Section 2

Description of the Proposal

PREAMBLE

This section describes the proposed Nyngan Scandium Project including:

- *the objectives of the Proposal;*
- *an overview of the Proposal and the approvals required;*
- *the infrastructure that would be established;*
- *the site preparation that would be undertaken;*
- *the proposed mining and processing operations and management of overburden and processing residue;*
- *ancillary activities that would be undertaken; and*
- *the proposed rehabilitation of the areas that would be disturbed throughout the life of the Proposal, including the development and implementation of a Biodiversity Offset Strategy.*

The Proposal is described in sufficient detail to provide the reader with an overall understanding of the nature and extent of the activities proposed, how the various activities would be undertaken and to enable an assessment of the potential impacts on the surrounding environment. The boundaries and dimensions of the various components described throughout this section are indicative only.

Details of the safeguards and management measures that the Applicant proposes to implement to minimise or negate the potential impacts on components of the surrounding environment are provided in Section 4 of this document.

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2.1 INTRODUCTION

2.1.1 Proposal objectives

The Applicant's objectives in constructing and operating the Proposal would be as follows.

- To mine the identified scandium reserves in a safe and environmentally responsible manner.
- Maximise the recovery of the identified scandium reserves through efficient mining and processing operations.
- Minimise the consumption of water, power and chemical reagents.
- Ensure that the by-products of the processing operations are managed to minimise the risk of pollution or contamination, as well as minimise the impact footprint required to manage these.
- To operate the Proposal in a manner that would minimise surface disturbance and impacts on surrounding residents and the local environment.
- To implement appropriate design, operational control and mitigation measures that ensures compliance with appropriate environmental criteria and reasonable community expectations.
- To develop and operate the Proposal in compliance with all relevant statutory requirements.
- To create a final landform that is suitable for a post-mining land use that would include a mixture of agriculture, nature conservation and water storage.
- To continue to develop trust within the local community through a transparent and accountable approach to all activities and through maintaining an open and honest relationship.
- To achieve the above objectives in a cost-effective manner to ensure security of employment and the continued economic viability of the Applicant.

2.1.2 Overview of the Proposal

The Proposal would incorporate the following (**Figure 2.1**).

- Establishment of infrastructure required for the Proposal, including a Site Access Road, power and water supply, levee bunds and administration area.
- Extraction of overburden and ore material from two open cuts and a surrounding borrow pit using conventional free dig mining methods on a campaign basis. Annual ore production would be up to 80 000t of high grade ore, and up to 95 000t of low grade ore. Mining would be undertaken for a period of up to 21 years.

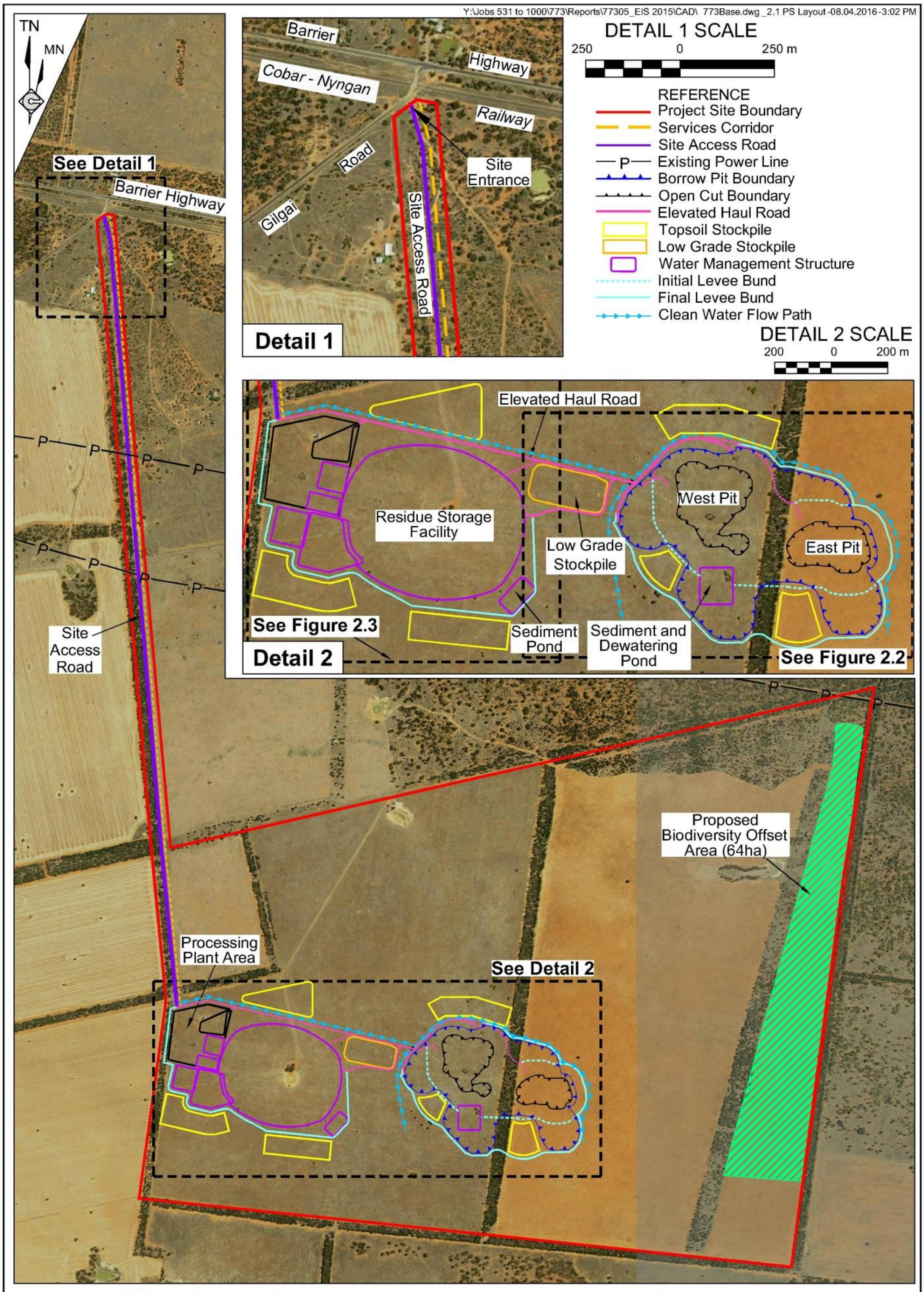


Figure 2.1
PROJECT SITE LAYOUT

- Use of extracted overburden for the construction of site infrastructure, including the Residue Storage Facility, levee bunds, haul roads and water management structures.
- Construction and use of a Processing Plant, incorporating a ROM Pad, feed preparation circuit, high pressure acid leach plant and associated infrastructure, including boilers, reagent and consumable stores and residue management systems to produce up to approximately 45t per year of scandium oxide which would be transported from the Project Site in small, sealed containers with an indicative capacity of less than 100L. Processing would be undertaken for the life of the mining operations, namely 21 years.
- Construction and use of a Residue Storage Facility.
- Construction and use of water management structures, including a Raw Water Pond, Event Pond, External Decant Pond, Evaporation Pond and a number of Sediment Ponds.
- Construction and use of a transformer and electrical distribution network.
- Construction of soil stockpiles (for use in rehabilitation works).
- Establishment of a Biodiversity Offset Area.

Disturbance associated with the mining and associated activities would be rehabilitated to create a geotechnically stable final landform, suitable for a final land use of light industry agriculture or nature conservation.

In addition, throughout the life of the Project, the Proponent proposes to undertake additional exploration drilling to further identify mineralisation. Should further mineable mineralisation be identified, and once sufficient information is available to adequately identify the proposed activities, a subsequent application for approval to extract these resources may be prepared.

2.1.3 Approvals Required

The Proposal would require development consent from the Minister for Planning and Environment and under Division 4.1 of the *Environmental Planning and Assessment Act 1979*. In addition, the following licences, leases, permits, agreements and approvals would be required to allow commencement of the Proposal.

1. An Environment Protection Licence issued by the Environment Protection Authority (EPA) under Section 47 of the *Protection of the Environment Operations Act 1997*[1].
2. A Mining Lease issued by the Department of Trade and Investment – Division of Resources and Energy (DRE) under the *Mining Act 1992*. The Applicant currently holds EL8316, EL6096 and ELA5232 over the Project Site and will submit a Mining Lease Application (MLA)[1].

[1] By virtue of Section 89K of the EP&A Act, such an authorisation or approval cannot be refused if it is necessary for carrying out State Significant Development that is authorised by a development consent under Division 4.1 of the EP&A Act. The authorisation or approval must also be and substantially consistent with the development consent.

3. Water Supply Works and Use Approval and Water Access Licence issued by the DPI – Water under the *Water Management Act 2000* for incidental water intersected by the proposed open cut. The Water Access Licence must be consistent with the *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources.*

4. A Section 138 Permit issued by the Bogan Shire Council under the *Roads Act 1993*, for construction of the intersection of the Site Access Road and Gilgai Road.[1]

5. An approval from the NSW Dams Safety Committee for the design and construction of the Residue Storage Facility, Evaporation Pond and External Decant Pond.

6. A high voltage connection agreement with Essential Energy which holds an electricity distributor's licence under the *Electricity Supply Act 1995*.

Following receipt of development consent, the Applicant would also seek the necessary approvals from Bogan Shire Council for the construction of buildings, structures and appropriate waste water treatment systems for the Proposal.

2.2 SITE ESTABLISHMENT AND CONSTRUCTION ACTIVITIES

2.2.1 Introduction

In order for mining, processing and product transportation to be undertaken within the Project Site, the establishment and construction of various infrastructure and other site features would be required. These activities are described in the following subsections. Site establishment would involve site preparation activities and the construction of various infrastructure and facilities associated with processing operations, residue management and, other site facilities and services. Operation of the relevant facilities is described in subsequent subsections.

The site establishment phase, i.e. from commencement of initial earthworks until the completion of all Project Site infrastructure and facilities, is anticipated to take approximately 12 months. It is noted, however, that mining and processing may be undertaken concurrently for a period towards the end of the site establishment phase.

2.2.2 Site Preparation

2.2.2.1 Introduction

The following subsections describe the activities that would be undertaken in preparation for mining operations, the construction of the Processing Plant and associated infrastructure and the construction and operation of the Residue Storage Facility. The activities would include:

- mark out and fencing;
- vegetation clearing; and
- soil management.

2.2.2.2 Mark Out, Fencing and Installation of Surface Water Controls

Prior to the commencement of any ground-disturbing activities, the Applicant would survey all areas of proposed disturbance and physically mark out on the ground approved areas of disturbance using appropriately labelled survey pegs. Permanent markers such as steel or concrete posts would be used to mark out critical areas such as the limit of approved disturbance or sensitive "no-go areas." All site personnel would be made aware of the approved areas of disturbance and the significance of not disturbing areas outside the approved areas.

Following marking out and fencing of the disturbance areas, temporary surface water controls would be installed. These controls would be constructed in accordance with *Managing Urban Stormwater – Volume 1* (Landcom, 2004). The controls would typically be temporary controls that would minimise the potential for erosion or sedimentation during site preparation and construction operations. Following completion of the proposed levee bund, all disturbed areas not within the levee bund (with the exception of roads and tracks – see Section 2.2.3) would be stabilised and the temporary surface water controls would be removed.

The Applicant notes that the landform within the Project Site is extremely flat and risks associated with erosion and sedimentation are limited. Notwithstanding the above, the Applicant would install the following temporary surface water controls.

