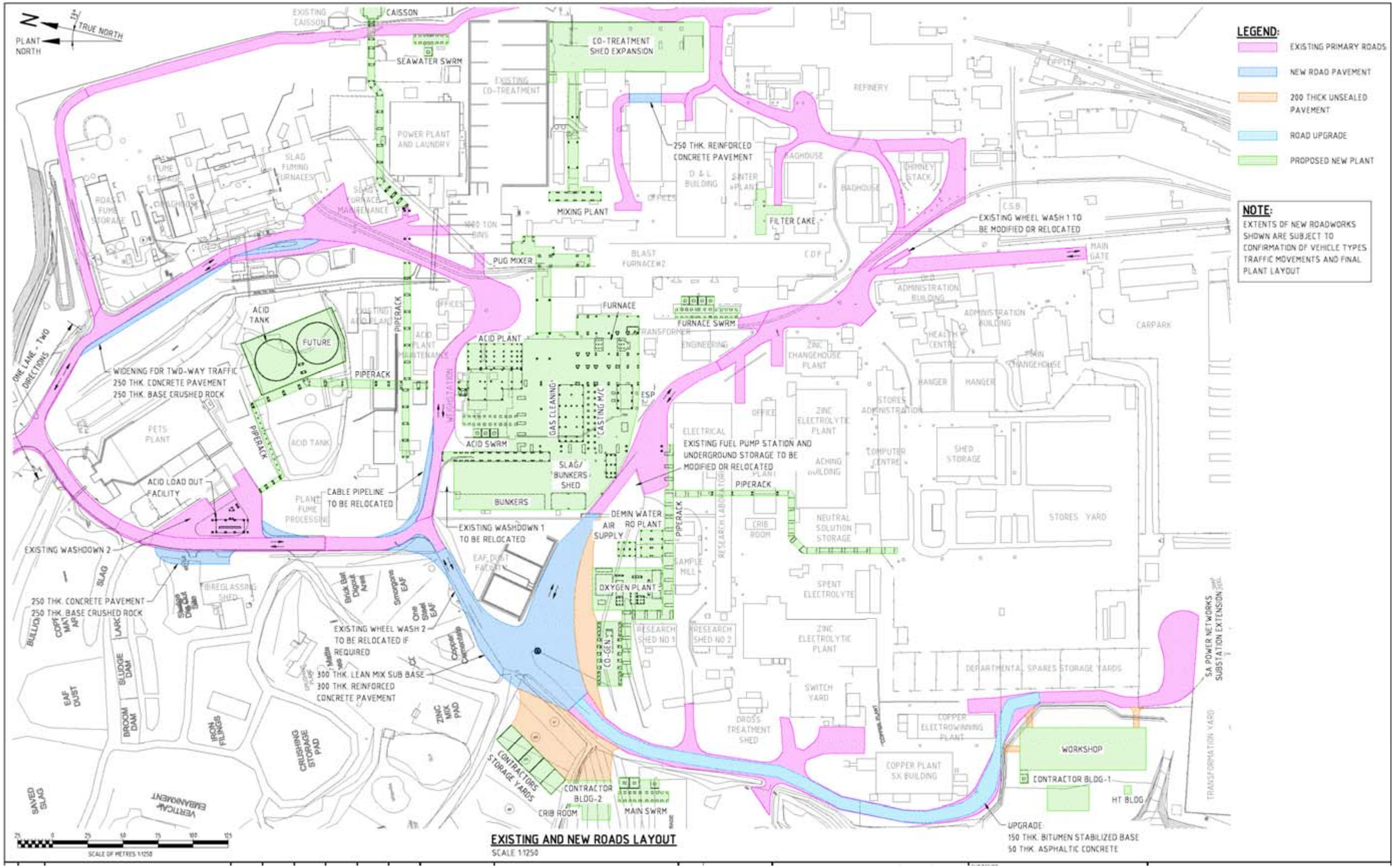

Figure 1-1: Layout of the Project Site

2 Environmental Management System

Nyrstar operates an Environmental Management System (EMS) certified to Australian Standards (AS/NZS ISO 14001:2004) for the existing Smelter facilities. Protection of the environment during construction and operation of the Transformation will be managed through the development and implementation of new Environmental Management Plans (EMP) specifically targeting the new plant, equipment and works to ensure they complement the existing management systems.

This draft CEMP is intended to provide a basis for the public review and approvals process prior developing a CEMP that will incorporate specific control measures designed to suit the plant and equipment selected in the final design. The CEMP will address all the comment from the public review and approvals process.

The CEMP will describe the controls proposed to prevent, monitor and manage possible impacts and will be incorporated with the existing Environmental Monitoring and Reporting Program (EMRP).

The CEMP and modified EMRP will be incorporated into the Nyrstar EMS and submitted to relevant authorities for approval prior to the commencement of construction.

2.1 Specific Requirements of the draft CEMP

The draft CEMP outlines the responsibilities of the Nyrstar Project Manager in protecting the community and environment during decommissioning, demolition and construction activities (the Construction Phase). The draft CEMP provides a framework for the implementation of appropriate control measures and practices in order to achieve risk levels that are as low as reasonably practicable (ALARP).

3 Roles and Responsibilities

It will be compulsory for all personnel involved in the Transformation including Nyrstar employees and their contractors and consultants to comply with this draft CEMP. All personnel involved in the construction phase must be familiar with the details of the management plan and understand the implications presented in this document. Everyone associated with the Transformation must also undertake their work in accordance with and in compliance to:

a) The statutory requirements as outlined in Section 4 of this document; and
b) The terms of their engagement.

All personnel working on site during construction will be required to complete a Site Induction explaining the environmental and social context and the management systems implemented to protect the environment and surrounding communities. All persons completing the induction must sign the Environmental Induction Register to confirm that they understand and will implement the environmental management system. The Register will be maintained on Site and available for inspection by auditors.

The process of finalising the CEMP will entail an education program to ensure awareness for staff, contractors and consultants.

The roles, responsibilities and requirements for the environmental and social management of the Construction Phase of the Transformation are outlined in **Table 3-1**.

Table 3-1: Roles and Responsibilities

Role	Responsibility
Project Manager	Overview the implementation of the draft CEMP and the development and implementation of the CEMP. Allocate sufficient funds and resources to fully implement every component of the CEMP.
Contractor	Contribute to the development of the CEMP to ensure that every environmental aspect covered in the draft CEMP is fully incorporated. The contractor is responsible for any environmental or social impacts attributed to any work, plant and equipment that falls within the boundaries of their contract. Ensure that Nyrstar's intent of significantly reducing the current environmental and social impacts during and after construction.
Consultant	Contribute to the development of the CEMP to ensure that every environmental aspect covered in the draft CEMP is fully incorporated. The consultant is responsible for any environmental or social impacts that may be attributable to specialist advice that they provide. Ensure that Nyrstar's intent of significantly reducing the current environmental and social impacts during and after construction.
Employees	All persons working on the construction of the Transformation are responsible for understanding the environmental and social management systems. All persons working on the construction phase will fully understand and implement the control measures and follow the procedures associated with their work.
Supervisors	All supervisors are responsible for implementing the control measures and directly or through specially trained environmental specialist monitor that the management systems are working as intended.

4 Relevant Legislation and Guidelines

4.1 Environmental Legislation, Regulations and Guidelines

Construction activities will be conducted in compliance with applicable environmental legislation, regulations and guidelines, including but not limited to:

- *Environmental Protection Act*, 1993;
- *Environment Protection (Water Quality) Policy*, 2003;
- *Environment Protection (Air Quality) Policy*, 1994;
- *Environment Protection (Noise) Policy*, 2007;
- National Environment Protection (Ambient Air Quality) Measure;
- National Environment Protection (National Pollutant Inventory) Measure;
- Guideline for Air Quality Impact Assessment Using Design Ground Level Pollutant Concentrations (EPA South Australia, 2006);
- Guideline for the use of the Environment Protection (Noise) Policy (EPA South Australia, 2007);
- Guidelines for the Assessment and Remediation of Groundwater Contamination (EPA South Australia, 2009); and
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, (ANZECC & ARMCANZ, 2000).

4.2 Licenses and Permits

The Transformation will operate under licences issued by the South Australian EPA on approval. The CEMP and any subsequent OEMP will adhere to the conditions of these licences, ensuring that all onsite works are compliant. The existing EMRP will be updated to incorporate changes expected during the construction Phase of the Transformation.

Nyrstar will ensure that all personnel will obtain all relevant permits prior to the commencement of construction activities and that all contractors and their employees will hold relevant licences and/or permits to operate all plant and equipment required to undertake the work.

5 Environmental Management

5.1 Activities and events that may impact on the environment and community

Activities and events that were identified (**Chapter 16** of the PER) as potentially having an impact on environmental and social aspects during the Construction Phase are detailed in Table 5-1. This table shows the inherent level of risk evaluated prior to implementing the control measures. These measures reduce the residual level of risk to as low as reasonably practical (ALARP). The proposed control measures are discussed in Section 5.2.

Table 5-1: Activities and Events that may impact environmental and social aspects during the construction phase

Activity	Event Description	Aspect (Risk Level*)
Demolition Phase		
Demolition of infrastructure	Asbestos is disturbed in the course of activities	• Air quality (L) • By-product/Waste generation (M) • Community health (L)
Decommissioning Phase		
EBS Oxidation Furnace	Dust levels exceeding current baseline levels	• Air quality (L) • Community health (L)
Oxygen Plant	Waste generation – Drainage of molecular material (Alumina zeolite)	• By-product/Waste generation (L)
EBS reduction furnace	Dust levels exceeding current baseline levels	• Air quality (L) • Community health (L)
Sulphuric Acid Plant	Spills/leakage of acid into secondary containment Generation of waste product – Removal of Catalyst (Vanadium Pentoxide)	• By-product/Waste generation (M) • Groundwater (M) • Sub-surface material quality (M) • Surface water quality (M) • By-product/Waste generation (L)
Decommissioning of infrastructure	Dust levels exceeding current base line levels	• Air quality (L) • Community health (L)
Construction Phase		

Activity	Event Description	Aspect (Risk Level*)
EBS Oxidation Furnace	Production of spoil	• Air quality (M) • By-product/Waste generation (H) • Groundwater (M) • Noise (L) • Surface water quality (M)
EBS Oxidation Furnace – subsurface geotechnical testing for foundation design	Generation of contaminated material and contaminant migration through interconnection of aquifers	• By-product/Waste generation (H) • Groundwater (M) • Surface water quality (L)
EBS Oxidation Furnace – installation of piles	Generation of contaminated material and contaminant migration through interconnection of aquifers	• By-product/Waste generation (H) • Groundwater (M) • Noise (L) • Surface water quality (L)
EBS Oxidation Furnace – pavements removed	Excessive surface water recharge to open areas driving groundwater contamination migration/noise/waste	• By-product/Waste generation (M) • Groundwater (M) • Noise (L) • Surface water quality (L)
Oxygen Plant	Preparation of land Generation of contaminated material	• Air quality (M) • By-product/Waste generation (H) • Groundwater (M) • Noise (L) • Surface water quality (M) • By-product/Waste generation (M) • Groundwater (L) • Surface water quality (L)

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Activity	Event Description	Aspect (Risk Level*)
EBS Reduction Furnace	Production of spoil	• Air quality (M) • By-product/Waste generation (H) • Groundwater (M) • Noise (L) • Surface water quality (M)
EBS Reduction Furnace – subsurface geotechnical testing for foundation design	Generation of contaminated material and contaminant migration through interconnection of aquifers	• By-product/Waste generation (H) • Groundwater (M) • Surface water quality (L)
EBS Reduction Furnace – installation of piles	Generation of contaminated material and contaminant migration through interconnection of aquifers	• By-product/Waste generation (H) • Groundwater (M) • Noise (L) • Surface water quality (L)
EBS Reduction Furnace – pavements removed	Excessive surface water recharge to open areas driving groundwater contamination migration/noise/waste	• By-product/Waste generation (M) • Groundwater (M) • Noise (L) • Surface water quality (L)
Sulphuric Acid Plant	Production of spoil	• Air quality (M) • By-product/Waste generation (H) • Groundwater (M) • Sub-surface material quality (L) • Surface water quality (M)
Sulphuric Acid Plant – subsurface geotechnical testing for foundation design	Generation of contaminated material and contaminant migration through interconnection of aquifers	• By-product/Waste generation (H) • Groundwater (M) • Surface water quality (L)

Activity	Event Description	Aspect (Risk Level*)
Sulphuric Acid Plant – installation of piles	Generation of contaminated material and contaminant migration through interconnection of aquifers	• By-product/Waste generation (H) • Groundwater (M) • Noise (L) • Surface water quality (L)
Cooling Water System	Production of spoil	• Air quality (M) • By-product/Waste generation (H) • Groundwater (M) • Noise (L) • Surface water quality (M)
	Increased suspended sediment from dredging to install new intake caisson	• Natural resources (marine) (M) • Visual amenity (L)
	Deposition of dredged material onsite	• By-product/Waste generation (M) • Groundwater (M) • Natural resources – marine (L) • Surface water quality (M)
	Increased suspended sediment – Installation of the diffuser on the channel floor	• Natural resources – marine (L) • Visual amenity (L)
Minor infrastructure	Preparation of land	• Air quality (M) • By-product/Waste generation (H) • Groundwater (M) • Noise (L) • Surface water quality (M)

Activity	Event Description	Aspect (Risk Level*)
Minor infrastructure – subsurface geotechnical testing for foundation design	Generation of contaminated material and contaminant migration through interconnection of aquifers	• By-product/Waste generation (H) • Groundwater (M) • Surface water quality (L)
Overall Project – Transportation/logistics of material	Increased frequency of traffic	• Community amenity (M) • Noise (M) • Vibration (M)
	Increased demand on parking spaces	• Community amenity (M)
	Fugitive emissions	• Air quality (M) • Community health (M) • Surface water quality (L)
	Introduction of foreign flora/fauna (including marine and terrestrial pests)	• Natural resources – marine and terrestrial (M)
	Additional winnowing of sediments and the generation of sediment plumes	• Natural resources – marine (M)
Overall Project - Construction workforce and overflow accommodation – Shutdown during construction	Increased demand for personnel	• Community amenity (M)
Overall Project - Construction workforce and overflow accommodation – Waste management (sewage)	Leakage of raw sewage (black or grey)	• By-product/Waste generation (L) • Groundwater (M) • Odour (L) • Sub-surface material quality (L)
Overall Project - Construction workforce and overflow accommodation – Accommodation	Anti-social behaviour in the community	• Community amenity (L)

Activity	Event Description	Aspect (Risk Level*)
Overall Project - Waste management	Stockpiling, handling and disposal of waste and recyclable resources	• Air quality (M) • By-product/Waste generation (M) • Groundwater (M) • Natural resources – marine (L) • Sub-surface material quality (M) • Surface water quality (M)
Overall Project - Flooding of site	Flooding of site (Storm surge/sea level variation/high tide significant rainfall event - Increased frequency of events)	• Groundwater (L) • Natural resources – marine (L) • Surface water quality (L)
Overall Project– Increased fugitive emissions	Increased fugitive emissions (Cumulative impact of multiple dust sources)	• Air quality (M) • Community health (M) • Groundwater (M) • Surface water quality (M) • Visual amenity (M)
Overall Project – Contamination of surface water and groundwater	Multiple construction activities and operations together (Cumulative effect of flooding event, and/or road wet down, and/or rain during construction)	• Groundwater (M) • Natural resources – marine (M) • Surface water quality (M)

* Risk levels are inherent levels of risk (without controls). 'L'= low risk level, 'M' = medium risk level, 'H' = high risk level and 'VH' = very high risk level.

5.2 Environmental and Social Impacts

Potential impacts, objectives, management strategies and monitoring and reporting requirements associated with the environmental and social aspects identified in Table 5-1 are discussed in Sections 5.2.1 to 5.2.12.

5.2.1 Air Quality

Objectives for Managing Air Quality

- To reduce lead, sulphur dioxide and particulate emissions to below the current levels and to be in compliance with the relevant State regulatory instruments, namely *Environment Protection (Air Quality) Policy* 1994.
- To be in compliance with Site-specific South Australian EPA Licence agreements.
- To receive no complaints from adjoining commercial/industrial neighbours or Site personnel.

Potential Impacts on Air Quality

- Activities or events associated with the Construction Phase of the EBS Oxidation Furnace, Oxygen Plant, EBS Reduction Furnace, Sulphuric Acid Plant, Cooling Water System and minor infrastructure could result in lead dust that exceeds current baseline levels and the Guidelines at EPA monitoring sites.
- Demolition activities associated with minor infrastructure may increase asbestos particulates in the air.
- Increased fugitive lead dust emissions arising from the cumulative impact of multiple dust sources and/or increased Site traffic movement may exceed EPA Guidelines.

Performance Criteria for Air Quality

- Monitoring of the Transformation during the Construction Phase demonstrates that:
    - Air quality is maintained within current levels by prevention of lead emissions from any additional sources during the construction phase.
    - Dust levels are within accepted guideline levels and no excessive dust is generated
    - Asbestos is treated and managed in accordance with relevant standards.
- Plans and procedures are approved and implemented prior to the Construction Phase.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Air Quality Management Strategy

The following actions will be taken prior to any Construction Phase activities and will also apply to all aspects of decommissioning, demolition:

- EBS Oxidation Furnace and EBS Reduction Furnace:
    - Develop an Earth moving plan (including dust suppression) for each unit.
    - Develop a Demolition Plan.
    - Prepare a Waste Management and Recycling Plan.
    - Prepare procedures for top-down cleaning and post-cleaning inspections.

- Oxygen Plant, Sulphuric Acid Plant and Cooling Water System;
  - Develop an Earth Moving Plan (including dust suppression) for each unit.
  - Develop a Demolition Plan.
  - Prepare a Waste Management and Recycling Plan.
- Minor Infrastructure:
  - Develop an Earth Moving Plan (including dust suppression).
  - Develop a specific asbestos register and procedures (based on existing site register and procedures) for the removal and disposal to IAW Australian Standards.
  - Prepare a Dust Management Plan.
  - Prepare a Waste Management and Recycling Plan.
  - Prepare procedures for top-down cleaning and post-cleaning inspections.
  - Develop a Demolition Plan.
- Overall Project:
  - Develop a schedule to manage Construction Phase activities.
  - Monitor the control of individual dust sources.
  - Prepare a Dust Management Plan.
  - Prepare a Construction Management Plan.

Monitoring of the Effectiveness of Air Quality Management

- The current EMRP for air emissions will be maintained.
- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- The implementation of plans and procedures to protect air quality will be checked and audited.
- A Post-activity (demolition activity) asbestos test/audit will be undertaken.

Reporting on Air Quality

A Prestart Audit Report will be undertaken to confirm air quality plans and procedures are correct and in place.

Corrective Action

If any impacts on air quality exceed what is predicted, Nyrstar will review operating procedures and management plans and make changes to meet the EPA Guidelines.

5.2.2 By-product/Waste Generation

Objectives for Managing By-product/Waste

- To prevent any spills or leakage.
- To minimise impacts on existing waste facilities.
- To minimise environmental impacts associated with waste generation and accidental spills.
- To maximise waste minimisation, recycling, reuse and recovery.

Potential Impacts on By-product/Waste

Generation of waste from demolition, decommissioning, construction activities and events associated with the Transformation may impact on by-product/waste management. For example:

- Incorrect disposal of spoil during land preparation activities;
- Spills/leakage of acid into secondary containment can lead to mobilisation of contamination in soil/groundwater/surface water;
- Creation of lead and acid sulphate contaminated waste material from dredging to place the new caisson;
- Increase in asbestos particulate in air during demolition;
- Leakage of raw sewage from the construction workforce overflow accommodation; and
- Contamination of groundwater, surface water, soil and/or marine environment due to incorrect stockpiling, handling and disposal of waste and recyclable resources.

Performance Criteria for By-product/Waste

- All waste generated by decommissioning will be handled in a safe and environmentally acceptable manner.
- Waste is handled in accordance with appropriate procedures and standards and disposed of correctly.
- Waste is characterised and prioritised for appropriate waste management.
- Monitoring of the Transformation during the Construction Phase demonstrates that:
    a. asbestos is treated and managed in accordance with relevant standards.
    b. no contamination to surface water, groundwater or soil results from spills/leakage.
- Plans and procedures are approved and implemented prior to the Construction Phase.

By-product/Waste Management Strategy

The following actions will be taken prior to any Construction Phase activities:

- EBS Oxidation Furnace and EBS Reduction Furnace:
    - Develop an Earth Moving Plan (including dust suppression) for each unit.
    - Develop a Demolition Plan.
    - Prepare a Waste Management and Recycling Plan.
- Oxygen Plant:
    - As for (1) and
    - Prepare Material Handling Procedures.
- Sulphuric Acid Plant:
    - As for (2) and
    - Develop a Operation and Maintenance Plan (including operating procedure to manage bund levels).

- Cooling Water system;
    - As for (1) and
    - Prepare a site location and design plan for onsite deposition of dredged material for caisson placement.
- Minor Infrastructure:
    - Develop an Earth Moving Plan (including dust suppression).
    - Develop a specific asbestos register and procedures (based on existing site register and procedures) for the removal and disposal to IAW Australian Standards.
    - Prepare a Dust Management Plan.
    - Prepare a Waste Management and Recycling Plan.
    - Prepare procedures for top-down cleaning and post-cleaning inspections.
    - Develop a Demolition Plan.
- Overall Project:
    - Develop operation and contingency planning of the onsite sewage system including high-level alarms and triggers in the event of a sewage leak.
    - Prepare waste characterisation instructions.
    - Prepare a Waste Management and Recycling Plan.

Monitoring of the Effectiveness of By-product/Waste Management

- The implementation of plans and procedures to protect any By-product/Waste impacts will be checked and audited.
- A Post-activity (demolition activity) asbestos test/audit will be undertaken.

Reporting on By-product/Waste

A Prestart Audit Report will be undertaken to confirm by-product/waste management plans and procedures are correct and in place.

Corrective action

If any impacts on by-product/waste exceed what is predicted, Nyrstar will review operating procedures and management plans and make any required changes to meet performance criteria.

5.2.3 Community Health

Objectives for Managing Community Health

- To reduce lead, sulphur dioxide and particulate emissions to below current levels.
- To be in compliance with the relevant State regulatory instruments, namely *Environment Protection (Air Quality) Policy* 1994.
- To be in compliance with Site-specific South Australian EPA Licence agreements.