- Small diversion structures to divert clean water away from areas to be disturbed.
- Sediment fencing downslope of all areas to be disturbed.
- Suitably sized temporary sediment basins, where required.

2.2.2.3 Vegetation Removal

A large proportion of the Project Site has been cleared of native vegetation and has been grazed or cropped over many years. Of the 145ha of direct disturbance, approximately 135.7ha is classified as exotic vegetation, namely cleared, grazed or cropping land without remnant native vegetation. The remaining 9.3ha is classified as Benson ID 103 – Poplar Box – Gum Coolabah and White Cypress Pine Shrubby Woodland mainly in the Cobar Peneplain Bioregion.

As there would be limited progressive establishment of the Project Site infrastructure, vegetation clearing within all areas except the East Pit cut would occur in a single campaign during site establishment operations.

Prior to commencement of clearing of native vegetation, if large vegetation with the potential to host nesting or roosting fauna is present, a pre-clearing inspection would be undertaken by a suitably qualified and experienced expert to ensure that any roosting or nesting fauna are identified and relocated. Such vegetation would then be removed using a bulldozer with its blade positioned just above the surface. This material would be stockpiled adjacent to the area of disturbance for later use during rehabilitation. No cleared vegetation material would be burnt or mulched. Ground cover vegetation would be removed with the topsoil to maximise the retention of the seed bank and nutrients within the soil, as well as to minimise opportunities for erosion and dust lift-off between removal and soil stripping.

2.2.2.4 Soil Management

SEEC (2016) undertook an assessment of the soils within the Project Site. That assessment is presented in Part 9 of the *Specialist Consultant Studies Compendium* and a detailed overview is presented in Section 4.12 of this document. In summary, the soils of the Project Site are identified by SEEC (2016) as belonging to Unit 1 of the Pangee Land System, described by Walker (1991) as “deep calcareous red earths with hardpan [and] isolated Gilgai areas”

The following soil stripping, stockpiling and management measures would be implemented during site preparation activities.

- Strip topsoil and subsoil together to a depth of approximately 300mm.
- Ensure that sufficient soil stripped and stockpiled to enable 300mm of soil to be placed over the rehabilitated landform, namely the Processing Plant Area, Residue Storage Facility, Borrow Pit and all other associated disturbance, with the exception of the open cuts which would remain as voids (see Section 2.13.3).
- Store stripped topsoil would be stored in stockpiles no more than 3m in height, and side slopes of 1:3 (V:H) or shallower. **Figure 2.1** presents the location of the proposed soil stockpiles.
- Ensure soil is not be stripped when either excessively dry or wet to preserve soil structure.
- Establish ground cover on soils exposed for more than two months in order to minimise wind and water erosion potential, and the threat of soil structural decline. Spray-on polymer covers or mulches may be used until vegetation can become established.
- Prevent the operation of machinery on soil stockpiles once formed and shaped to avoid compaction.
- Ensure that weeds are managed so that they do not become established on the soil stockpiles.

2.2.3 Site Access and Road Network

2.2.3.1 Introduction

The Applicant would construct a Site Access Road to permit access from Gilgai Road to the Project Site. An internal road network would also be constructed to facilitate movement of mobile equipment between the Open Cut and the Processing Plant and associated infrastructure. The following subsections describe the planned construction activities proposed to provide access to and within the Project Site.

It is noted that no modifications are proposed to the intersection of the Barrier Highway and Gilgai Road or the level railway crossing on Gilgai Road as these have recently been upgraded (**Figure 2.1**).

2.2.3.2 Project Site Entrance

The intersection of the Site Access Road and Gilgai Road and Project Site entrance would be constructed approximately 40m south of the existing railway crossing on Gilgai Road. This would permit a single B-double truck to be queued on Gilgai Road when the level crossing is in use by a train. Should two vehicles leave the Project Site at the same time, the second vehicle would be able to wait within the Project Site until the first vehicle has crossed the rail line.

The intersection would indicatively be a sealed basic right turn and basic left turn treatments (BAR/BAL) be designed and constructed in accordance with Austroads *Guide to Road Design*. A stop sign would be provided on the Site Access Road and the intersection would be designed to cater for B-double.

Detailed intersection designs would be provided to Bogan Shire Council to support an application for a permit under s138 of the *Roads Act 1919.*

2.2.3.3 Site Access Road

The Site Access Road would be constructed between Gilgai Road and the Processing Plant Area (**Figure 2.1**). The road would be approximately 4.9km in length. The location adjacent to the unnamed road reserve was selected to avoid unnecessary disturbance to native vegetation with the road reserve.

The Site Access Road would be an all-weather, unsealed two lane road suitable for use by light and heavy vehicles. The road would be constructed to a width that would provide dimensional adequacy for two loaded semi-trailer trucks to pass safely. The road would be slightly above the natural ground surface and appropriate road-side drainage would be constructed in accordance with the requirements of *Managing Urban Stormwater – Soils and Construction – Volume 2C Unsealed Roads* published by the Department of Environment and Climate Change in 2008 (DECC, 2008).

The Site Access road would be sheeted with suitable material to minimise dust generation as a result of vehicle movements and would be watered using a water truck as required. Alternatively, suitable dust suppressant products would be mixed with water sprayed on the roads to minimise water required for dust suppression operations. The road would also be graded as needed to maintain the surface where it is evident that physical wear has resulted in potholes or rutting.

A lockable agricultural-type gate would be erected at the site entrance, with a second lockable security gate installed where the Site Access Road passes through the Processing Plant security fence.

2.2.3.4 Internal Road Network

A range of internal roads would be required to facilitate extraction of ore and overburden and to permit movement of mobile plant within the Project Site **(Figure 2.1)**.

All proposed internal roads, other than temporary roads and those within the footprint of the proposed open cuts or borrow pits, would be unsealed and constructed in a manner that would permit all weather access to and within the Project Site. In addition, all proposed roads would be designed and constructed in accordance with the requirements of *Managing Urban Stormwater – Soils and Construction – Volume 2C Unsealed Roads* (DECC, 2008).

All internal roads would be managed for dust generation and maintained in a similar manner and frequency as the Site Access Road.

Finally, the Project Site internal road network would be constructed and signposted in a manner that would ensure separation between mine and non-mine vehicles. Site access would be controlled and non-approved drivers and vehicles would be prevented from accessing the active sections of the Project Site without an appropriate clearance or escort.

2.2.4 Electricity Supply

The Applicant would construct approximately 2.5km of high voltage electricity transmission line from an existing 33kV transmission line that crosses the Site Access Road. The proposed electricity transmission line would be located adjacent to the proposed Site Access Road **(Figure 2.1)** and would terminate into a high voltage switchboard located adjacent to the offices and workshop. Underground cabling would distribute the high voltage supply to a step down transformer and associated switch room in the Processing Plant Area. A further 2.5km of transmissions lines would be established within the Project Site to distribute power within the Project Site.

The electricity transmission line would be constructed in accordance with Essential Energy’s *High Voltage Connection Requirements* (CEPG8079 Issue 2). The transformer would comply with Australian Standard AS 2067 – *Switch Gear Assemblies and Ancillary Equipment for Alternating Voltages above 1kV* and would be bunded and enclosed within a suitable high security fence with appropriate signage.

2.2.5 Communications

External communications for site data and phone service will be provided via existing cellular services from the Nyngan town, with a planned migration to a wireless connection with the National Broadband Network (NBN) when the country wide rollout reaches Nyngan.

Within the Project Site, communications between facilities would be via buried or overhead fibre optic or copper cables and/or a wireless network.

2.2.6 Water Supply

Operational water would be sourced from the Cobar Water Board's Nyngan to Cobar pipeline that runs adjacent to the Barrier Highway. Water within that pipeline is sourced from Lake Burrendong Dam and is diverted from the Macquarie River at Warren via a 73km open channel (the Albert Priest Channel) to the Nyngan Weir Pools. From there it is pumped to Cobar.

The Applicant has commenced discussions with the Cobar Water Board and water brokers in relation to access to the pipeline and purchase of the relevant high security water licences.

The water supply pipeline would be constructed using HDPE pipe or similar in consultation with the Cobar Water Board. Tests would be undertaken to ensure the integrity of each join before it is buried. The pipeline would be laid within a trench in accordance with the trench dimension and installation specifications provided by *AS/NZ 2566.2:2002 Buried Flexible Pipelines – Installation*.

2.2.7 Levee Bunds

Section 2.7 provides a description of the operational water management procedures to be implemented within the Project Site. In summary, however, active sections of the Project Site would be surrounded by a levee bund (**Figure 2.1**). The purpose of the levee bunds would be to:

- exclude flood waters up to a 1 in 1 000 year or 0.1% annual exceedance probability (AEP) storm event; and
- retain all potentially sediment or chemical-laden water within the bunded area.

The levee bunds would be established during initial construction operations using overburden sourced from the initial pre-strip operations within the Open Cut. Knight Piésold (2016b) undertook an assessment of the anticipated height of a 0.1% AEP storm event. Incorporating a 1m freeboard above the modelled flood level, the proposed levee bunds would have a crest height of:

- approximately 186.6m AHD in the vicinity of the Processing Plant Area; and
- approximately 185.6m AHD in the vicinity of the open cuts.

The bunds would be shaped to have side slopes of 1:3 (V:H) or less. The northern bund would incorporate an elevated haul road approximately 15m wide suitable for two haul trucks to pass. In addition, the elevated haul road would incorporate suitable culverts and associated erosion protection devices to convey 2.6m^3/second.

Finally, the levee bund around the proposed open cuts would be constructed in two stages. An initial or inner levee bund would be constructed around the proposed open cuts during Stage 1 of the mining operations. Towards the end of Stage 1, a final or outer levee bund would be constructed. This bund would permit the construction of the proposed Borrow Pit during Stage 2 of the mining operations.

2.2.8 Workshops, Offices and Associated Infrastructure

The Applicant would establish the following buildings and structures within the Processing Plant Area.

- An administration area, including transportable buildings for offices, crib (meals) room, ablutions, laboratory, a first aid room and security. The administration area would also include an unsealed carpark for visitors and non-mine vehicles.

- A workshop, including a concrete-sealed floor and vehicle inspection bays. A small bund or drain around the perimeter of the building would contain potentially contaminated runoff and an oil/water separator would be incorporated in the drainage plan. The workshop would be surrounding by a hardstand area comprising an unsealed area for storage of excess equipment awaiting use or removal from site, or parking of mobile equipment.
- A fuel bay and refuelling area, incorporating a concrete bunded storage area containing fuel tanks, unused oil and grease, waste oil tank and a concrete sealed refuelling area. The capacity of the bunded area would be 110% of the volume of the largest tank. All potentially contaminated surface water runoff would be directed to an oil/water separator.
- A vehicle wash down bay would be located within the vicinity of the workshop.
- A range of stores facilities, including reagent stores constructed in accordance with:
  – AS4452 – *The storage and handling of toxic substances.*
  – AS1940 – *The storage and handling of flammable and combustible liquids*.

All visitors would be required to stop and sign in at the Administration Area prior to being permitted to access the active sections of the Project Site.

A mine contractor’s area would be established in the vicinity of the proposed open cuts and would include a series of transportable buildings that would include a site office, crib room and ablutions facilities. A concrete sealed area would be provided for a workshop, with the mining contractor to provide a transportable workshop to be installed within the concrete sealed area. All potentially contaminated surface water runoff would be directed to an oil/water separator.

2.3 MINING OPERATIONS

2.3.1 Introduction

Development consent is sought for the extraction of ore and overburden from two open cuts and a surrounding borrow pit. This subsection provides a description of the:

- geological setting of the Project Site;
- the layout of the proposed open cuts and borrow pit;
- the mining method that would be implemented;
- the mining rate and sequence; and
- the equipment that would be used during mining operations.

2.3.2 Geological Setting of the Deposit

The Nyngan Scandium Deposit has been formed through enrichment of scandium in the weathered profile. In summary, the Project Site is underlain by the Gilgai and Honeybugle intrusive complexes. These complexes are characterised by a range of mafic intrusives, including hornblende monzonite, hornblendite, pyroxenite and olivine pyroxenite to dunite-peridotites, with the more mafic intrusives having slightly elevated, but uneconomic concentrations of scandium.

During weathering of the underlying, mildly enriched material, scandium has become mobilised and redeposited within the weathering profile, resulting in substantial enrichment within selected horizons. The weathering profile and associated distribution of scandium from surface to the underlying basement rocks may be summarised as follows.

- Alluvial overburden – the uppermost section of the geological profile is dominated by transported “alluvial” material. This material is much younger in age than the underlying material and does not include scandium mineralisation. For the purposes of this document, that material is referred to as “overburden.” The alluvial material is separated from the underlying lateritic and basement material.
- Haematitic clay – typically this uppermost layer has limited to trace concentrations of scandium-bearing minerals and would be removed as overburden. This layer extends from surface to depths of up to 12m below surface. Occasional cemented hard bands occur within this layer, but these are suitable for ripping by a bulldozer.
- Limonitic clay – typically this layer has elevated concentrations of scandium-bearing minerals, with grades of >200ppm scandium. This layer is typically brown coloured, with traces of orange or yellow, is heavily weathered and is described as powdery or granular in texture.
- Saprolitic clay – this layer has lower concentrations of scandium-bearing minerals, with grades typically between 100ppm and 200ppm scandium. This layer is typically bright green coloured, is strongly weathered and is described as being a sticky clay which will at times disintegrate into chips.
- Weathered ultramafic rocks – the weathered bedrock typically contains only trace concentrations of scandium and is distinguished by having frequent chips of clearly identifiable weathered bedrock.
- Unweathered or fresh ultramafics – the basement material typically contains only trace concentrations of scandium and is distinguished by being competent and largely unweathered.

As a result of the fact that scandium has become enriched as a result of weathering patterns over an extended time period, the mineralisation is relatively consistent laterally. However, substantial changes occur in both the overall scandium concentration and the nature of the scandium-bearing minerals occur over small distances vertically.

The Applicant proposes to extract the uppermost Haematic Clay layer (as overburden) and the underlying Limonitic Clay layer (as ore). Both of these layers are amenable to extraction using free dig techniques, with the base of the open cut typically defined by the transition from the Limonitic Clay to the Saprolitic Clays layer.

2.3.3 Indicative Design of the Proposed Open Cuts and Borrow Pit

Figure 2.2 presents the design of the proposed Open Cuts and Borrow Pit. The design of the Open Cuts and Borrow Pit may be summarised as follows.

- Total area.. approximately 38.2ha.
- Crest elevation.. approximately 185m AHD.
- Maximum depth.
  - East Pit..approximately140m AHD or 45mbgl.
  - West Pit...approximately135m AHD or 50mbgl.
  - Borrow Pit...approximately170m AHD or 15mbgl.
- Face height ....approximately 10m.
- Face angle.
  - East and West Pits ....up to approximately 50º.
  - Borrow Pit..approximately 18º.

It is noted that the above design criteria are based on preliminary geotechnical studies. As a result, initial mining operations would not be undertaken in the vicinity of the terminal faces of the open cuts until sufficient geotechnical information has been obtained through both site investigations and observations of the temporary open cut walls.

Table 2.1 presents the volume of each of the material types within the proposed open cut that would be removed.

Table 2.1
Approximate Open Cut Material Movements

	East Pit			West Pit			Borrow Pit[1]		
Material	**Volume (Mm^3)**	**Density (t/m^3)**	**Tonnage (Mt)**	**Volume (Mm^3)**	**Density (t/m^3)**	**Tonnage (Mt)**	**Volume (Mm^3)**	**Density (t/m^3)**	**Tonnage (Mt)**
Overburden	0.98	2.02	1.98	1.14	2.02	2.31	2.69	2.02	5.43
Low Grade Ore	0.05	1.88	0.09	0.25	1.96	0.49	-	-	-
High Grade Ore	0.27	1.88	0.51	0.51	1.96	1.0	-	-	-
Total	**1.30**		**2.58**	**1.90**		**3.80**	**2.69**		**5.43**
Note 1: Excluding the East and West Pits									
Source: Mining One									

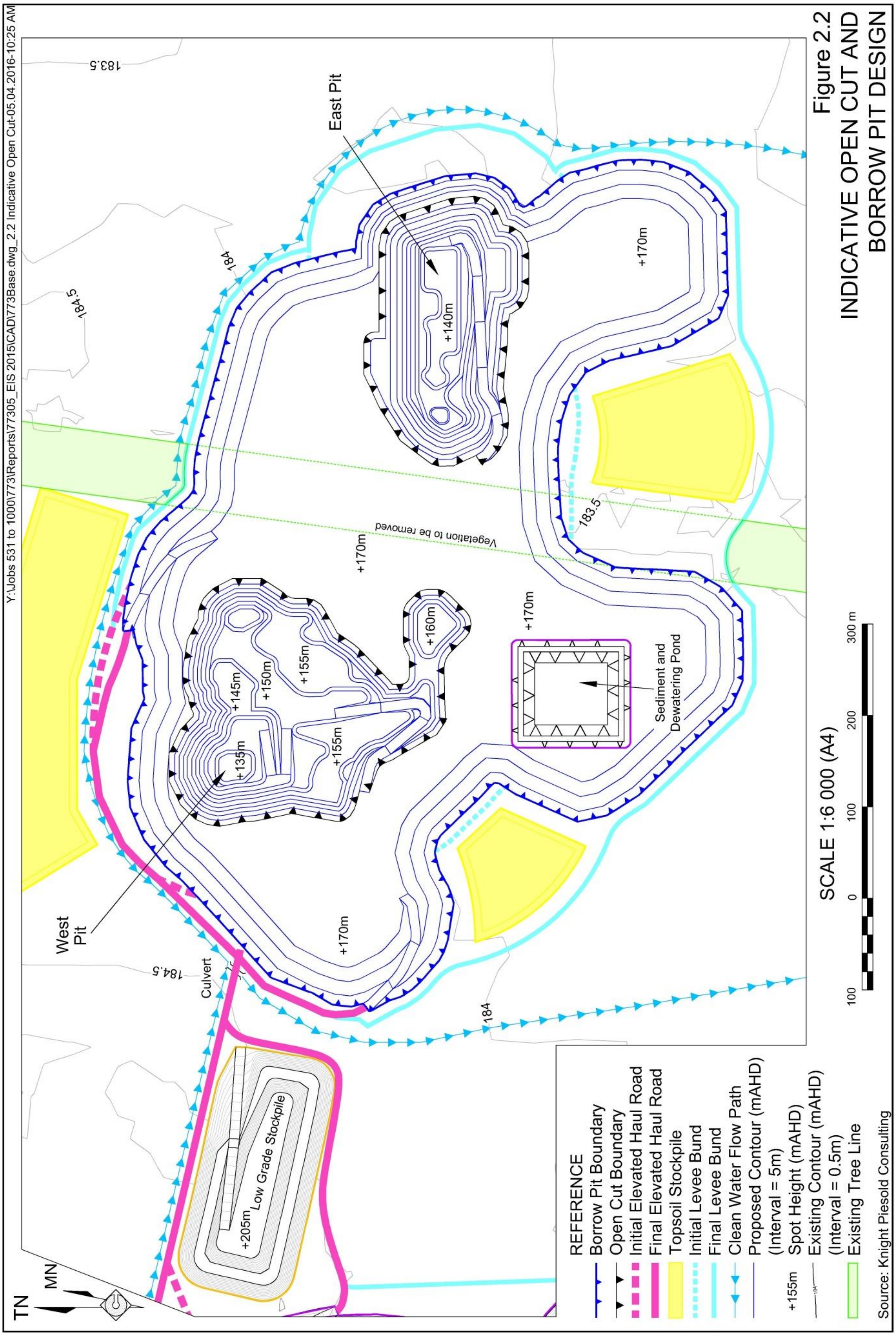


Figure 2.2
INDICATIVE OPEN CUT AND BORROW PIT DESIGN

2.3.4 Classes of Ore and Design of Low Grade Stockpiles

The Applicant anticipates that two classes of limonitic ore would be extracted as follows.

- High grade ore – this material would have an average grade of approximately 400ppm scandium and would be extracted, transported to the ROM pad and processed within a short time following extraction.
- Low grade ore – this material would have an average grade of less than 400ppm scandium and would be extracted and transported to the Low Grade Stockpile (**Figure 2.2**).

The Low Grade Stockpile would have the following design criteria.

- Area .... approximately 3.4ha.
- Maximum elevation/height ....205m AHD or approximately 30m high.
- Volume .... approximately 382 000m^3.

Low grade ore would be transported to the Low Grade Stockpile as it is extracted. Material may also be removed from the stockpile to blend with higher grade ore to ensure a consistent feed to the Processing Plant. As a result, the Low Grade Stockpile is likely to vary in size during the life of the Proposal. Low grade ore would then be processed following the completion of mining operations and the stockpile would be removed. In the event that market conditions do not justify processing of the low grade ore at that time, the Low Grade Stockpile would be shaped, covered with topsoil and rehabilitated as described in Section 2.13.

2.3.5 Efficiency of Resource Recovery

The Proponent notes that the nature of the Nyngan Scandium Deposit is that there is a distinct lower boundary to the Limonitic Clay. As a result, the base of the proposed open cuts represents the limit of the vertical extent of highest grade mineralisation. However, as the identified resource extends vertically below the base of the Open Cut, no in-pit placement of residue or overburden would be undertaken. Similarly, the Applicant has designed the Proposal in a manner that significant infrastructure, including the Processing Plant, Residue Storage Facility, External Decant Pond and Overburden Emplacement would be located outside the limit of the identified resource (**Figure 2.1**). As result, the Proposal would not result in sterilisation of resources that may be amenable to future extraction.

2.3.6 Open Cut Mining Methods

Following removal of vegetation and soil material as described in Sections 2.2.2.3 and 2.2.2.4, mining would commence with the removal of overburden. This material would be extracted using either a front-end loader and / or an excavator and loaded into small haul trucks or rigid road trucks for transportation to the following locations.

- Ore – ROM Pad.
- Ore with a scandium concentration less than approximately 400ppm – Low Grade Stockpile.

- Overburden – infrastructure areas such as the levee bunds, Residue Storage Facility or other areas for construction of Proposal-related infrastructure.

Where required, a bulldozer may be used to rip and push up occasional cemented horizons. The Applicant does not anticipate that drill and blast extraction methods will be required.