Potential Impacts on Community Health

- Windblown dust from existing sources during decommissioning activities for EBS Oxidation Furnace, EBS Reduction Furnace and minor infrastructure could lead to exceedances of current baseline levels and potentially affect community health.
- Demolition activities associated with minor infrastructure may increase asbestos particulates in the air.
- Increased fugitive lead dust emissions arising from the cumulative impact of multiple dust sources and/or increased Site traffic movement may exceed EPA Guidelines and impact community health.

Performance Criteria for Community Health

- Monitoring during the Construction Phase of the Transformation demonstrates that:
    - Air quality is maintained within current levels by prevention of lead emissions from any additional sources during the construction phase.
    - asbestos is treated and managed in accordance with relevant standards.
- Plans and procedures for the Construction Phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Community Health Management Strategy

The following actions will be taken prior to any Construction Phase activities:

- Develop procedures for top-down cleaning and post-cleaning inspections for the EBS Oxidation Furnace and EBS Reduction Furnace.
- Minor Infrastructure:
    - Develop specific asbestos register and procedures (based on existing register and procedures) for the removal and disposal to IAW Australian Standards.
    - Prepare a Dust Management Plan.
    - Prepare procedures for top-down wash and post-wash inspections.
- Overall Project:
    - Prepare a Dust Management Plan.
    - Develop a schedule to manage Construction Phase activities.
    - Monitor the control of individual dust sources.
    - Prepare a Construction Management Plan.

Monitoring of the Effectiveness of Community Health Management

- The current EMRP for air quality will be maintained.
- The implementation of plans and procedures to protect Community Health will be checked and audited.
- A Post-activity (demolition activity) asbestos test/audit will be undertaken.

Reporting on Community Health

A Prestart Audit Report will be undertaken to confirm Community Health plans and procedures are correct and in place.

Corrective Action

If any impacts on Community Health exceed what is predicted, Nyrstar will review operating procedures and management plans and make changes to meet the EPA Guidelines.

5.2.4 Community Amenity

Objective for Managing Community Amenity

To receive no community amenity complaints.

Potential Impacts on Community Amenity

Community amenity could be impacted due to:

- increased traffic movement due to mobilisation of staff, materials and plant that leads to delays to public road users on public roads (especially main road of Port Pirie);
- increased mobilisation of staff, materials and plant leads to increased demand for parking spaces and overflow from existing parking spaces onto roads and side streets;
- decreased availability of health, utilities, accommodation and critical services impacting on local population due to the construction workforce; and
- a larger workforce and potential antisocial behaviour.

Performance Criteria for Community Amenity

- Plans and procedures are approved and implemented prior to the Construction Phase.
- Demand on health utilities, accommodation and services will not impact local population.
- The community is informed of any potential impacts in advance of activities.
- Testing is undertaken as part of the drug and alcohol policy (included as part of OH&S).
- Liaison and collaboration is undertaken with Local Government Authorities (LGAs).

Community Amenity Management Strategy

The following actions will be taken prior to the Construction Phase of the Transformation:

- Develop a Public Engagement and Consultation Strategy.
- Prepare a Traffic Management Plan.
- Develop a schedule to manage Construction Phase activities.
- Designate overflow-parking areas.
- Prepare a Construction Management Plan.
- Close liaison with LGAs and the public on community amenity issues.

Monitoring of the Effectiveness of Community Amenity Management

- A Transformation schedule will be developed and followed.

- Records of engagement and agreed outcomes with Local Government Authorities, and the public will be documented and tracked.
- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- The implementation of plans and procedures to protect Community Amenity will be checked and audited.

Reporting on Community Amenity

A Prestart Audit Report will be undertaken to confirm Community Amenity plans and procedures are correct and in place.

Corrective Action

If any impacts on Community Amenity exceed what is predicted, Nyrstar will review operating procedures and management plans and make changes to meet the EPA Guidelines.

5.2.5 Noise

Objectives for Managing Noise

- To be in compliance with relevant State regulatory instruments, namely *Environment Protection (Noise) Policy* 2007.
- To receive no noise complaints from the community.

Potential Impacts on Noise

Activities or events from Construction Phase may result in exceedances of EPA noise regulations and/or noise complaints from the community.

Performance Criteria for Noise

- Plans are approved and implemented prior to the Construction Phase.
- Noise levels comply with EPA requirements, guidelines and measures and do not exceed EPA thresholds.
- The community informed of potential impacts in advance of activity.

Noise Management Strategy

The following actions will be taken prior to any Construction Phase activities:

- EBS Oxidation Furnace, EBS Reduction Furnace and Sulphuric Acid Plant;
    - Develop an Earth Moving Plan.
    - Develop a Demolition Plan.
    - Place a curfew on the installation of piles (7am to 7pm).
- Oxygen Plant, Cooling Water System and minor Infrastructure;
    - Develop an Earth Moving Plan.
    - Develop a Demolition Plan.

- Overall Project;
  - Develop a Public Engagement and Consultation Strategy.
  - Prepare a Traffic Management Plan.
  -
  - Develop a schedule to manage Construction Phase activities.

Monitoring of the Effectiveness of Noise Management

- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- The implementation of plans and procedures to protect Noise will be checked and audited.

Reporting on Noise

A Prestart Audit Report will be undertaken to confirm Noise plans and procedures are correct and in place.

Corrective Action

If any impacts on Noise exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA Guidelines.

5.2.6 Natural Resources

Objectives for Managing Natural Resources

- Achieve no adverse impacts on flora and fauna from the Transformation.
- To be in compliance with the relevant State regulations.
- To be in compliance with Site-specific South Australian EPA Licence agreements.

Potential Impacts on Natural Resources

- Dredging to install new intake caisson and/or instillation of the diffuser on the channel floor for the Cooling Water System could result in suspended sediment plumes and/or the exceedances of suspended metal and metalloids sediment guidelines in the Port Pirie River.
- The transportation/logistics of material may result in the introduction of foreign flora/fauna (including marine and terrestrial pests) and impact local ecology.
- Increased shipping sizes could result in additional winnowing of sediments and the generation of sediment plumes, causing re-suspension of contaminated sediments that degrades marine water quality.
- A flooding event could remove contaminated material from Site and deposit it at sea, resulting in adverse impacts to the marine environment.
- Cumulative effect of flooding events, and/or road wet down, and/or rain during could lead to increased contamination of marine environment.
- Contamination of marine environment could arise from incorrect stockpiling, handling and disposal of waste and recyclable resources.

Performance Criteria for Natural Resources

- Transformation Stakeholder and Community Engagement Register shows records of liaison with the Flinders Port Authority on shipping traffic.
- Waste is characterised and prioritised for appropriate waste management.
- Suspended sediment monitoring during the Construction Phase demonstrates that suspended sediments in seawater meets new licensing conditions.
- Plans and procedures are approved and implemented prior to the Construction Phase.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Natural Resources Management Strategy

The following actions will be taken prior to any Construction Phase activities:

- Cooling Water System:
  - Install silt curtains for dredging activities if shown to be effective.
  - Prepare a site location and design plan for instillation of the new intake caisson.
  - Prepare installation management procedure (tide/current selection) for the diffuser on the channel floor.
- Overall Project:
  - Consult with Flinders Port Authority on shipping traffic and ensure compliance with Flinders Port Authority Regulations.
  - Ensure compliance with Australian Quarantine Regulations.
  -
  - Prepare waste characterisation instructions.
  - Prepare a Waste Management and Recycling Plan.
  - Update Site Emergency Response Plan to ensure incorporation of extreme weather events (including inundation from river).
  - Develop a schedule for management of multiple operations activities.
  - Outline how control of individual dust sources will be achieved.
  - Develop housekeeping instructions.
  - Identify where placement of materials within known catchments will occur and receive internal environmental authorisation for this.

Monitoring of the Effectiveness of Natural Resources Management

- The current EMRP for wastewater discharge to Spencer Gulf and air emissions will be maintained.
- A Suspended Sediment Monitoring Program will be undertaken during the Construction Phase.
- Records of engagement and documentation of meetings with Flinders Port Authority will be kept.
- The implementation of plans and procedures to protect natural resources will be checked and audited.

Reporting on Natural Resources

A Prestart Audit Report will be undertaken to confirm Natural Resource plans and procedures are correct and in place.

Corrective Action

If any impacts on Natural Resources exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA Guidelines.

5.2.7 Odour

Odour impacts associated with construction activities are considered to be low risk level. Management of sewage was the only Transformation activity that flagged odour as a potential impact. Potential odour impacts will be managed by operation and contingency planning for sewage.

5.2.8 Sub-surface Material Quality

Objectives for Managing Sub-surface Material Quality

- To achieve no adverse impacts to soil from the Transformation.
- To be in compliance with Site-specific South Australian EPA Licence agreements.

Potential Impacts on Sub-surface Material Quality

- Incorrect disposal of spoil from land preparation activities for the Sulphuric Acid Plant may contaminate soil.
- Spills/leakage of acid into secondary containment due to activities associated with decommissioning of the existing Acid Plant could results in mobilisation of contamination into soil.
- Raw sewage leak from the construction workforce overflow accommodation could result in soil contamination.
- Contamination of soil could occur due to incorrect stockpiling, handling and disposal of waste and recyclable resources.

Performance Criteria for Sub-surface Material Quality

- There is no contamination to soil.
- Waste is characterised and prioritised for appropriate waste management.
- Plans and procedures are approved and implemented prior to the Construction Phase.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.
- An inherently safe design for decommissioning of the existing Acid Plant is implemented and no spills/leakage occur.

Sub-surface Material Quality Management Strategy

The following actions will be taken prior to any Construction Phase activities:

- Sulphuric Acid Plant:
  - Develop an Operation and Maintenance Plan (including operating procedure to manage bund levels).
  - Develop an Earth moving plan (including dust suppression).
  - Prepare a Waste Management and Recycling Plan.
  - Develop a Demolition Plan.
- Overall Project;
  - Develop operation and contingency planning of the onsite sewage system including high-level alarms and triggers in the event of a sewage leak.
  - Prepare waste characterisation instructions.
  - Prepare a Waste Management and Recycling Plan.

Monitoring of the Effectiveness of Sub-surface Material Quality Management

- The Existing EMRP upgraded to accommodate potential new impact sites (waste management).
- The Existing EMRP for soil quality will be maintained.
- The application of plans and procedures to protect soil will be checked and audited.

Reporting on Sub-surface Material Quality

A Prestart Audit Report will be undertaken to confirm plans and procedures to manage sub-surface material quality are correct and in place.

Corrective Action

If any impacts on sub-surface material quality exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA Guidelines.

5.2.9 Surface Water Quality

Objectives for Managing Surface Water Quality

- To achieve no contamination of surface water from the Transformation.
- To be in compliance with relevant State regulatory instruments, namely *Environment Protection (Water Quality) Policy* 2003.
- To be in compliance with Site-specific South Australian EPA Licence agreements.

Potential Impacts on Surface Water Quality

- Various Construction Phase activities and events could disturb surface water and lead to contamination.

- Contamination to surface water could arise during subsurface geotechnical testing, instillation of piles and/or removal of pavement activities for the EBS Oxidation Furnace, EBS Reduction Furnace and Sulphuric Acid Plant.
- Generation of contaminated material from construction activities associated with the Oxygen Facility and minor infrastructure, including subsurface geotechnical testing, may lead to contamination of surface water.
- Spills/leakage of acid from the Sulphuric Acid Plant into secondary containment could results in mobilisation of contamination in surface water.
- Incorrectly disposed waste from decommissioning activities of the existing Acid Plant could will degrade the environment and reduce water quality.
- Creation of lead and acid sulphate contaminated waste material from dredging for the Cooling Water System may contaminate surface water if disposed of incorrectly.
- Fugitive lead dust emissions from onsite traffic movement could impact surface water quality.
- Incorrect stockpiling, handling and disposal of waste and recyclable resources may result in surface water contamination.
- A flooding event could remove contaminated material from the Project Site and impact surface water quality.
- The cumulative impact of increased fugitive emissions from multiple dust sources could impact surface water quality.
- The cumulative effect of flooding events, and/or road wet down, and/or rain during could lead to increased contamination of surface water.

Performance Criteria for Surface Water Quality

- There is no contamination to surface water.
- An inherently safe design for decommissioning of the existing Acid Plant is implemented and no spills/leakage occur.
- Monitoring during the Construction Phase of the Transformation demonstrates that lead emissions are reduced from current levels.
- Plans and procedures for the operations phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.
- Waste is handled in accordance with appropriate standards.
- Waste is characterised and prioritised for appropriate waste management.

Surface Water Quality Management Strategy

The following actions will be taken prior to any Construction Phase activities:

- EBS Oxidation Furnace and EBS Reduction Furnace;
    - Develop an Earth Moving Plan (including dust suppression) for each unit.
    - Develop a Demolition Plan.
    - Prepare a Waste Management and Recycling Plan.
    - Develop pile design and installation plans with hydrogeological input.
    - Prepare a Construction Plan to cater for surface water management and minimise open pavement area and time.

- Oxygen Plant;
    - As for 1a to 1c.
- Sulphuric Acid Plant
    - As for 1a to 1c.
    - Develop pile design and installation plans with hydrogeological input.
    - Develop an Operation and Maintenance Plan.
    - Prepare Material Handling Procedures.
- Cooling Water System and minor Infrastructure;
    - As for 1a to 1c.
    - Prepare a Site location and Design Plan.
- Minor Infrastructure;
    - Develop an Earth Moving Plan (including dust suppression).
    - Develop a Demolition Plan.
    - Prepare a Waste Management and Recycling Plan.
    - Develop a Dust Management Plan.
- Overall Project;
    - Develop a Dust Management Plan.
    - Prepare waste characterisation instructions.
    - Prepare a Waste Management and Recycling Plan.
    - Update the site emergency response plan to ensure incorporation of extreme weather events (including inundation from river).
    - Develop a schedule to manage Construction Phase activities.
    - Develop a Construction Management Plan.
    - Outline how control of individual dust sources will be achieved.
    - Develop housekeeping instructions.
    - Identify where placement of materials within known catchments will occur and receive internal environmental authorisation for this.

Monitoring of the Effectiveness of Surface Water Quality Management

- The current EMRP for water quality will be maintained.
- The application of plans and procedures to protect surface water will be checked and audited.
- The Existing EMRP will be upgraded to accommodate potential new impact sites (waste management).

Reporting on Surface Water Quality

A Prestart Audit Report will be undertaken to confirm plans and procedures to manage Surface Water Quality are correct and in place.

Corrective Action

If any impacts on Surface Water Quality exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA Guidelines.

5.2.10 Groundwater

Objectives for Managing Groundwater

- To achieve no contamination of groundwater from the Transformation.
- To be in compliance with relevant State regulatory instruments, namely *Environment Protection (Water Quality) Policy* 2003.
- To be in compliance with Site-specific South Australian EPA Licence agreements.

Potential Impacts on Groundwater

- Various Construction Phase activities and events, such as preparation of land, could disturb surface water and/or groundwater, which result in contamination to groundwater.
- Contamination to groundwater could arise during subsurface geotechnical testing, instillation of piles and/or removal of pavement activities for the EBS Oxidation Furnace, EBS Reduction Furnace and Sulphuric Acid Plant.
- Generation of contaminated material from construction activities associated with the Oxygen Facility and minor infrastructure, including subsurface geotechnical testing, may lead to groundwater contamination.
- Spills/leakage of acid from the Sulphuric Acid Plant into secondary containment could results in mobilisation of contamination into groundwater.
- Creation of lead and acid sulphate contaminated waste material from dredging for the Cooling Water System may contaminate groundwater if disposed of incorrectly.
- A flooding event could remove contaminated material from the Project Site and impact groundwater quality.
- Increased wetting down to control the cumulative impact of multiple dust sources could contribute to groundwater impacts.
- The cumulative effect of flooding events, and/or road wet down, and/or rain during could lead to increased contamination of groundwater.
- Raw sewage leak from the construction workforce overflow accommodation could lead to contamination of groundwater.
- Groundwater contamination could occur due to incorrect stockpiling, handling and disposal of waste and recyclable resources.

Performance Criteria for Groundwater

- Monitoring during the Construction Phase of the Transformation demonstrates that:
  - there is no increased contamination to groundwater or groundwater contamination migration.
  - that lead emissions are reduced from current levels and are within EPA thresholds.
- An inherently safe design for decommissioning of the existing Acid Plant is implemented and no spills/leakage occur.
- Waste is handled in accordance with appropriate standards.
- Waste is characterised and prioritised for appropriate waste management.
- Plans and procedures for are approved and implemented prior to the Construction Phase.

- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Groundwater Management Strategy

The following actions will be taken prior to any Construction Phase activities:

- EBS Oxidation Furnace and EBS Reduction Furnace;
  - Develop an Earth Moving Plan (including dust suppression).
  - Develop a Demolition Plan.
  - Prepare a Waste Management and Recycling Plan.
  - Develop pile design and installation plans with hydrogeological input.
  - Prepare a Construction Plans to cater for surface water management and minimise open pavement area and time.
  - Design appropriate controls to protect groundwater during subsurface geotechnical testing for foundation design.
- Oxygen Plant;
  - As for 1a to 1c.
- Sulphuric Acid Plant
  - As for 1a to 1d.
  - Develop an Operation and Maintenance Plan (including operating procedure to manage bund levels).
- Cooling Water System and minor Infrastructure;
  - As for 1a to 1c.
  - Prepare a Site location and Design Plan.
- Minor Infrastructure;
  - As for 1a to 1c.
  - Develop a Dust Management Plan.
- Overall Project;
  - Prepare waste characterisation instructions.
  - Prepare a Waste Management and Recycling Plan.
  - Update the site emergency response plan to ensure incorporation of extreme weather events (including inundation from river).
  - Develop a schedule to manage Construction Phase activities.
  - Develop a Construction Management Plan.
  - Outline how control of individual dust sources will be achieved.
  - Develop housekeeping instructions.
  - Identify where placement of materials within known catchments will occur and receive internal environmental authorisation for this.
  - Develop operation and contingency planning of the onsite sewage system including high-level alarms and triggers in the event of a sewage leak.

Monitoring of the Effectiveness of Groundwater Management

- The existing EMRP for groundwater and air quality will be maintained.
- The application of plans and procedures to protect groundwater will be checked and audited.

- The Existing EMRP will be upgraded to accommodate potential new impact sites (waste management).

Reporting on Groundwater

A Prestart Audit Report will be undertaken to confirm plans and procedures to manage groundwater are correct and in place.

Corrective Action

If any impacts on groundwater exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA Guidelines.

5.2.11 Vibration

Objective for Managing Vibration

To receive no receive no complaints relating to vibration from the community.

Potential Impacts on Vibration

Transport and logistics of material for the Construction Phase will lead to an increased frequency of traffic that generates vibration.

Performance Criteria for Vibration

- Plans are approved and implemented prior to the Construction Phase.
- The community is informed of potential impacts in advance of activity.

Vibration Management Strategy

The following actions will be taken prior to the Construction Phase of the Transformation:

- Develop a Public Engagement and Consultation Strategy.
- Prepare a Traffic Management Plan.
- Undertake a building dilapidation survey.
- Develop a schedule to manage Construction Phase activities.

Monitoring of the Effectiveness of Vibration Management

- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- A Transformation schedule will be developed and followed.
- The implementation of plans and strategies to protect vibration will be checked and audited.

Reporting on Vibration

A Prestart Audit Report will be undertaken to confirm vibration plans and strategies are correct and in place.

Corrective Action

If any impacts to vibration exceed what is predicted, Nyrstar will review strategies and management plans and make any required changes.

5.2.12 Visual Amenity

Objective for Managing Visual Amenity

To receive no visual amenity complaints from the community.

Potential Impacts on Visual Amenity

- Activities to install the diffuser on the channel floor for the Cooling Water System could result in suspended sediment plumes and/or the exceedances of suspended metal and metalloids sediment guidelines in the Port Pirie River that impact visual amenity.
- An increase in fugitive emissions from the cumulative impact of multiple dust sources could lead to adverse impacts on visual amenity.

Performance Criteria for Visual Amenity

- Monitoring during the Construction Phase demonstrates that lead dust emissions are reduced from current levels.
- No complaints relating to visual amenity are received.
- Suspended sediment monitoring during the Construction Phase demonstrates that suspended sediments in seawater meet new licensing conditions.
- Plans and procedures are approved and implemented prior to the Construction Phase.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Visual Amenity Management Strategy

The following actions will be taken prior to any Construction Phase activities:

- Cooling Water System:
  - Use silt curtains for dredging activities if appropriate.
  - Prepare installation management procedure (tide/current selection) for the diffuser on the channel floor.
- Overall Project;
  - Develop a schedule to manage Construction Phase activities.
  - Develop a Construction Management Plan.
  - Outline how control of individual dust sources will be achieved.

Monitoring of the Effectiveness of Visual Amenity Management

- The current EMRP air quality will be maintained.
- A Suspended Sediment Monitoring Program will be undertaken during the Construction Phase.
- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- The implementation of plans and procedures to protect Community Amenity will be checked and audited.

Reporting on Visual Amenity

A Prestart Audit Report will be undertaken to confirm Visual Amenity plans are correct and in place.

Corrective Action

If any impacts on Visual Amenity exceed what is predicted, Nyrstar will review operating procedures and management plans and make changes to meet the EPA Guidelines.

6 References

ANZECC & ARMCANZ, 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* Canberra: Australian and New Zealand Environment and Conservation Council & Agriculture and Resources Management Council of Australia and New Zealand.

EPA South Australia, 2006. *Guideline for Air Quality Impact Assessment Using Design Ground Level Pollutant Concentrations,* s.l.: Environmental Protection Authority.

EPA South Australia, 2007. *Guideline for the use of the Environment Protection (Noise) Policy,* s.l.: Environmental Protection Authority.

EPA South Australia, 2009. *Guidelines for the Assessment and Remediation of Groundwater Contamination,* s.l.: Environmental Protection Authority.

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Appendix K:

Draft Operational Environmental Management Program

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1 Introduction

This Draft Operational Environmental Management Plan (draft OEMP) has been prepared as part of the Public Environment Report (PER) for the proposed upgrade to the Nyrstar Port Pirie Pty Ltd (Nyrstar) Smelter known as the Transformation. The Operational Phase includes commissioning, operation and maintenance activities.

The aim of the draft OEMP is to provide a framework of proposed environmental management and monitoring, for operational activities of the Transformation, as identified from the Risk Assessment (**Chapter 16** of PER). The draft OEMP is a precursor to the Operational Environment Management (OEMP) designed to ensure that the control measures identified during the Risk Assessment are implemented. It is anticipated that a detailed operational management plan will be developed prior to commissioning to factor in all the specific process changes.