2.3.7 Mining Campaigns, Schedule and Staging

2.3.7.1 Mining Campaigns

The Processing Plant has been designed to process up to approximately 240t per day or 80 000tpa. This production rate, together with the requirement to blend ore material to achieve a consistent feed stock for the Processing Plant would not justify a continuous mining operation. As a result, the Proponent proposes to undertake mining operations on a campaign basis with earthmoving contractors engaged to undertake the mining operations. Mining campaigns would typically be undertaken three times per year, with each campaign expected to be undertaken over a period of three to five weeks, with the mining contractor demobilised between mining campaigns. The initial mining campaign(s) would, however, be longer than the typical campaign to enable sufficient overburden material to be extracted initially for construction of the Project Site infrastructure, including:

- levee bunds;
- initial Residue Storage Facility and External Decant Pond embankments; and
- access and haul roads.

2.3.7.2 Mining Schedule

Table 2.2 presents the anticipated mining schedule for the life of the Proposal. It is noted that **Table 2.2** indicates a maximum high and low grade ore production rate of 75 000tpa and 88 000tpa respectively while approval is sought for a maximum rate of 80 000tpa and 95 000tpa respectively. The Applicant notes that approval for higher rates of production is sought to allow for variation in campaign mining rates, where mining rates in one year may vary from the scheduled rates presented in **Table 2.2**.

2.3.7.3 Mining Stages

The Applicant would require approximately 9.7Mt of overburden to construct infrastructure required for the Proposal, in particular, the levee bunds and Residue Storage Facility. Section 2.4.3 provides an overburden balance for the Proposal. However, in summary, the proposed open cuts do not include sufficient overburden for construction of the required infrastructure. As a result, the Applicant proposes to construct a Borrow Pit surrounding the proposed East and West Pits. The Borrow Pit has been designed in a manner that that would effectively remove overburden from areas of scandium resource that at not the subject of this application. This would reduce the amount of pre-strip that would be required for any subsequent mining operation.

Table 2.2
Indicative Mining Schedule[1]

Year	High Grade Ore (t)	Low Grade Ore (t)	Overburden (t)		
			Open Cuts	Borrow Pit	Total
1	27 000	13 000	770 000	-	770 000
2	62 000	28 000	400 000	-	400 000
3	75 000	37 000	390 000	-	390 000
4	75 000	31 000	440 000	-	440 000
5	75 000	42 000	450 000	-	450 000
6	75 000	76 000	660 000	-	660 000
7	75 000	60 000	340 000	-	340 000
8	75 000	43 000	260 000	-	260 000
9	75 000	88 000	270 000	580 000	850 000
10	75 000	58 000	90 000	-	90 000
11	75 000	34 000	30 000	850 000	880 000
12	75 000	39 000	60 000	-	60 000
13	75 000	6 000	50 000	940 000	990 000
14	75 000	6 000	10 000	10 000	20 000
15	75 000	8 000	10 000	970 000	980 000
16	75 000	13 000	20 000	10 000	30 000
17	75 000	5 000	10 000	1 400 000	1 410 000
18	75 000	7 000	-	50 000	50 000
19	75 000	7 000	-	-	-
20	75 000	14 000	-	-	-
21	50 000	10 000	-	650 000	650 000
Note 1: Mining schedule subject to change and is indicative only					
Source: After Mining One					

In light of the above, the Applicant proposed to undertake mining operation in two stages, as follows (**Figure 2.3**).

Stage 1 – Year 1 to Year 8

During Stage 1 mining operations a starter pit would be constructed within the West Pit to provide overburden for construction of the proposed:

- initial levee bund around the open cuts;
- final levee bund around the Residue Storage Facility and Processing Plant Area;
- initial lift of the Residue Storage Facility; and
- other infrastructure.

Concurrently, the initial parcels of ore would be extracted and transported to the ROM Pad for processing.

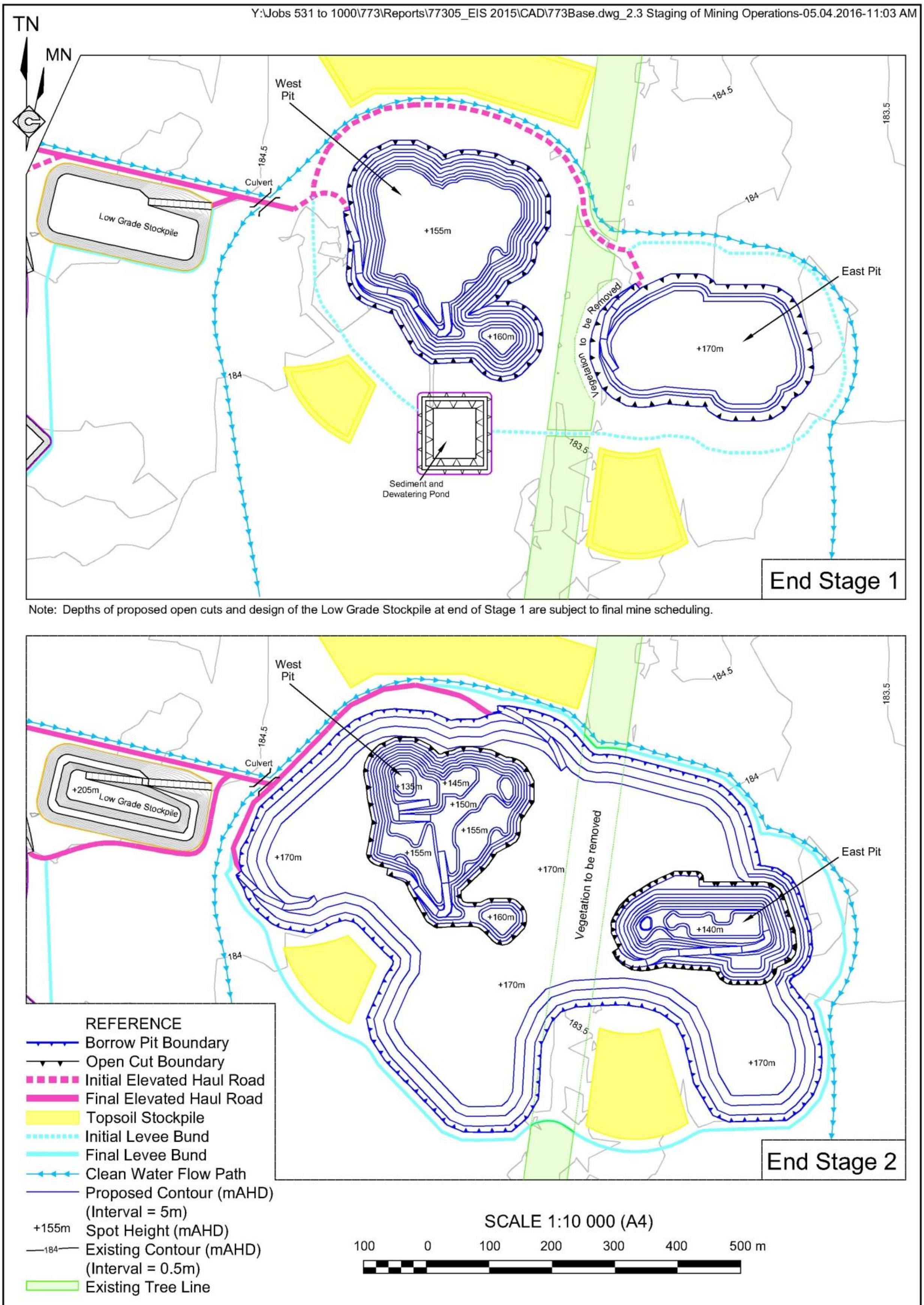


Figure 2.3
STAGING OF MINING OPERATIONS

Source: Knight Piesold Consulting

Following commencement of processing operations, Stage 1 mining operations would continue, with both ore and overburden extracted at rates that would ensure an adequate supply of both classes of material for processing and for construction of the Residue Storage Facility respectively. As indicated in **Table 2.2**, between 0.77Mt and 9.7Mt per year of overburden would be required for construction of the Residue Storage Facility and other infrastructure during Years 1 to 8. This material would initially be sourced from the West Pit, with overburden mining operations expected to commence in the East Pit in approximately Year 3. By Year 9, available overburden would have been removed from both the East and West Pits. This would represent the completion of Stage 1 mining operations.

During Stage 1 mining operation, a Sediment and Dewatering Pond would be established to the south of the West Pit. Operation of this facility is described in more detail in Section 2.7.

Stage 2 – Year 9 to Year 21

Stage 2 mining operations would commence with the establishment of the Final Levee Bund as shown in **Figure 2.3**. Following completion of the bund, overburden extraction would commence in the western section of the Borrow Pit, with mining operations progressing generally eastwards then southwards. The Applicant would delay as long as possible disturbance of the existing tree line through the Borrow Pit to allow the maximum time for the vegetation within the Biodiversity Offset Area to become established (see Section 2.14). Based on current projections, the tree line would be removed between Years 11 and 15.

The floor of the proposed Borrow Pit would be approximately 170m AHD or approximately 15mbgl. The walls of the Borrow Pit would be sloped at approximately 1:3 (V:H) or 18º to facilitate subsequent rehabilitation.

No ore would be extracted from within the Borrow Pit, with ore extraction limited to the proposed East and West Pits. The Applicant would ensure that appropriate bunding of the crest of the open cuts is maintained during mining of the Borrow Pit to ensure that mining equipment and personnel are not placed at risk and that surface water from the Borrow Pit is not permitted to flow to the open cuts.

Finally, the proposed Sediment and Dewatering Pond would be relocated to the floor of the Borrow Pit during Stage 2 and the previously constructed pond would be removed.

2.3.8 Mining Equipment

Table 2.3 presents the indicative mining equipment that would operate during each mining campaign. It is noted that as mining operations would be undertaken by a contractor, that mining equipment may vary from that indicated and from campaign to campaign.

Table 2.3
Indicative Mining Equipment

Equipment	Model / Size	Number	Task
Excavator/front-end loader	CAT330	1	Excavation and loading of overburden / ore into haul trucks.[1]
Haul truck	Road registerable rigid trucks or small haul trucks	1 to 2	Transportation of overburden to the Overburden Emplacement or elsewhere for use in construction of Project Site infrastructure and ore to the ROM Pad.
Water Cart	Road registerable rigid truck	1	Dust suppression throughout disturbed sections of the Project Site.
Bulldozer	D8	1	Pushing and ripping of material within the Open Cut, shaping of site infrastructure, management of overburden within the Overburden Emplacement.
Grader	CAT140	1	Management of internal roads.
Note 1: A front-end loader would also operate within the ROM Pad managing the ore stockpiles and feeding the Processing Plant			
Source: EMC Metals Australia Pty Ltd			

2.4 OVERBURDEN MANAGEMENT

2.4.1 Introduction

In order to access the identified scandium mineralization, initial mining operations would require removal of overburden overlying the scandium-bearing limonite clays. As described in Section 2.4.1, this material has been described as "alluvium" and is much younger that the underlying scandium-bearing material.

Overburden would be initially be used for construction of the Project Site infrastructure. The following subsections provide a brief overview of the characteristics of the overburden, and procedures that would be implemented during transportation and placement of this material.

2.4.2 Overburden Characteristics

Knight Piésold prepared an assessment of the characteristics of the overburden (as well as underlying laterite and saprolite) to be produced by the proposed mining operations. That report is presented as Part 1 of the *Specialist Consultant Studies Compendium* and is referred to hereafter as Knight Piésold (2016a).

In summary, Knight Piésold (2016a) determined the following in relation to the overburden. Classification of the laterite and saprolite material is not discussed here as that material would be classified as ore (in the case of laterite) and processed ore would remain *in situ* (in the case of saprolite).

- The overburden may be classified as non-acid forming.