The draft OEMP addresses the following:

- Background and site summary information;
- Roles and responsibilities of parties involved;
- Regulatory, licensing and legislative requirements;
- Identification of environmental and social aspects; and
- Identification of quality control measures to manage potential impacts and achieve risk levels ALARP for each aspect.

Note that health and safety requirements for employees and organisational risks will be addressed by upgrading the current operational Nyrstar Management System.

1.1 Background to the Transformation

The Transformation involves replacing the outdated lead smelting plant (oxidation stage and possibly the reduction stage also) to allow the site to become an advanced poly-metallic processing and recovery facility coupled to a new sulphuric acid plant. These improvements are expected to reduce emissions and improve the associated air quality within the Port Pirie community.

The Port Pirie Smelter Transformation will involve the construction and operation of:

- an Enclosed Bath Smelter (EBS) Oxidation Furnace to replace the sinter plant;
- an EBS Reduction Furnace being considered for Stage 2 to replace the blast furnace;
- a new Sulphuric Acid Plant;
- new storage areas for mineral concentrate and raw materials;
- an upgraded Cooling Water System;
- new fuel coal preparation and conveying plant;
- New infrastructure (including workshop and roads); and
- decommissioning and/or demolition of the existing Sintering Plant, Blast Furnace (should it be required) and Acid Making operations and associated infrastructure.

1.2 Site Information

The Transformation will be located within the existing Port Pirie Smelter property. The development site layout, including the proposed Project infrastructure is shown in **Figure 1-1.**

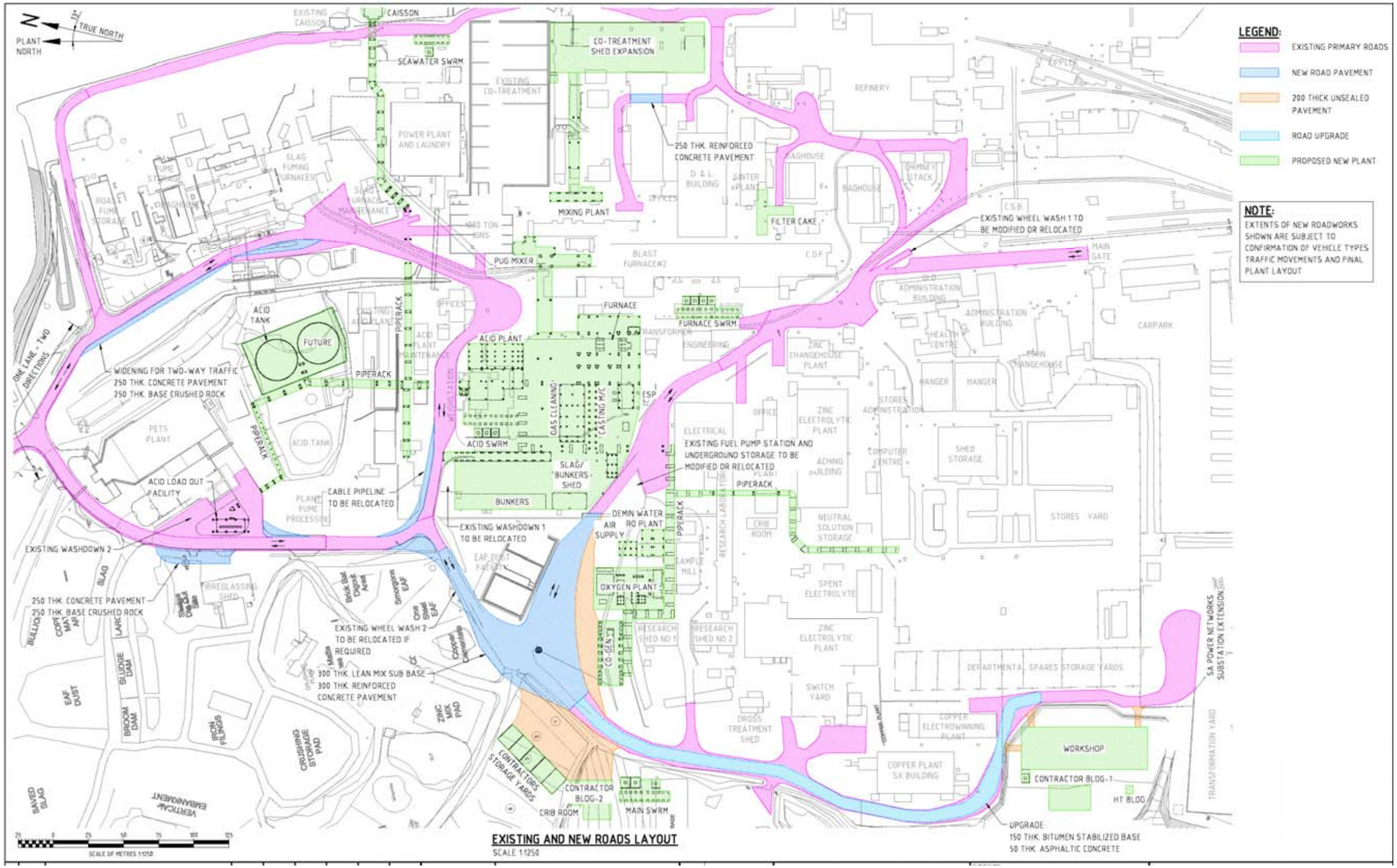

Figure 1-1: Site Layout of the Transformation

2 Environmental Management System

Nyrstar operates an Environmental Management System (EMS) which is certified to Australian Standards (AS/NZS ISO 14001:2004) for the existing Smelter facilities. Protection of the Environment and community during the Operational Phase of the Transformation will be managed through the development and implementation of new Environmental Management Plans (EMP) specifically targeting the new plant, equipment and works to ensure they complement the existing management systems.

This draft OEMP is intended to provide the basis for the public environmental report and approvals process prior to developing an OEMP that will incorporate specific control measures designed to suit the plant and equipment selected in the final design. The OEMP will address all comments from the public response and approvals process.

The OEMP will describe the controls proposed to prevent, monitor and manage possible impacts and will be incorporated with the existing Environmental Monitoring and Reporting Program (EMRP).

The OEMP and EMRP will be incorporated into the Nyrstar EMS and submitted to relevant authorities for approval prior to the commissioning the new plant and facilities.

2.1 Specific Requirements of the Draft Operational EMP

The draft OEMP outlines the responsibilities of the Nyrstar Project Manager in protecting the local community and environment during commissioning, operation and maintenance activities (the Operational Phase). The draft OEMP provides a framework for the implementation of appropriate control measures and practices in order to achieve risk levels that are as low as reasonably practicable (ALARP).

3 Roles and Responsibilities

It will be compulsory for all personnel involved in the Transformation including Nyrstar employees and their contractors and consultants to comply with this OEMP. All personnel involved in the operational stage must be familiar with the details of the management plan and understand the implications presented in this document. Everyone associated with the Transformation must also undertake their work in accordance with and in compliance to:

a) The statutory requirements as outlined in Section 4 of this document; and
b) The terms of their engagement.

All personnel working on Site will be required to complete a Site Induction explaining the environmental and social context and the management systems implemented to protect the environment and surrounding communities. All persons completing the induction must sign the Environmental Induction Register to confirm that they understand and will implement the environmental management system. The Register will be maintained on Site and available for inspection by Auditors.

The roles, responsibilities and requirements for the environmental and social management of the Operational Phase of the Transformation are outlined in Table 3-1.

Table 3-1: Roles and Responsibilities

Role	Responsibility
Project Manager	Overview the implementation of the draft OEMP and the development and implementation of the OEMP. Allocate sufficient funds and resources to fully implement the OEMP.
Contractor	Contribute to the development of the OEMP to ensure that every environmental aspect covered in the draft OEMP is fully incorporated. The contractor is responsible for any environmental or social impacts attributed to any work, plant and equipment that falls within their contract. Ensure that Nyrstar's intent of significantly reducing the current environmental and social impacts, is carried out.
Consultant	Contribute to the development of the OEMP to ensure that every environmental aspect covered in the draft OEMP is fully incorporated. The consultant is responsible for any environmental or social impacts that may be attributable to specialist advice that they provide.

	Ensure that Nyrstar's intent of significantly reducing the current environmental and social impacts is carried out.
Employees	All employees are responsible for understanding the environmental and social management systems. All employees are responsible to fully understand and implement the control measures and follow the procedures associated with their work.
Supervisors	All supervisors are responsible for implementing the control measures, whether it be directly or indirectly via specially trained environmental specialists, monitor that the management systems are working as intended.

4 Relevant Legislation and Guidelines

4.1 Environmental Legislation, Regulations and Guidelines

Operational activities will be conducted in compliance with applicable environmental legislation, regulations and guidelines, including but not limited to:

- *Environmental Protection Act*, 1993;
- *Environment Protection (Water Quality) Policy*, 2003;
- *Environment Protection (Air Quality) Policy*, 1994;
- *Environment Protection (Noise) Policy*, 2007;
- National Environment Protection (Ambient Air Quality) Measure;
- National Environment Protection (National Pollutant Inventory) Measure;
- Guideline for Air Quality Impact Assessment Using Design Ground Level Pollutant Concentrations (EPA South Australia, 2006);
- Guideline for the use of the Environment Protection (Noise) Policy (EPA South Australia, 2007);
- Guidelines for the Assessment and Remediation of Groundwater Contamination (EPA South Australia, 2009); and
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, (ANZECC & ARMCANZ, 2000).
- *Port Pirie (Regional Council) Development Plan – Consolidated 10 January 2013,* (DPTI, 2013)

4.2 Licenses and Permits

The Transformation will operate under licences issued by the South Australian EPA on approval. The OEMP will adhere to the conditions of these licences, ensuring that all onsite works are compliant. The existing EMMP will be updated to incorporate changes expected during the operational phase of the Transformation.

Nyrstar will ensure that personnel will obtain all relevant permits prior to the commencement of operational activities and that contractors and their employees will hold relevant licences and/or permits to operate all plant and equipment required to undertake the work.

5 Environmental management

5.1 Activities and Events that may Impact Environmental and Social Aspects

The activities and events post construction that were identified by the risk assessment (**Chapter 16**) as potentially impacting environmental and social aspects are detailed in Table 5-1. This table shows the inherent level of risk evaluated prior to implementing the control measures. The proposed control measures will reduce the residual level of risk to as low as reasonably practical (ALARP). The proposed control measures are discussed in Section 5.2.