- The overburden may be slightly enriched in arsenic, boron and bismuth. One sample of was significantly enriched in chloride and chromium. Similarity in composition with the underlying lateritic material suggest possible miss classification of the sample or mobilisation of these elements from the laterite to the overburden.
- Multi-element analysis of the overburden indicates that the material does not meet the trigger levels for contamination identified in the following guidelines, except where stated.
  - *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1). Health Investigation Levels for Soil Contaminants, Generic Land Use.*
  - *Netherlands Ministry of Housing, Spatial Planning and the Environment (VROM) 2000. Circular on Target Values and Intervention Values for Soil Remediation.*
  - *United States Environmental Protection Agency (U.S. EPA) Ecological Soil Screening Levels* with limited exceedances for antimony and chromium.
- Distilled water extracts from the overburden indicate that runoff from any overburden that may be exposed at the surface would compare with the following criteria.
  - ANZECC (2000) livestock and irrigation water trigger levels – generally compliant, with the exception of aluminium,
  - ANZECC (2000) aquatic protection and drinking water trigger levels – generally not compliant for a range of metals

Overall, Knight Piésold (2016a) determined that the overburden within the Project Site should be considered to have a low geochemical risk to the environment and is suitable for use in constructing the proposed infrastructure.

2.4.3 Overburden Balance

Table 2.2 presents the overburden mining schedule for the life of the Proposal. The schedule has been designed by Mining One to ensure that all overburden, in including material extracted from the borrow pits, would be directly used to construct site infrastructure.

2.4.4 Management of Overburden

Overburden would be transported directly from the proposed open cuts to the location where it is to be used by haul truck or scraper, depending on the method used to extract the material.

During construction of the levee bunds and elevated haul road, overburden would, to the extent practicable, be transported within areas that would be subject to subsequent disturbance. During transportation of overburden to the Residue Storage Facility, overburden would initially be transported via an initial haul road located to the west of the Low Grade Stockpile (**Figures 2.1** and **2.3**). However, as the Residue Storage Facility nears completion, the access ramp for the facility would progressively move from the northern perimeter of the facility to the eastern perimeter. As a result, overburden towards the end of the life of the Proposal would be transported to the south of the Low Grade Stockpile (**Figure 2.3**).

Once placed the material would be shaped using a bulldozer. In the case of the various water storages and the Residue Storage Facility, the material would be conditioned using water and a roller compactor to achieve the required permeability. In the case of the levee bunds and the elevated haul road, the outer face of the bunds would be shaped to achieve the final slope of 1:3 (V:H) or less and rehabilitated as described in Section 2.13.

2.5 PROCESSING OPERATIONS

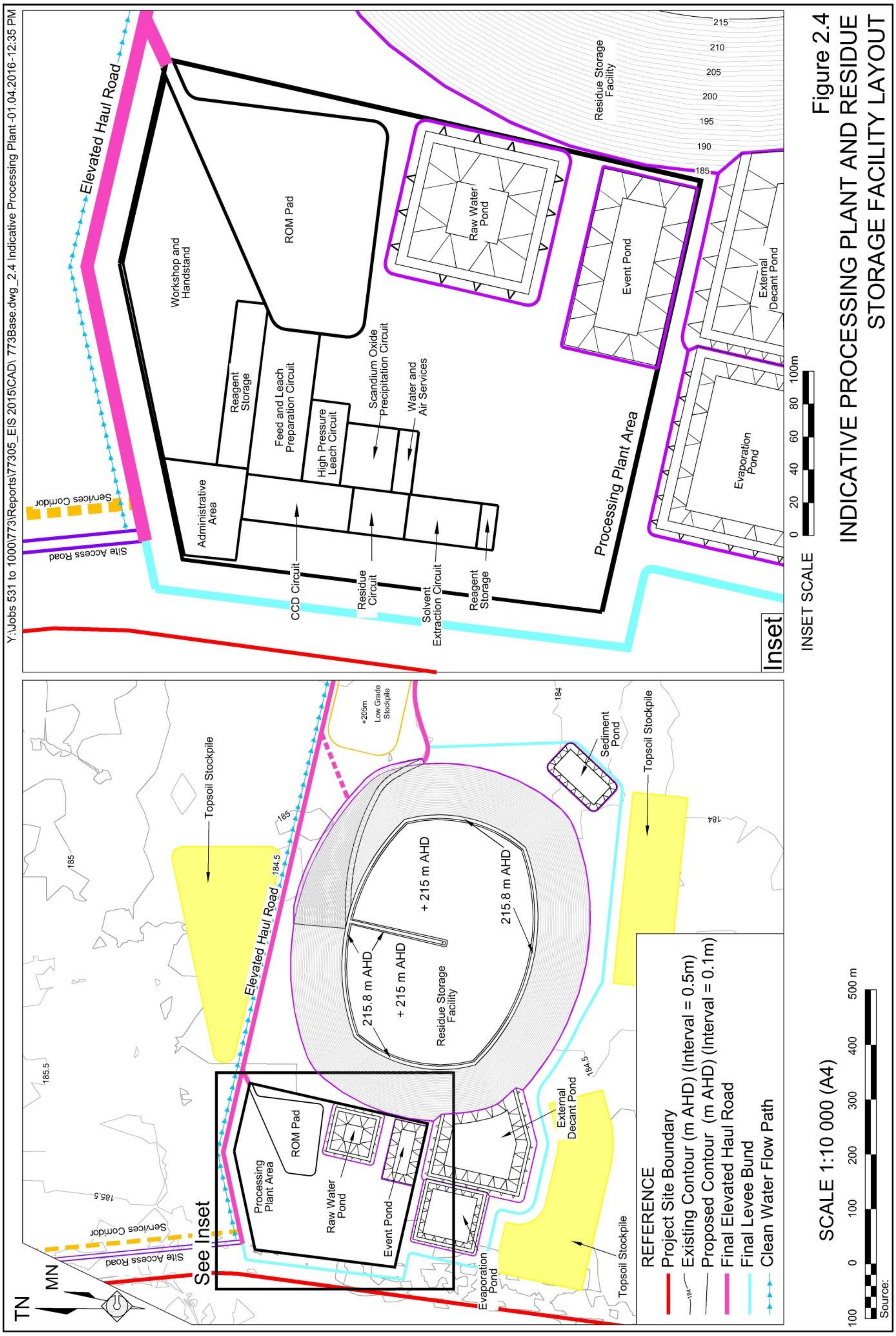
2.5.1 Introduction

Ore material would be processed within the on-site Processing Plant. This subsection provides a description of the Processing Plant, together with the feed preparation and scandium extraction methodologies.

2.5.2 Processing Plant

The Processing Plant would comprise the following principal components. Each of these would be located within the Processing Plant Area. Additional ancillary components would also be constructed within this area. **Figure 2.4** presents an indicative layout of the Processing Plant area. **Figure 2.5** presents a summary flow sheet identifying the principal Processing Plant circuits. The operation of each of the identified components is described in Sections 2.5.3 to 2.5.10.

- Run-of-Mine (ROM) Pad – comprising a hardstand area suitable for stockpiling up to 20 000t of ore.
- Feed Preparation Circuit – comprising the infrastructure required for the physical preparation of the ore or feed material, including:
  - a feed hopper and roller sizer;
  - a drum scrubber; and
  - a ball mill and cyclone.
- Leach Preparation Circuit – comprising two high pressure acid leach feed tanks and slurry preheating infrastructure.
- High Pressure Acid Leach (HPAL) Circuit – comprising a single autoclave and associated flash vessels.
- Counter Current Decant (CCD) Circuit – comprising eight interlinked decant thickeners and associated materials handling infrastructure.
- Solvent Extraction Circuit – comprising seven counter current mixer-settler units and a range of filters.


Y:\Jobs 531 to 1000\773\Reports\77305_EIS 2015\CAD\ 773Base.dwg_2.4 Indicative Processing Plant -01.04.2016-12:35 PM
Figure 2.4
INDICATIVE PROCESSING PLANT AND RESIDUE STORAGE FACILITY LAYOUT
Inset
INSET SCALE
0 20 40 60 80 100m
Elevated Haul Road
Services Corridor
Site Access Road
Workshop and Handstand
ROM Pad
Raw Water Pond
Event Pond
External Decant Pond
Evaporation Pond
Residue Storage Facility
Reagent Storage
Feed and Leach Preparation Circuit
High Pressure Leach Circuit
Scandium Oxide Precipitation Circuit
Water and Air Services
Administrative Area
CCD Circuit
Residue Circuit
Solvent Extraction Circuit
Reagent Storage
Processing Plant Area
215
210
205
200
195
190
185
Topsoil Stockpile
+205m Low Grade Stockpile
Sediment Pond
+ 215 m AHD
215.8 m AHD
See Inset
TN
MN
REFERENCE
Project Site Boundary
Existing Contour (m AHD) (Interval = 0.5m)
Proposed Contour (m AHD) (Interval = 0.1m)
Final Elevated Haul Road
Final Levee Bund
Clean Water Flow Path
SCALE 1:10 000 (A4)
100 0 100 200 300 400 500 m
Source:

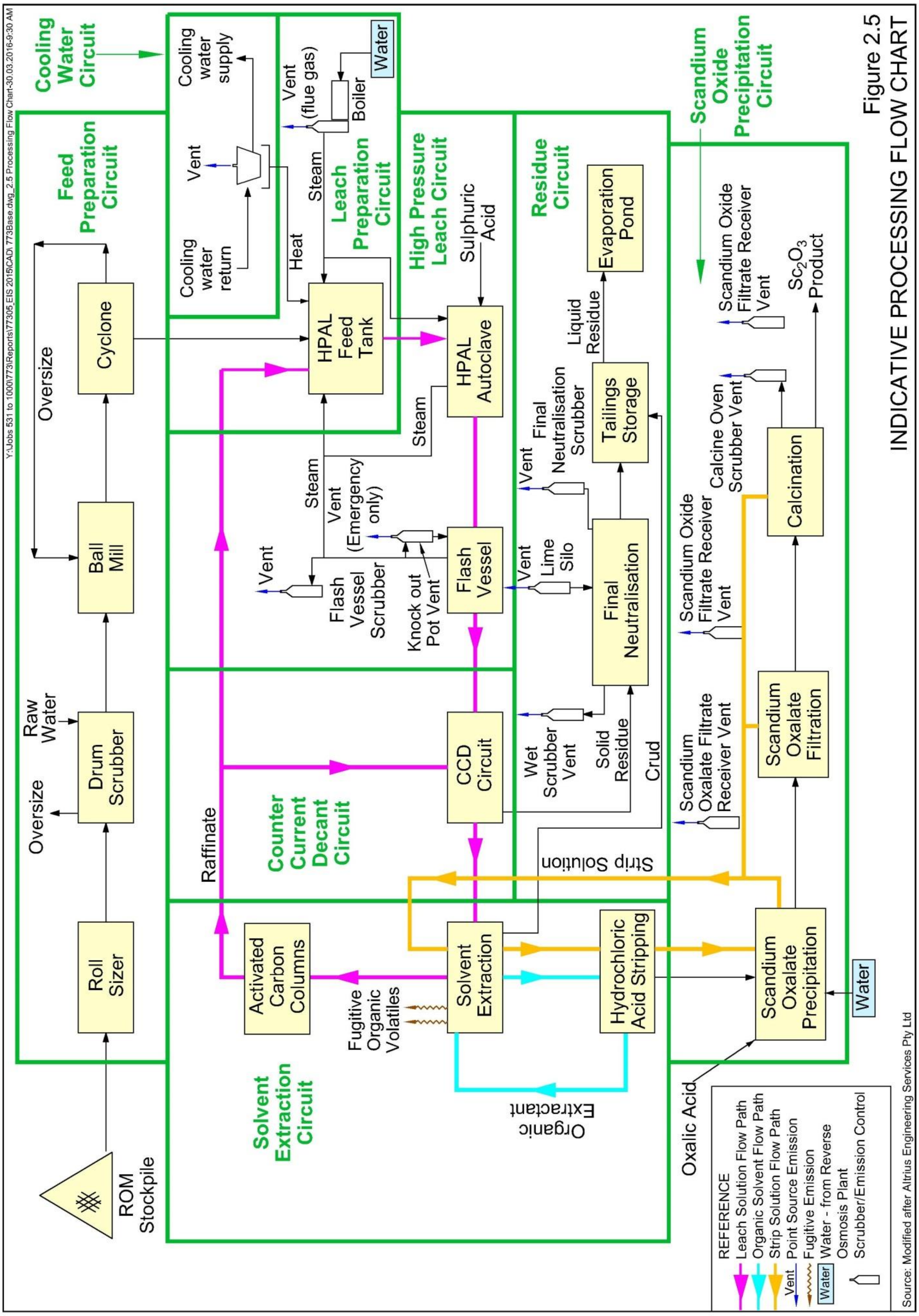


Figure 2.5
INDICATIVE PROCESSING FLOW CHART

- Scandium Precipitation Circuit – comprising oxalate precipitation tanks, water washing tanks, oxalate filters and a calcine oven and associated off-gas scrubber.
- Residue Preparation Circuit – comprising a neutralisation tank, thickener and residue transfer infrastructure.

In addition, ancillary infrastructure would be constructed within the Processing Plant Area, including but not limited to the following:

- Boiler for the generation of steam and heat and associated LPG storage tanks.
- A reverse osmosis plant to provide potable water for steam generation and ablutions.
- Reagent and consumable storages, including separate storage for incompatible chemicals. Each of these storages would be constructed in accordance with the relevant Australian Standards, including:
  - AS4452 – *The storage and handling of toxic substances*.
  - AS1940 – *The storage and handling of flammable and combustible liquids*.
- An administration area located in the northwest section of the Processing Plant Area, including:
  - site access gate and security infrastructure.
  - transportable offices, lunch room, change rooms and ablutions.
  - staff and visitor parking.

2.5.3 ROM Pad

The ROM Pad would be constructed in the northeastern section of the Processing Plant Area and would comprise a hardstand area of sufficient size to stockpile up to 20 000t of ore (**Figure 2.4**).

Ore material would be transported to the ROM Pad during mining campaigns and stockpiled separately based on the characteristics of the different classes of material. These stockpiles would be covered with tarpaulins to facilitate management of the moisture content of the material and to prevent generation of wind-blown dust.

The material stockpiled within the ROM Pad would be managed using a front-end loader which would selectively blend material from the various stockpiles to ensure consistent feed for the Processing Plant.

2.5.4 Feed Preparation Circuit

The Feed Preparation Circuit would operate as follows (**Figure 2.5**).

- Ore material would be loaded into a hopper by front-end loader.

- Material within the hopper would be passed via a belt feeder and conveyor to a drum scrubber and mixed with water to reduce the size to less than 10mm. Oversize material would be passed to a coarse rejects stockpile.
- Undersize material will pass into to a ball mill for further size reduction.
- Discharge from the ball mill would be passed to cyclones for size separation, with the coarse fraction (greater than approximately 75µm) returned to the ball mill and the fine fraction (less than approximately 75µm) passed to a thickener to increase the solids density of the slurry before being passed to one of two HPAL feed tanks.

2.5.5 Leach Preparation Circuit

The Leach Preparation Circuit would operate as follows (**Figure 2.5**).

- Within the HPAL feed tanks, the ore slurry would be mixed with regenerated water-based leach solution that would be recycled from the Solvent Extraction Circuit to achieve a 25% solids density in the leach slurry.
- The leach slurry would then be passed through a series of pre-heating tanks and vessels that would recover heat released from the HPAL Circuit. Steam generated from an on-site boiler would also facilitate heating of the slurry.

2.5.6 High Pressure Acid Leach Circuit

The HPAL Circuit would operate as follows (**Figure 2.5**).

- The preheated leach slurry would then be passed to an agitated, titanium-lined, high pressure autoclave where it would be further heated under pressure through the addition of steam to a temperature of approximately 265ºC. Concentrated sulphuric acid would also be added. In this process the contained scandium would be dissolved and pass into the liquid fraction.
- Following completion of leaching operations, slurry from the autoclave would pass through a series of flash vessels to reduce the pressure and recover heat which would be used for preheating of the leach slurry as described previously. Any excess steam would be vented to atmosphere via the proposed flash vessel scrubber.
- The flash vessels would be fitted with a knock out pot vent that would operate in emergencies only and would ensure separation of steam and superheated water.

2.5.7 Counter Current Decant Circuit

The Counter Current Decant Circuit would operate as follows (**Figure 2.5**).

- The Counter Current Decant Circuit would comprise eight thickeners that would operate in sequence.
- The leach solution would be increased to a 31% solids density and the scandium-bearing leach solution would progressively be removed from the solid fraction.
- The solid residue would be passed to the Residue Circuit, while the pregnant, scandium-bearing leach solution would be passed to the solvent extraction circuit.

2.5.8 Solvent Extraction Circuit

The Solvent Extraction Circuit would operate as follows (**Figure 2.5**).

- Following removal of the majority of the solids, the pregnant leach solution would be cooled to 45ºC and filtered.
- The pregnant leach solution would be mixed with a solvent comprising an organic extractant, namely a primary amine (Primene JM-T) dissolved in a diluent similar to kerosene. The scandium would pass from the water-based leach solution to the organic solution via a three-stage, counter-current mixing and settling circuit.
- The stripped leach solution (raffinate) and the organic extractant would be permitted to separate in a settler unit, with the less dense extractant and denser leach solution extracted separately. The intervening layer, referred to as “crud,” comprising an emulsion of extractant, leach solution and minor solid particles would be transferred to the Residue Storage Facility.
- The raffinate would be passed to a series of activated carbon columns where any entrained organic solvent would be removed, before being passed back to the leach preparation circuit for reuse.
- The loaded organic extractant would then be stripped of scandium using concentrated hydrochloric acid in a second two-stage, counter-current mixing and settling circuit.
- The stripped organic extractant would then be regenerated using a sulfuric acid solution and returned to the solvent extraction circuit.
- The pregnant hydrochloric acid solution would then be passed to the scandium oxide precipitation circuit

2.5.9 Scandium Oxide Precipitation Circuit

The scandium oxide precipitation circuit would operate as follows (**Figure 2.5**).

- The scandium-bearing strip solutions would be mixed with a solution of oxalic acid and water sourced from the reverse osmosis plant. The scandium would then precipitate as scandium oxalate.

- The resulting slurry would be filtered with the liquid (filtrate) fraction comprising hydrochloric acid strip solution returned to the Solvent Extraction Circuit.
- The precipitated scandium oxalate would be calcined at 900ºC to produce scandium oxide which would be placed into small drums are transported from the Project Site. The gases produced by the calcining process (largely water vapour and carbon dioxide) would be passed to the Calcine Oven Scrubber prior to discharge to the atmosphere.

2.5.10 Residue Circuit

The residue preparation circuit would operate as follows (**Figure 2.5**).

- The solid residue from the Counter Current Decant Circuit would initially be mixed with water and neutralised in a two stage process using lime to increase the pH of the residue to approximately 8.5. Emissions from the neutralisation process would be managed through the use of a wet scrubber, while the lime silo would be fitted with a dust bag to control emissions during filling.
- The neutralised residue, together with a small quantity of crud from the solvent extraction circuit would then be passed through a thickener to achieve the required solids density and recover as much process water as possible and pumped to the Residue Storage Facility.

2.5.11 Cooling Water Circuit

Cooling water will be required at various stages of the process. A cooling water circuit would be installed within the Processing Plant Area to facilitate capture of waste heat and recycling of cooling water. The cooling tower would be fitted with a vent for evaporated water.

2.5.12 Management of Emissions to Air

2.5.12.1 Introduction

The following subsections describe the categories and scale of emissions to air that are expected to be generated from the proposed Processing Plant, including the measures that would be implemented to manage such emissions. A detailed assessment of the impact of such emissions is presented in Section 4.2. The following subsections address emissions resulting from the processing operations only.

For the purpose of this subsection, air emissions from the proposed Processing Plant may be classified, as follows.

- Point source emissions – being defined as releases confined to a stack, duct or vent.

- Fugitive emissions – being defined as releases not confined to a stack, duct or vent and which generally include equipment leaks or emissions from other processes within the Processing Plant. For the purposes of this subsection, fugitive emissions do not include emissions associated with:
  – emissions from open tanks or containers where those facilities have been fitted with an emissions control device;
  – material movements, bulk handling or processing of raw materials; or
  – windblown dust and greenhouse gasses.

2.5.12.2 Point Source Emissions and Management

The processing operations described above require the release of steam and a range of gasses at various stages during the processing operations to enable the relevant chemical reactions to take place efficiently. In addition, particulate emissions may be generated at various locations within the processing operations. **Figure 2.5** presents an overview of where in the process flow chart selected point source emissions are anticipated.

Each of the identified scrubbers would be maintained in accordance with the manufacturer's specifications and emissions testing would be undertaken on commissioning until compliance with the identified criteria is achieved. Following demonstration that compliance has been achieved, monitoring of emissions would be reduced in frequency to that identified in the *Air Quality and Greenhouse Gas Management Plan* to be prepared for the Proposal.

The identified emissions criteria for the gas boiler stack would be achieved through the use of a purpose built boiler and LPG as fuel to fire the boiler. The boiler would also be maintained in accordance with the manufactures specifications.

Assessment of the likely impacts of stack emissions on the surrounding environment are considered in Section 4.2.

2.5.12.3 Fugitive Emissions

The Applicant has identified that the principal source of fugitive emissions from the Processing Plant would be organic volatiles from the Solvent Extraction Circuit. These emissions would be associated with evaporation of the organic extractant or associated dilutant. Assessment of the likely impacts of fugitive emissions on the surrounding environment are considered in Section 4.2.

2.5.13 Management of Chemicals and Reagents

2.5.13.1 Overview

Table 2.4 presents the principal reagents that would be used within the Processing Plant, their purpose, delivery method and form.