Table 5-1: Activities and Events that may impact Environmental and Social Aspects during the Operational Phase

Activity	Event Description	Aspect (Inherent Risk Level*)
Commissioning Phase		
EBS Oxidation Furnace	Fugitive emissions exceed current baseline levels	• Air Quality (M) • Community health (M) • Odour (L) • Sub-surface material quality (L) • Surface water quality (L) • Visual amenity (L)
EBS Reduction Furnace	Fugitive emissions exceed current baseline levels	• Air quality (M) • Community health (M) • Odour (L) • Sub-surface material quality (L) • Surface water quality (L) • Visual amenity (L)
Sulphuric Acid Plant	Acid plant stack discharge to atmosphere Tall stack discharge to atmosphere	• Air quality (M) • Community health (M) • Natural resources - flora (L) • Odour (M) • Air quality (M) • Community health (M) • Natural resources – flora (L) • Odour (M)
Operational Phase		
EBS Oxidation Furnace – Smelting	Fugitive emissions exceed proposed post-transformation levels	• Air Quality (M) • Visual amenity (L)

Activity	Event Description	Aspect (Inherent Risk Level*)
EBS Oxidation Furnace – Pile Foundation maintenance	Acid attack on piles creating interconnection of aquifers	• Groundwater (M) • Natural resources - marine flora/fauna (M) • Sub-surface material quality (L)
EBS Oxidation Furnace – Bunding/drainage/paving	Spillage/leak to groundwater Spillage to surface water system	• Groundwater (L) • Natural resources - marine environment (L) • Surface water quality (L)
EBS Oxidation Furnace – Maintenance	Fugitive emissions exceed proposed post-transformation levels	• Air quality (M) • Community health (M) • Odour (L) • Sub-surface material quality (L) • Surface water quality (L) • Visual amenity (L)
Oxygen Plant	Generation of noise	• Community amenity (L) • Noise (L)
EBS Reduction Furnace – Smelting	Fugitive emissions exceed proposed post-transformation levels COGEN machinery contributes to noise of plant	• Air quality (M) • Visual amenity (L) • Community amenity (L) • Noise (L)
EBS Reduction Furnace – Pile Foundation maintenance	Acid attack on piles creating interconnection of aquifers	• Groundwater (M) • Natural resources - marine flora/fauna (M) • Sub-surface material quality (L)

Activity	Event Description	Aspect (Inherent Risk Level*)
EBS Reduction Furnace – Bunding/drainage/paving	Spillage/leak to groundwater Spillage to surface water system	• Groundwater (L) • Natural resources - marine environment (L) • Surface water quality (L)
EBS Reduction Furnace – Maintenance	Fugitive emissions exceed proposed post-transformation levels	• Air quality (M) • Community health (M) • Odour (L) • Sub-surface material quality (L) • Surface water quality (L) • Visual amenity (L)
Sulphuric Acid Plant	Acid plant stack discharge to atmosphere	• Air quality (M) • Community health (M) • Natural resources – flora (L) • Odour (M)
	Tall stack discharge to atmosphere	• Air quality (M) • Community health (M) • Community amenity (M) • Natural resources – flora (L) • Odour (M)
	Generation of noise	• Community amenity (L) • Noise (L)
	Spills/leakage of acid into secondary containment	• By-product/Waste generation (M) • Groundwater (M) • Sub-surface material quality (M) • Surface water quality (M)

Activity	Event Description	Aspect (Inherent Risk Level*)
Sulphuric Acid Plant – Start-up	Acid plant stack discharge to atmosphere	• Air quality (M) • Community health (M) • Community amenity (M) • Natural resources – flora (L) • Odour (M)
Materials Storage Area – Storage of materials	Fugitive emissions/Dust	• Air quality (M) • Community health (M) • Surface water quality (L)
Materials Storage Area – Materials handling	Creation of fugitive dust emissions	• Air quality (L)
Cooling Water System– Cooling water discharge	Cooling water discharge elevated temperature Seabed erosion	• Natural resources – marine (L) • Natural resources – marine (L)
Cooling Water System – Cooling water intake	Intake of water exceeds 0.6 m/s	• Natural resources - marine fauna (M)
Overall Project – transportation/logistics of material	Introduction of foreign flora/fauna (including marine and terrestrial pests) due to international shipping incorrectly discharging ballast water and/or failure to follow wet down procedures Additional winnowing of sediments and the generation of sediment plumes from increased shipping size resulting in deeper draught	• Natural resources - marine and terrestrial (M) • Natural resources – marine (M)
Overall Project – Flooding of site	Flooding of site (Storm surge/sea level variation/high tide significant rainfall event - Increased frequency of events)	• Groundwater (L) • Natural resources - marine (L) • Surface water quality (L)

Activity	Event Description	Aspect (Inherent Risk Level*)
Overall Project – Increased fugitive emissions	Increased fugitive emissions (Cumulative impact of multiple dust sources)	• Air quality (M) • Community health (M) • Groundwater (M) • Surface water quality (M) • Visual amenity (M)
Overall Project – Multiple operational activities together	Cumulative effect of flooding event, and/or road wet down, and/or rain during operations	• Groundwater (M) • Natural resources - marine (M) • Surface water quality (M)
Overall Project – New infrastructure in prominent positions	New infrastructure in prominent positions (necessary infrastructure)	• Community amenity (M) • Visual amenity (M)

* Risk levels are inherent levels of risk (without controls). ‘L’= low risk level, ‘M’ = medium risk level, ‘H’ = high risk level and ‘VH’ = very high risk level.

5.2 Environmental and Social Impacts

Potential impacts, objectives, management strategies and monitoring and reporting requirements associated with the environmental and social aspects identified in **Chapter 16** and **Appendix G** are discussed in Sections 5.2.1 to 5.2.11.

5.2.1 Air Quality

Objectives for Managing Air Quality

- To reduce lead, sulphur dioxide and particulate emissions to below the current levels and to be in compliance with the relevant State regulatory instruments, namely *Environment Protection (Air Quality) Policy* 1994.
- To be in compliance with Site-specific South Australian EPA Licence agreements.
- To receive no complaints from adjoining commercial/industrial neighbours or Site personnel.

Potential Impacts on Air Quality

- Activities or events associated with the EBS Oxidation Furnace and EBS Reduction Furnace could result in lead, sulphur dioxide and particulate emissions, which may exceed the Guidelines at EPA monitoring sites.
- Controlled discharge of sulphur dioxide, sulphur trioxide and acid mist from the Sulphuric Acid Plant, Reduction furnace and Tall Stack to the atmosphere may exceed the Guidelines at EPA monitoring sites.
- Activities or events associated with the Materials Storage Area may create fugitive emissions of lead-bearing dust.
- Increased fugitive emissions of lead-bearing dust arising from the cumulative impact of multiple dust sources may exceed EPA Guidelines.

Performance Criteria for Air Quality

- Post-construction monitoring of the Transformation demonstrates that:
    - Air quality is improved from current levels by a reduction in sulphur dioxide and lead emissions.
    - Controlled discharges from the Reduction furnace, Tall Stack and the Sulphuric Acid Plant do not to exceed new EPA licensing conditions.
- Plans and procedures for the operational phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Air Quality Management Strategy

The following actions will be taken prior to commissioning and will also apply to all aspects of decommissioning, demolition that occur during the operations phase:

- EBS Oxidation Furnace and EBS Reduction Furnace:
    - Develop a Commissioning Plan for each unit.
    - Design a Process and Hygiene drafting system.
    - Prepare an Operations and Maintenance Plan.

    - Develop an Operational Environmental Management and Monitoring Plan.
- Sulphuric Acid Plant:
    - Prepare a Commissioning Plan.
    - Prepare a Communication Plan.
    - Develop an Operation and Maintenance Plan.
    - Develop Start-up procedures.
- Materials Storage Area:
    - Develop an Earth Moving Plan (including dust suppression).
    - Eliminate sinter and sinter returns.
    - Relocate intermediate materials containing lead from the current Sinter Plant to the co-treatment shed.
    - Reclaim and treat sludge through the oxidation furnace.
    - Develop handling procedures.
- Overall Project:
    - Implement schedule management tracking.
    - Monitor the control of individual dust sources.

Monitoring of the Effectiveness of Air Quality Management

- The current EMRP for air emissions will be maintained.
- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- The implementation of plans and procedures to protect air quality will be checked and audited.

Reporting on Air Quality

A Prestart Audit Report will be undertaken to confirm air quality plans and procedures are correct and in place.

Corrective Action

If any impacts on air quality exceed limits and licence requirements and responsibilities under legislation, Nyrstar will review operating procedures and management plans and make changes to meet the EPA Guidelines.

5.2.2 By-product/Waste generation

Objective for Managing By-product/Waste

- To prevent any acid spills or leakage.
- To minimise impacts on existing waste facilities.
- To minimise environmental impacts associated with waste generation and accidental spills.
- To maximise waste minimisation, recycling, reuse and recovery.

Potential Impacts of By-product and Waste Generation

Impacts from by-product and waste generation could result due to spills or leakage of acid from the Sulphuric Acid Plant into secondary containment, which in turn may lead to mobilisation of contamination into soil, groundwater and/or surface water.

Performance Criteria for By-product/Waste

- Post-construction monitoring of the Transformation demonstrates that no contamination to surface water, groundwater or soil results from acid spills/leakage of the Sulphuric Acid Plant.
- Plans and procedures for the operational phase are approved and implemented prior to commissioning.

By-product/Waste Management Strategy

An inherently safe design of the Sulphuric Acid Plant and Development of an Operation and Maintenance Plan will be undertaken prior to commissioning to prevent any potential spills/leakage. The design height and volume of bunds will be as per EPA guidelines. Ongoing maintenance during the operational phase will ensure that contained liquor heights within the bunds will be zero unless an incident occurs and then returned to zero as soon as practical.

Monitoring of the Effectiveness of By-product/Waste Management

- The current EMRP for soil and groundwater quality will be maintained.
- The implementation of plans and procedures to protect any By-product/Waste impacts will be checked and audited.

Reporting on By-product/Waste

A Prestart Audit Report will be undertaken to confirm the Sulphuric Acid Plant Operation and Maintenance Plan is correct and in place.

Corrective action

If any impacts on By-product/Waste exceed what is predicted, Nyrstar will review operating procedures and management plans and make changes to meet the EPA Guidelines.

5.2.3 Community Health

Objectives for Managing Community Health

- To reduce lead, sulphur dioxide and particulate emissions to below current levels.
- To be in compliance with the relevant State regulatory instruments, namely *Environment Protection (Air Quality) Policy* 1994.
- To be in compliance with Site-specific South Australian EPA Licence agreements.

Potential Impacts on Community Health

- Activities or events associated with the EBS Oxidation Furnace in and EBS Reduction Furnace could result in lead, sulphur dioxide and particulate emissions, which may exceed the Guidelines at EPA monitoring sites and affect community health.
- Controlled discharge of sulphur dioxide, sulphur trioxide and acid mist from the Sulphuric Acid Plant and tall stack to the atmosphere may exceed the Guidelines at EPA monitoring sites and affect community health.
- Activities or events associated with the Materials Storage Area may create fugitive emissions of lead dust and affect community health.
- Increased fugitive emissions of lead-bearing dust arising from cumulative impact of multiple dust sources may exceed EPA Guidelines and impact community health.

Performance Criteria for Community Health

- Post-construction monitoring of the Transformation demonstrates that:
    - Air quality is improved from current levels by a reduction in sulphur dioxide and lead emissions.
    - Controlled discharges from reduction furnace and Tall Stack in the Sulphuric Acid Plant do not to exceed new EPA licensing conditions.
- Plans and procedures for the operational phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Community Health Management Strategy

The following actions will be taken prior to commissioning:

- EBS Oxidation Furnace and EBS Reduction Furnace:
    - Develop a Commissioning Plan for each unit.
    - Prepare an Operations and Maintenance Plan.
    - Develop an Operational Environmental Management and Monitoring Plan.
- Sulphuric Acid Plant:
    - Prepare a Commissioning Plan.
    - Prepare a Communication plan.
    - Develop an Operation and Maintenance Plan.
    - Develop Start-up procedures.
- Materials Storage Area:
    - Develop a Materials Movement Plan (including dust suppression).
    - Eliminate sinter and sinter returns.
    - Relocate intermediate materials containing lead from the current Sinter Plant to the co-treatment shed.
    - Reclaim and treat sludge through the oxidation furnace.
    - Develop handling procedures.
- Overall Project:
    - Develop a schedule for management of multiple operational activities.

  - Outline how control of individual dust sources will be achieved

Monitoring of the Effectiveness of Community Health Management

- The current EMRP for air emissions will be maintained.
- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- The implementation of plans and procedures to protect Community Health will be checked and audited.

Reporting on Community Health

A Prestart Audit Report will be undertaken to confirm Community Health plans and procedures are correct and in place.

Corrective Action

If any impacts on Community Health exceed what is predicted, Nyrstar will review operating procedures and management plans and make changes to meet the EPA Guidelines.

5.2.4 Community Amenity

Objectives for Managing Community Amenity

- To be in compliance with relevant State regulatory instruments, namely *Environment Protection (Air Quality) Policy* 1994 and *Environment Protection (Noise) Policy* 2007.
- To receive no noise, odour or visual amenity complaints from the community.
- To ensure that all new structures do not adversely affect Port Pirie skyline.

Potential Impacts on Community Amenity

- Activities or events from the EBS Reduction Furnace, New Oxygen Plant and Sulphuric Acid Plant may result in noise complaints from the community.
- Controlled discharge of sulphur dioxide, sulphur trioxide and acid mist from the Sulphuric Acid Plant reduction furnace and Tall Stack to the atmosphere may reduce odour and to complaints from the community.
- Prominent infrastructure from the Transformation may be visible from town of Port Pirie and surrounding areas and lead to visual amenity complaints from the community.

Performance Criteria for Community Amenity

- Monitoring during the Commissioning Phase of the of the Transformation demonstrates that the design standards for the EBS Reduction Furnace, New Oxygen Plant and Sulphuric Acid Plant ensure noise levels are within EPA thresholds.
- Post-construction monitoring of the Transformation demonstrates that:
  - controlled discharges from reduction furnace via the Tall Stack and the Sulphuric Acid Plant do not to exceed new EPA licensing conditions.

  - the Port Pirie skyline is not adversely affected by new structures beyond that outlined for development under Policy Area 15 of the Industry Zone, Port Pirie (Regional Council) Development Plan (DPTI, 2013).
- Transformation Stakeholder and Community Engagement Register show records of liaison with the Local Government Authority (LGA) and public on the issue of prominent infrastructure and the EPA on noise.
- Plans and procedures for the operational phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Community Amenity Management Strategy

The following actions will be taken prior to commissioning:

- Oxygen Plant, EBS Reduction Furnace:
  - Communication and consultation is undertaken with the EPA on noise.
  - Design standards for the facility will ensure noise levels meet with the *Environmental Protection Policy (Noise)* 2007.
- Sulphuric Acid Plant:
  - Communication and consultation is undertaken with the EPA on noise.
  - Design standards for the facility will ensure noise levels meet with the *Environmental Protection Policy (Noise)* 2007.
  - Develop an Operation and Maintenance Plan.
  - Develop Start-up Procedures.
- Overall Project:
  - Develop a Public Engagement and Consultation Strategy.

Monitoring of the Effectiveness of Community Amenity Management

- Noise monitoring during Commissioning Phase of Stage 1 Oxygen Plant, Stage 2 Reduction Furnace and Sulphuric Acid Plant will be undertaken to ensure they meet design standards for noise.
- Records of engagement and agreed outcomes with Local Government Authorities, the public, the EPA and any other Stakeholders will be kept.
- Photo-point monitoring to document pre and post construction skyline of Project Site from strategic viewpoints will be undertaken to ensure compliance with the Port Pirie (Regional Council) Development Plan (DPTI, 2013).
- The current EMRP for air emissions will be maintained.
- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- The implementation of plans and procedures to protect Community Amenity will be checked and audited.

Reporting on Community Amenity

A Prestart Audit Report will be undertaken to confirm Community Amenity plans and procedures are correct and in place.

Corrective Action

If any impacts on Community Amenity exceed what is predicted, Nyrstar will review operating procedures and management plans and make changes to meet the EPA Guidelines.

5.2.5 Noise

Objectives for Managing Noise

- To be in compliance with relevant State regulatory instruments, namely *Environment Protection (Noise) Policy* 2007.
- No receive no noise complaints from the community.

Potential Impacts on Noise

Activities or events from the EBS Reduction Furnace, New Oxygen Plant and Sulphuric Acid Plant may result in exceedances of EPA noise regulations and/or noise complaints from the community.

Performance Criteria for Noise

Monitoring during the Commissioning Phase of the of the Transformation demonstrates that design standards ensure noise levels for the EBS Reduction Furnace, New Oxygen Plant and Sulphuric Acid Plant are within EPA thresholds.

Noise Management Strategy

Prior to Commissioning Phase for the Oxygen Plant, EBS Reduction Furnace and Sulphuric Acid Plant, the following actions will be taken:

- Noise limits have been negotiated with the EPA through the PER process, see **Section 9.3** and **Appendix B**.
- Design standards for the facility will ensure noise levels meet with the *Environmental Protection Policy (Noise)* 2007.

Monitoring of the Effectiveness of Noise Management

- Sound monitoring during Commissioning Phase of Stage 1 Oxygen Plant, Stage 2 Reduction Furnace and Sulphuric Acid Plant will be undertaken to ensure they meet design standards for noise.
- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- Records of engagement and agreed outcomes with the EPA will be kept.

Reporting on Noise

A Prestart Audit Report will be undertaken to confirm records of engagement with the EPA on noise levels and implementation of design standards had been achieved.

Corrective Action

If any noise impacts exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA Guidelines.

5.2.6 Natural Resources

Objectives for Managing Natural Resources

- No adverse impacts on flora and fauna from the Transformation Project.
- To be in compliance with the relevant State regulations.
- To be in compliance with Site-specific South Australian EPA Licence agreements.

Potential Impacts on Natural Resources

- Degradation of piles during pile foundation maintenance and/or bunding/drainage/paving on the EBS Oxidation Furnace and EBS Reduction Furnace may lead to flow of contaminated material from the into the marine environment and exceedances of EPA Licence conditions (wastewater discharge to Spencer Gulf).
- Controlled discharge of sulphur dioxide, sulphur trioxide and acid mist to the atmosphere from the Sulphuric Acid Plant reduction furnace and tall stack may results in adverse impacts to flora.
- Elevated temperatures of discharged cooling water from the Cooling Water System may lead to increases in delta-T (thermal plume), salinity and dissolved oxygen, and localised impacts on marine fauna (invertebrates).
- Seabed erosion from cooling water discharge may lead to adverse impacts to marine water quality due to re-suspension of contaminated sediments, increased turbidity and increased localised temperatures.
- If cooling water intake exceeds 0.6 m/s from the Seawater Cooling Water Intake and Discharge Expansion, marine organisms (including larvae) may become entrained with water intake.
- The transportation/logistics of material may result in the introduction of foreign flora/fauna (including marine and terrestrial pests) and impact local ecology.
- Increased shipping sizes could result in additional winnowing of sediments and the generation of sediment plumes, causing re-suspension of contaminated sediments that degrades marine water quality
- A flooding event could remove contaminated material from the Transformation Site and deposits it at sea, resulting in adverse impacts to the marine environment.
- Cumulative effect of flooding events, and/or road wet down, and/or rain during could lead to increased contamination of marine environment.

Performance Criteria for Natural Resources

- Channel markings to protect the Cooling Water System diffuser are installed if required (if discharge to the Pirie River)
- Post-construction monitoring of the Transformation demonstrates that:

    - There are no adverse impacts on the marine environment by meeting current and new EPA licencing conditions.
    - Air quality is improved from current levels by a reduction in sulphur dioxide and lead emissions.
    - Controlled discharges from reduction furnace and Tall Stack in the Sulphuric Acid Plant do not to exceed new EPA licensing conditions.
- Transformation Stakeholder and Community Engagement Register show records of liaison with the Flinders Ports on shipping traffic.
- Plans and procedures for the operational phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Natural Resources Management Strategy

The following actions will be taken prior to commissioning:

- Oxygen Plant, EBS Reduction Furnace:
    - Inherent design of piles and targeted testing and evaluation of the pile design.
    - Development of an Operation and Maintenance Plan.
    - Development of an Operational Environmental Management and Monitoring Plan.
    - Design of pre-collection pits.
- Sulphuric Acid Plant:
    - Prepare a Commissioning Plan.
    - Prepare a Communication plan.
    - Develop an Operation and Maintenance Plan.
    - Develop Start-up procedures.
- Cooling Water Intake and Discharge Expansion:
    - Design diffuser for cooling water discharge.
    - Prepare Operation and Maintenance Procedures.
    - Develop Start-up Procedures.
    - Design a real-time discharge temperature monitoring system.
    - Install channel markings for the diffuser.
    - Design cooling water intake so that intake velocity is less than 0.6 m/s.
    - Develop Operating Procedures.
- Overall Project:
    - Consult with Flinders Ports on shipping traffic and ensure compliance with Flinders Ports Regulations.
    - Ensure compliance with Australian Quarantine Regulations.
    - Develop restrictions on shipping sizes.
    - Update Site Emergency Response Plan to ensure incorporation of extreme weather events (including inundation from river).
    - Develop a schedule for management of multiple operational activities.
    - Outline how control of individual dust sources will be achieved.
    - Develop housekeeping instructions.

  - Identify where placement of materials within known catchments will occur and obtain internal environmental authorisation for this.

Monitoring of the Effectiveness of Natural Resources Management

- Pre-collection pits will be installed prior to starting operations.
- The current EMRP for wastewater discharge to Spencer Gulf and air emissions will be maintained.
- A Marine Habitat Monitoring Plan will be developed and implemented if the discharge water quality at the 1M flume exceeds licence conditions.
- A new Marine Monitoring Program for the operation of the Cooling Water Intake and Discharge Expansion, e.g. temperature plume monitoring, will be developed and applied.
- Records of engagement and documentation of meetings with Flinders Ports will be kept.
- The implementation of plans and procedures to protect natural resources will be checked and audited.

Reporting on Natural Resources

A Prestart Audit Report will be undertaken to confirm Natural Resource plans and procedures are correct and in place.

Corrective Action

If any impacts on Natural Resources exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA Guidelines.

5.2.7 Odour

Objectives for Managing Odour

- To be in compliance with relevant State regulatory instruments, namely *Environment Protection (Air Quality) Policy* 1994.
- To receive no complaints of odour from the community.

Potential Impacts on Odour

Sulphur dioxide, sulphur trioxide, particulate and acid mist emissions from activities or events from the EBS Oxidation Furnace, EBS Reduction Furnace and Sulphuric Acid Plant may result in odour complaints from the community.

Performance Criteria for Odour

- Monitoring during the Commissioning and Operating Phases of the of the Transformation demonstrate that sulphur emissions from the EBS Oxidation Furnace, EBS Reduction Furnace and Sulphuric Acid Plant are reduced from current levels and are within EPA thresholds.

- Plans and procedures for the operational phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Odour Management Strategy

The following actions will be taken prior to commissioning:

- Oxygen Plant, EBS Oxidation and Reduction Furnaces:
    - Prepare a Commissioning Plan
    - Develop an Operations and Maintenance Plan
    - Develop an Operational Environmental Management and Monitoring Plan
- Sulphuric Acid Plant:
    - Prepare a Commissioning Plan.
    - Prepare a Communication plan.
    - Develop an Operation and Maintenance Plan.
    - Develop Start-up procedures.