Table 2.4
Indicative Processing Reagents and Chemicals

Reagent/Chemical	Purpose	Delivery Method	Reagent Form	Storage	Annual Usage	Potentially Hazardous[1]
Sulphuric Acid (98% concentration)	High pressure acid leaching	Bulk transport via B-Double Truck	Liquid	Carbon steel storage vessel sufficient for 10 days storage.	20 000t	Yes
Hydrochloric Acid (33% concentration)	Solvent Extraction Circuit	Bulk transport via semi-trailer or B-Double Truck	Liquid	Fiberglass reinforced plastic storage vessel sufficient for 10 days storage.	1 200t	Yes
Magnafloc 338	Flocculant	25kg Bags	Powder	On pallets in reagent store.	50t	No
Primene JM-T	Primary Amine Extractant	1m^3 IBC	Liquid	Bunded flammable reagent storage area.	3m^3	No
Shellsol D70	Diluent for primary amine extractant	1m^3 IBC	Liquid	Bunded flammable reagent storage area.	76m^3	No
Oxalic Acid	Scandium precipitation	1t Bulka Bags	Powder	On pallets in reagent store.	159t	No
Sodium Hydroxide (caustic soda)	Acid:chloride ratio balance in strip solution	1t Bulka Bags	Powder	On pallets in reagent store.	110t	No
Sodium hydrosulphide (NaHS)	Water treatment	1m^3 IBC	Liquid	In reagent store.	167t	No
Hydrated lime	Neutralisation	Bulk delivery	Powder	Silo	9 000t	No
LPG	Fuel for steam boiler	Bulk delivery	Liquefied gas	LPG storage bullet.	2 700m^3	Yes
Note1: After Appendix 4 – SEPP 33 Preliminary Hazard Analysis						
Source: EMC Metals Australia Pty Ltd						

Appendix 4 presents a risk screening for the previously identified and proposed reagents identified in **Table 2.4**. That assessment has been undertaken in accordance with the requirements of the following documents.

- *Applying SEPP 33* published by the NSW Department of Planning in January 2011.
- *Hazardous Industry Planning Advisory Paper No 3 – Risk Assessment 33* published by the NSW Department of Planning in January 2011.

Based on the risk screening, the following reagents require preparation of a Preliminary Hazard Analysis.

- Sulphuric Acid.
- Hydrochloric Acid.
- LPG.

Appendix 4 also provides a Risk Classification and Prioritisation Assessment. In summary, that assessment determined that a Qualitative Risk Assessment was required for storage of hydrochloric and sulphuric acid. However, no assessment was required for storage of LPG. **Appendix 4** presents the results of the Qualitative Risk Assessment.

2.5.13.2 Reagent Management

The following measures would be implemented to manage reagents within the Project Site.

- Ensure that reagent suppliers and transportation contractors are required to transport all reagents in accordance with *Australian Code for Transportation of Dangerous Goods by Road and Rail.* Implementation of the Code would be the responsibility of the reagent supplier and transportation contractor.
- Store and use all reagents in accordance with the manufacturers' instructions and the relevant Material Safety Data Sheets.
- Store all chemically incompatible reagents separately, with sufficient offset distances that unintended reactions cannot occur in the event of an unplanned discharge of either reagent.
- Store and handle all hydrocarbon-based and flammable reagents in accordance with Australian Standard *AS1940 – The storage and handling of flammable and combustible liquids.*
- Store all liquid reagents within a covered bunded area with a capacity of at least 110% of the capacity of the largest container.
- Store all solid reagents in a concrete sealed area under cover.
- Ensure that only the minimum volume of reagents required for the ongoing operation of the Project are stored within the Project Site. Typically sufficient reagent storage for two weeks operations would be maintained.
- Ensure that Material Safety Data Sheets and appropriate spill management equipment are available in the vicinity of all reagent storage areas.
- Ensure that the *Hydrocarbon, Chemical and Reagent Management Plan*, including emergency management procedures, is updated to include the additional reagents to be used within the Project Site and implement the Plan throughout the life of the Project.

2.5.13.3 Fire and Fire-related Emergency Management

The Applicant notes that the following reagents may be classified as flammable.

- Primene JM-T.
- Shellsol D70.
- LPG.

As indicated in Section 2.5.12.2, these reagents would be stored and handled in accordance with Australian Standard *AS1940 – The storage and handling of flammable and combustible liquids*. In summary, the Applicant would ensure that the following management measures are implemented to ensure that the risk of fire is minimised to the greatest extent practicable and that measures are in place to ensure that fire may be managed in the event that it occurs.

- Ensure that a suitable firefighting system for liquid fire is installed within the flammable reagent store.

- Ensure that a suitable isolation system is in place for LPG storage and transfer.
- Ensure that the flammable reagent store is separated from potential ignition sources, including by a suitable hardstand area in the event of bush or grass fire impacting the Project Site.
- Ensure that sufficient water remains on site at all time to permit management of fires, including fires associated with flammable liquids.
- Ensure that sufficient training and equipment is provided to workers to enable safe and effective management of fires and fire-related emergencies.

2.6 RESIDUE MANAGEMENT

2.6.1 Introduction

As indicated in Section 2.5.10, solid residue from the Counter Current Decant Circuit would be passed to the Residue Circuit where it would be neutralised using lime. The resulting slurry would be pumped to the Residue Storage Facility where the solid and liquid fractions would be permitted to separate and the liquid fraction would then be pumped to the External Decant Pond. The liquid from the External Decant Pond would be returned to the Processing Plant for recycling.

The following subsections describe the characteristics of the residue, the design and operation of the Residue Storage Facility and the design and operation of the External Decant Pond. The information presented in this subsection has largely been drawn from a document entitled *Definitive Feasibility Study Report – Residue Storage and Water Management* prepared by Knight Piésold and referred to hereafter as Knight Piésold (2016b). That report was confidential at the time of finalisation of this document. However, excerpts may be provided by the Applicant on request.

2.6.2 Residue Characteristics

2.6.2.1 Physical Properties of the Residue

Physical testing on a sample of residue was conducted by Knight Piésold to determine the optimal slurry density, settling behaviour and consolidation and water release rates from the residue. That testing determined that the optimum discharge density for the residue is expected to be approximately 31% solids.

Settling tests indicated that the residue settled relatively quickly, but that low solids densities of between 0.50t/m^3 to 0.59t/m^3 solids were achieved initially, increasing to approximately 0.92t/m^3 solids following air drying. Knight Piésold estimated that the residue is expected to release between 20% to 25% of the water contained within the residue slurry pumped to the Residue Storage Facility.

Finally, Knight Piésold identify that on closure, the residue would develop a crust soon after deposition ceases. This would permit cover materials to be progressively placed over the residue to establish a trafficable surface that would permit long-term stabilisation of the

Residue Storage Facility. Knight Piésold note, however, that covering of the facility would be required to be completed progressively to allow excess pore pressures within the residue to dissipate and to reduce the potential for flow liquefaction of the material.

2.6.2.2 Acid Base Accounting of the Residue Solids

Acid base accounting assesses a sample's potential to form acid from the oxidation of sulfides and the ability to neutralise acid by the dissolution of minerals, especially carbonates, contained in the sample. The methodology is based on a comparison of the following.

- Determination of the Net Acid Producing Potential (NAPP) of a sample. This is the balance between:
  - the Maximum Potential Acidity or the amount of acid that the sample could produce; and
  - the Acid Neutralising Capacity or the ability of the sample to neutralise acid.

  The NAPP is a measure of how much acid a sample may produce (or consume), measured in kilograms of sulphuric acid per tonne of sample (kg H_2SO_4/t).
- Determination of the Net Acid Generation (NAG), a measure of the actual ability of a sample to produce acid through oxidation of sulphides present.

Table 2.5 presents the acid formation potential classification system referenced by Knight Piésold (2016a) for classifying samples.

Table 2.5
Acid Formation Potential Classification System

Acid Formation Potential Class	NAPP (kg H_2SO_4/t)	NAG pH
Potentially Acid Forming (PAF)	>10	<4.5
Potentially Acid Forming – Low Capacity (PAF-LC)	0 to 10	<4.5
Non Acid Forming (NAF)	Negative	≥4.5
Acid Consuming (AC)	Less than -100	≥4.5
Uncertain(UC)	Positive	≥4.5
	Negative	<4.5
Source: Knight Piésold (2016a) – Table 2.1		

Knight Piésold (2016b) determined that the residue to be produce within the Project Site would not contain any sulphide minerals. This result is unsurprising as the ore material within the Project Site is oxidised and all sulphide minerals that may have once been present have also be oxidised. However, mineralogical analysis of the sample determined that alunite (chemical formula = $KAl_3(SO_4)_2(OH)_6$) makes up 37% of the sample. Alunite has the potential to generate limited amounts of acid under certain circumstances.

The NAPP analysis determined that the sample had an acid generation capacity of 31.4kg H_2SO_4/t. However, as the NAPP assessment assumes that all sulphur is present at pyrite and the mineralogical analysis determined that there were no sulphides present, Knight Piésold (2016b) states that the NAPP analysis is likely to substantially overestimate the acid generation potential of the sample.

The NAG test work determined a NAG pH of 8.2.

Based on **Table 2.5** the sample may be classified as 'Uncertain'. However, Knight Piésold (2016b) note that as alunite may generate limited amounts of acid, the residue should be classified as Potentially Acid Forming – Low Capacity.

2.6.2.3 Multi-element Analysis of the Residue Solids

Knight Piésold (2016b) undertook a multi-element analysis of the composition of the residue sample and determined the Geochemical Abundance Index for each element. The Geochemical Abundance Index is a measure of the enrichment of each element compared to the average crustal abundances. **Table 2.6** presents an overview of the results of that analysis for those elements determined to be enriched compared to average crustal abundance.

Table 2.6
Multi-Element Analysis Results and Geochemical Abundance Indices

Element	Assay Result[1]	Average Crustal Abundance[1]	Geochemical Abundance Index	Enrichment
As	134	1.5	6	Highly enriched
Cr	579	100	2	Slightly enriched
Fe	190 000	41 000	2	Slightly enriched
Mn	6 950	950	2	Slightly enriched
Sb	4.4	0.2	4	Significantly enriched
Sc	81	16	2	Slightly enriched
Se	2	0.05	5	Highly enriched
Note 1: Units = ppm				
Source: Knight Piésold (2016a) – After Table 3.6				

Knight Piésold (2016b) state that while only a limited number of elements were enriched compared with the average crustal abundance, a number of those elements have a high degree of environmental toxicity and display solubility over a range of pH conditions. As a result, the residue solids will be required to be suitably managed throughout and following the life of the Proposal.

2.6.2.4 Composition of the Residue Supernatant

Knight Piésold (2016a) undertook an assessment of the composition of the supernatant water, namely the liquid fraction of the residue, and the results were compared to a range of water quality guideline trigger values.

Section 3.6 of Knight Piésold (2016b) presents the results of that analysis and may be summarised as follows.

- pH – 8.54.
- Electrical conductivity – 20 500µS/cm.

Of particular note, the hexavalent chrome (Cr(IV)) result in the sample tested was 7.52mg/L. This compares with the ANZECC (2000) livestock and irrigation guideline of 0.05mg/L and aquatic protection guideline of 0.001mg/L. However further process optimisation was conducted following the geochemical assessment work conducted by Knight Piésold which indicates that the concentration of hexavalent chrome (Cr(IV)) can be reduced to 0.04mg/L.

Knight Piésold (2016b) determined the following in relation to the anticipated composition of the residue supernatant water.

- The supernatant water would be unsuitable for stock watering or irrigation.
- The supernatant water would have a detrimental impact on:
  - aquatic systems should it be allowed to enter natural waterways;
  - on drinking water should it be allowed to enter a drinking water supply; and
  - on groundwater should it be permitted to enter the underlying aquifers.

2.6.2.5 Conclusion

Knight Piésold (2016b) determined that in designing the Residue Storage Facility, that the following will influence the design of the facility.

- There is potential for the residue to generate a weakly acidic leachate.
- The residue solids are enriched in a range of deleterious elements.
- The supernatant water is unsuitable for discharge to either surface water or to underlying aquifers.

As a result, Knight Piésold (2016b) determined that the consequence category under *ANCOLD Guidelines on the Consequence Categories for Dams* and the *New South Wales Dam Safety Committee Guidance Sheet for Consequence Categories for Dams* that the Residue Storage Facility a dam failure consequence category of “High B” and an Environmental Spill consequence category of “Significant”.