Monitoring of the Effectiveness of Odour Management

- The current EMRP for and air quality will be maintained.
- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- The application of plans and procedures to protect natural resources will be checked and audited.

Reporting on Odour

A Prestart Audit Report will be undertaken to confirm plans and procedures to manage Odour are correct and in place.

Corrective Action

If any impacts on Odour exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA Guidelines.

5.2.8 Sub-surface Quality

Objectives for Managing Sub-surface Quality

- To achieve no adverse impacts on sub-surface from the Transformation Project.
- To be in compliance with Site-specific South Australian EPA Licence agreements.

Potential Impacts on Sub-surface Quality

- Deposition of lead, sulphur dioxide and particulate emissions from operational activities and events of the EBS Oxidation Furnace and EBS Reduction Furnace could lead to adverse impacts to the local sub-surface environment.

- Degradation of piles from acid attack on the EBS Oxidation Furnace and EBS Reduction Furnace could leads to contamination of the sub-surface.
- Spills/leakage of acid from the Sulphuric Acid Plant into secondary containment could results in mobilisation of contamination in the sub-surface.

Performance Criteria for Sub-surface Quality

- Monitoring during the Commissioning and Operating Phases of the Transformation demonstrates that lead and sulphur dioxide emissions from the EBS Oxidation Furnace, EBS Reduction Furnace and Sulphuric Acid Plant are reduced from current levels and are within EPA thresholds.
- There is no contamination to soil.
- Plans and procedures for the operational phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Sub-surface Quality Management Strategy

The following actions will be taken prior to commissioning:

- Oxygen Plant, EBS Reduction Furnace:
    - Prepare a Commissioning Plan
    - Develop an Operations and Maintenance Plan
    - Develop an Operational Environmental Management and Monitoring Plan
    - Ensure inherent design of piles and perform targeted testing and evaluation of pile design.
- Sulphuric Acid Plant:
    - Develop an Operation and Maintenance Plan.

Monitoring of the Effectiveness of Sub-surface Quality Management

- The current EMRP for and air and sub-surface quality will be maintained.
- The application of plans and procedures to protect natural resources will be checked and audited.

Reporting on Sub-surface Quality

A Prestart Audit Report will be undertaken to confirm plans and procedures to manage Sub-surface Quality are correct and in place.

Corrective Action

If any impacts on Sub-surface Quality exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA Guidelines.

5.2.9 Surface Water Quality

Objectives for Managing Surface Water Quality

- To achieve no contamination of surface water from the Transformation Project.
- To be in compliance with Site-specific South Australian EPA Licence agreements.

Potential Impacts on Surface Water Quality

- Deposition of lead, sulphur dioxide and particulate emissions from operational activities and events of the EBS Oxidation Furnace and EBS Reduction Furnace could lead to adverse impacts to the local surface water.
- Degradation of piles from acid attack on the EBS Oxidation Furnace and EBS Reduction Furnace could leads to contamination of surface water.
- Spillage of contaminated material during bunding/drainage/paving activities associated with the EBS Oxidation Furnace and EBS Reduction Furnace could contaminate surface water and potentially result in 1M non-compliance (wastewater discharge to Spencer Gulf).
- Fugitive lead dust emissions from activities or events associated with the Materials Storage Area could impact surface water quality.
- A flooding event could remove contaminated material from the Transformation Site and impact surface water quality.
- The cumulative impact of increased fugitive emissions from multiple dust sources could impact surface water quality.
- Cumulative effect of flooding events, and/or road wet down, and/or rain during could lead to increased contamination of surface water.

Performance Criteria for Surface Water Quality

- Monitoring during the Commissioning and Operating Phases of the Transformation demonstrates that lead and sulphur dioxide emissions from the EBS Oxidation Furnace, EBS Reduction Furnace and Sulphuric Acid Plant are reduced from current levels and are within EPA licence thresholds.
- Surface water quality shall not adversely affect the site waste water discharge water quality (this operates under current EPA Licence.
- Plans and procedures for the operational phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Surface Water Quality Management Strategy

The following actions will be taken prior to commissioning:

- Oxygen Plant, EBS Reduction Furnace:
    - Prepare a Commissioning Plan.
    - Develop an Operations and Maintenance Plan.
    - Develop an Operational Environmental Management and Monitoring Plan.
    - Design of pre-collection pits.
- Sulphuric Acid Plant:
    - Develop an Operation and Maintenance Plan.
- Materials Storage Area:

    - Develop an Earth Moving Plan (including dust suppression).
    - Eliminate sinter and sinter returns.
    - Relocate intermediate materials containing lead from the current Sinter Plant to the co-treatment shed.
    - Reclaim and treat sludge through the EBS oxidation furnace.
- Overall Project:
    - Update Site Emergency Response Plan to ensure incorporation of extreme weather events (including inundation from river).
    - Develop a schedule for management of multiple operational activities.
    - Outline how control of individual dust sources will be achieved.
    - Develop housekeeping instructions.
    - Identify where placement of materials within known catchments will occur and receive internal environmental authorisation for this.

Monitoring of the Effectiveness of Surface Water Quality Management

- The current EMRP for water quality will be maintained.
- Pre-collection pits installed prior to starting operations.
- The application of plans and procedures to protect natural resources will be checked and audited.

Reporting on Surface Water Quality

A Prestart Audit Report will be undertaken to confirm plans and procedures to manage Surface water Quality are correct and in place.

Corrective Action

If any impacts on surface water quality exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA requirements.

5.2.10 Groundwater

Objectives for Managing Groundwater

- To achieve no contamination of groundwater from the Transformation Project.
- To be in compliance with relevant State regulatory instruments, namely *Environment Protection (Water Quality) Policy* 2003.
- To be in compliance with Site-specific South Australian EPA Licence agreements.

Potential Impacts on Groundwater

- Degradation of piles from acid attack on the EBS Oxidation Furnace and EBS Reduction Furnace could leads to contamination of groundwater and contamination flow between aquifers.
- Spillage of contaminated material during bunding/drainage/paving activities associated with the EBS Oxidation Furnace and EBS Reduction Furnace could

contaminate groundwater and potentially result in 1M non-compliance (wastewater discharge to Spencer Gulf).
- Spills/leakage of acid from the Sulphuric Acid Plant into secondary containment could results in mobilisation of contamination in groundwater.
- A flooding event could remove contaminated material from the Transformation Site and impact groundwater quality.
- Increased wetting down to control the cumulative impact of multiple dust sources contributes to groundwater impacts.
- Cumulative effect of flooding events, and/or road wet down, and/or rain during could lead to increased contamination of groundwater.

Performance Criteria for Groundwater

- Monitoring during the Commissioning and Operating Phases of the Transformation demonstrates that:
  - there is no contamination to groundwater.
  - that lead and sulphur dioxide emissions are reduced from current levels and are within EPA thresholds.
- The existing groundwater monitoring program is refined and upgraded to track pH in various aquifers.
- Plans and procedures for the operational phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Groundwater Management Strategy

The following actions will be taken prior to commissioning:

- Oxygen Plant, EBS Reduction Furnace:
  - Prepare a Commissioning Plan.
  - Ensure inherent design of piles and perform targeted testing and evaluation of pile design.
  - Develop an Operations and Maintenance Plan.
  - Develop an Operational Environmental Management and Monitoring Plan.
  - Design of pre-collection pits.
- Sulphuric Acid Plant:
  - Develop an Operation and Maintenance.
- Overall Project:
  - Update Site Emergency Response Plan to ensure incorporation of extreme weather events (including inundation from river).
  - Develop a schedule for management of multiple operational activities.
  - Outline how control of individual dust sources will be achieved.
  - Develop housekeeping instructions.
  - Identify where placement of materials within known on-site catchments will occur and receive internal environmental authorisation for this.

Monitoring of the Effectiveness of Groundwater Management

- The groundwater monitoring program in the existing EMRP will be upgraded to reflect changes introduced by the Transformation.
- Inspecting runoff water collection pits installed prior to starting operations.
- The application of plans and procedures to protect natural resources will be checked and audited.

Reporting on Groundwater

A Prestart Audit Report will be undertaken to confirm plans and procedures to manage groundwater are correct and in place.

Corrective Action

If any impacts on groundwater exceed what is predicted, Nyrstar will review design standards and management plans and make changes to meet the EPA Guidelines.

5.2.11 Visual Amenity

Objectives for Managing Visual Amenity

- To receive no visual amenity complaints from the community.
- To ensure that all new structures do not adversely affect Port Pirie skyline beyond that outlined in the Port Pirie (Regional Council) Development Plan (DPTI, 2013).

Potential Impacts on Visual Amenity

- Activities or events from the EBS Oxidation Furnace and EBS Reduction Furnace may result in a visible plume of emissions that impacts visual amenity.
- The cumulative impact from multiple dust sources may impact on visual amenity.
- Prominent infrastructure from the Transformation may be visible from town of Port Pirie and surrounding areas and lead to visual amenity complaints from the community.

Performance Criteria for Visual Amenity

- Monitoring during the Commissioning Phase of the of the Transformation demonstrates that the design standards for the EBS Reduction Furnace, New Oxygen Plant and Sulphuric Acid Plant ensure noise levels are within EPA thresholds.
- Post-construction monitoring of the Transformation demonstrates that:
    - Sulphur dioxide and lead emissions are reduced from current levels.
    - the Port Pirie skyline is not adversely affected by new structures beyond that outlined for development under Policy Area 15 of the Industry Zone, Port Pirie (Regional Council) Development Plan (DPTI, 2013).
- Transformation Stakeholder and Community Engagement Register show records of liaison with the Local Government Authority (LGA) and public on the issue of prominent infrastructure.

- Plans and procedures for the operational phase are approved and implemented prior to commissioning.
- Ongoing compliance with EPA requirements, guidelines and measures is achieved.

Visual Amenity Management Strategy

The following actions will be taken prior to commissioning:

- EBS Oxidation Furnace and EBS Reduction Furnace:
    - Develop a Commissioning Plan for each unit.
    - Design the Process and Hygiene drafting system
    - Prepare an Operations and Maintenance Plan
    - Develop an Operational Environmental Management and Monitoring Plan
- Overall Project:
    - Develop a schedule for management of multiple operational activities.
    - Outline how control of individual dust sources will be achieved.
    - Develop a Public Engagement and Consultation Strategy.

Monitoring of the Effectiveness of Visual Amenity Management

- Records of engagement and agreed outcomes with Local Government Authorities and the public, the EPA and any other Stakeholders will be kept.
- Photo-point monitoring to document pre and post construction skyline of Project Site from strategic viewpoints will be undertaken to ensure compliance with the Port Pirie (Regional Council) Development Plan (DPTI, 2013).
- The current EMRP for air quality will be maintained.
- A Transformation Complaints and Corrective Actions Register will be developed and implemented.
- The implementation of plans and procedures to protect Community Amenity will be checked and audited.

Reporting on Visual Amenity

A Prestart Audit Report will be undertaken to confirm Visual Amenity plans and procedures are correct and in place.

Corrective Action

If any impacts on Visual Amenity exceed what is predicted, Nyrstar will review operating procedures and management plans and make changes to meet the EPA Guidelines.

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