2.6.3 Residue Storage Facility

2.6.3.1 Introduction

The preliminary design of the Residue Storage Facility has been prepared by Knight Piésold. This subsection describes the design of the facility in sufficient detail to allow readers to gain an understanding of the overall design. The detailed design report was not publicly available at the time of finalisation of this document and information provided in this subsection has been provided by Knight Piésold. Knight Piésold state that the design of the facility will be the subject of independent third party review prior to submission of the detailed designs and construction drawings for each stage of construction to the Dams Safety Committee of NSW.

Notwithstanding the above, Knight Piésold state that the facility has been designed in accordance with the following.

- *ANCOLD Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure* (ANCOLD, 2012).
- *New South Wales Dam Safety Committee Guidance Sheet for Tailings Dams* (NSW-DSC, 2012).

2.6.3.2 Design Objectives

The principal objectives for the design of the Residue Storage Facility are as follows.

- To produce a design that complies with relevant Australian regulations, guidelines and standards.
- Permanent, secure and total containment of all residues within an engineered disposal facility.
- Achieve a high density (i.e. as high as practicable), consolidated residue mass by employing controlled subaerial deposition.
- Control, collect and remove free draining liquids from the residues during operation for recycling as process water to the maximum extent practicable.
- Maintain excess storage capacity within the facility to contain the design storm allowance.
- Provide an engineered structure to control discharges from the facility in the event of a rainfall event greater than the design storm criteria.
- To minimise seepage from the facility during operation and on closure.
- Cost-efficient utilisation of available materials for embankment construction.
- To allow for rapid, effective and stable rehabilitation.
- To provide monitoring instrumentation for all aspects of the facility and associated works to ensure the adopted performance standards can be measured and are continually achieved.

2.6.3.3 Geotechnical and Hydrological Setting

Geotechnical Setting of the Facility

Knight Piésold (2016b) conducted a geotechnical investigation within the footprint of the Residue Storage Facility to determine the foundation conditions. Knight Piésold also conducted geotechnical investigations of the open pit to determine the material types available for construction of the facility. The geotechnical investigations found that the facility is underlain by a clayey topsoil layer averaging 300mm thick, underlain by indurated or hardened alluvial clays of between 1.7m and 24m thickness. These clays are moderate to high plasticity and in places are cemented by iron oxides. Underlying the clay layer is a variable sequence of alluvial sands, gravel, silts and clays. Geotechnical drilling within the footprint of the facility was undertaken to a depth of 62m. Neither underlying basement (laterite, saprolite or unweathered material) nor observable groundwater was intersected during the drilling program.

Knight Piésold (2016b) state that the geotechnical setting of the facility is considered to be favourable for the construction of the Residue Storage Facility due to low permeability nature of the upper in-situ soils. The in-situ soils will provide sufficient strength to support the embankment of the facility.

Suitability of Construction Materials

The Residue Storage Facility embankment would be constructed using overburden sourced from the proposed open cuts. Knight Piésold (2016b) conducted a geotechnical investigation within the footprint of the open cuts to determine the physical characteristics of the overburden.

In summary, the subsurface materials within the open cut pit shells exhibited a similar strata profile to the Residue Storage Facility area, with the exception that basement laterite was encountered at depths of approximately 17m. Groundwater has previously been intersected at depths of 22m to 25m below surface.

Knight Piésold (2016b) state that the material within the proposed open cuts and Borrow Pit is well suited for the construction of the Residue Storage Facility, with the upper clay materials providing suitable material for the low permeability zones of the embankment and the deeper alluvial material providing material suitable for construction of the structural zones of the embankment.

Hydrological Setting of the Facility

Section 4.4 presents an assessment of the hydrological setting of the Project Site. In summary, however, the Residue Storage Facility is located on the alluvial flood plain of Whitbarrow Creek, located approximately 1.2km to the south of the facility. Knight Piésold conducted a flood study of Whitbarrow Creek to estimate the flood levels under both 1 in 100 year ARI rainfall conditions and 1 in 1 000 year ARI rainfall conditions. The study indicates that both flood events would inundate the proposed Residue Storage Facility footprint area, as well as the Processing Plant Area and the open cuts. As a result, levee bunds have been designed around the Residue Storage Facility and Processing Plant Area and the open cuts, with crest elevations of 1m above the 1 in 1 000 year flood level.

2.6.3.4 Design of the Facility

Consequence Category

A consequence category assessment of the facility was undertaken by Knight Piésold in accordance with the following guidelines.

- *ANCOLD Guidelines on the Consequence Categories for Dams*, (ANCOLD 2012b).
- *New South Wales Dam Safety Committee Guidance Sheet for Consequence Categories for Dams* (NSW-DSC 2015).

Knight Piésold determined that the facility may be classified as follows.

- Dam failure consequence category – High B.
- Environmental Spill consequence category – Significant.

These consequence categories have been used to inform the design of the Residue Storage Facility.

Design of the Facility

The proposed Residue Storage Facility would be a paddock-style facility with a perimeter embankment on all sides of the facility, with the embankment constructed in stages over the life of the Proposal. The principal design criteria for the proposed Residue Storage Facility are as follows (**Figure 2.4**).

- Maximum embankment elevation ....approximately 215.8m AHD.
- Maximum embankment height .... approximately 32m.
- Number of lifts...indicatively 19.
- Slope of the outer face of the final lift.................. approximately 1:3 (V:H) or 18º.
- Total area of the facility (to the embankment toe) ....approximately 28ha.
- Area of final tailings surface ....approximately 12.7ha.
- Residue storage capacity.................................. approximately 1.94Mt or 2.09Mm^3
- Final embankment volume .... approximately 4.4Mm^3.

In order to maximise promote air drying of the residue to maximise the resulting density of the residue stored within the facility Knight Piésold has incorporated the following design elements.

- Staging of the construction of the facility so that the drying area expands as the process plant throughput increase over the initial years of operation of the facility.
- Installation of a specialised decant tower system that would allow the supernatant pond on the facility to be reduced in size below that which would normally be achievable with conventional tailings storage facility decant systems.
- Establishment of an External Decant Pond to accept and store supernatant water and incident rainfall from the facility for recycling to the Processing Plant for processing purposes.

The Residue Storage Facility would incorporate a liner system with the following design features (presented from uppermost to lowermost).

- An underdrainage system comprising basin underdrainage drains and embankment toe drains encased in a drainage medium sand. The underdrainage system would reduce the phreatic surface (boundary between saturated and unsaturated residue) within the residue pile to minimise the pore pressure operating on the underlying liner and to maximise dewatering of the residue. The underdrainage system would incorporate slotted drain-coil pipe within a geotextile wrapped fine sand filter which would drain to an underdrainage sump from where the water would be recovered and pumped to the surface of the Residue Storage Facility for where it wold report to the External Decant Pond.

- A basin liner system to reduce the potential for seepage from the facility. The basin liner system would comprise a 1.5mm HDPE liner overlying a 300mm compacted clay liner.
- A flownet or synthetic drainage layer would be installed below the basin liner and clay to capture and recover seepage (if any) which passes through the basin liner system.
- A secondary basin liner of 300mm of compacted clay would be constructed below the flownet drainage layer. Drains within the subliner drainage would report to a subliner drainage sump from where the water would be recovered and pumped to the supernatant pond.
- In situ indurated clay a minimum of 1.7m thick.

The embankment of the facility would be constructed with two zones as follows.

- An inner or upstream, 7m wide low permeability zone comprising compacted clay with a maximum permeability of $1x10^{-9}$m/s overlain by a 1.5mm HDPE liner which would be welded the basin liner to form a single HDPE liner.
- An outer or downstream structural embankment zone constructed using overburden sourced from the proposed open cuts.

Knight Piésold state that seepage analysis of the proposed liner and embankment arrangement indicates that the seepage rates from the Residue Storage Facility would approximately 35% lower than that recommended for solid waste landfill leachate barriers identified in the document *Draft Environmental Guidelines: Solid Waste Landfills* published by the NSW Environment Protection Authority and dated March 2015.

The embankments have been designed to be geotechnically stable under design loading conditions with stability analysis conducted in accordance with ANCOLD Guidelines (ANCOLD, 2012) taking into consideration drained, undrained and seismic design loads.

Finally, Knight Piésold states that the facility has been designed in accordance with the freeboard requirements of the Dams Safety Committee of NSW (NSW-DSC, 2012) with the facility provided with an operational freeboard of 500mm and an environmental containment freeboard sufficient to contain the runoff generated by a 1 in 1 000 year ARI 72-hour rainfall event. A spillway has been designed and would be constructed at each stage of construction with sufficient capacity to pass the peak flow generated by the probable maximum precipitation event.

2.6.3.5 Construction of the Facility

The facility would be constructed in approximately 19 stages over the life of the Proposal.

Initially, the facility would be constructed with two cells. The first cell would be located in the western half of the Residue Storage Facility footprint would be constructed during the pre-commissioning phase for the Proposal. This initial cell would be raised once after the first year of production. After the second year of production the second cell would be constructed to the east of the first cell. The two cells would then be combined into a single cell during the third year of production and the facility would then be constructed and operated as a single cell.

The facility would be constructed using a downstream construction method. This method would require subsequent lifts to be constructed over the outer face of the embankment, effectively ensuring that the embankment materials are not placed on top of placed residue. The embankment would be constructed using overburden extracted from the proposed open cuts and direct placed using haul trucks. The material would then be moisture conditioned using water truck prior to compaction using a combination of traffic compaction and vibratory rollers. Compaction, moisture content, particle size, plasticity and *in situ* permeability of the embankment would be measured during construction to ensure the material meets the geotechnical technical specification identified in the design report presented to the Dams Safety Committee of NSW.

The proposed HDPE liners and flownet drain layer would be installed by a specialist geomembrane installation company. Quality control and quality assurance testing of the geomembranes and the installation welds would be conducted during the production of the liner material and during the installation process.

Construction of the all stages of the facility would be overseen and signed off by a qualified engineer in accordance with the Dams Safety Committee of NSW requirements. A construction report would be prepared which would contain a record of the all the quality control and quality assurance testing conducted during the construction, with the report submitted to the Dams Safety Committee of NSW.

2.6.3.6 Operation of the Facility

As described in Section 2.5.10, the residue would be neutralised and thickened before being pumped to the Residue Storage Facility in a HDPE pipeline. The pipeline would be installed within a bunded corridor which would direct discharge of residue released in the event of the pipeline failure to a lined pond such as the Event Pond.

Residue would be deposited from a series of spigots located around the perimeter of the facility. During the deposition process the solids would settle out to form sloping beaches and the liquid fraction (supernatant) would drain to the supernatant pond.

The deposition location would be moved on a regular to ensure residue builds up evenly and to maintain the supernatant pond at the decant tower location.

Supernatant and incident rainfall runoff would be removed from the facility by pumping from the decant tower to the External Decant Pond via a HDPE pipeline. The decant pond within the Residue Storage Facility would be maintained as small as practical to maximise the beach area and drying potential. The proposed pumping infrastructure would be capable of removing the runoff generated by a 1 in 1 000 year ARI 72-hour rainfall event within 7 days with capacity provided in the External Decant Pond to store this volume.

Submersible pumps would be installed in the underdrainage and subliner drainage sumps to recover any water collected in these sumps. These pumps would have float switch so that when water is present within the sumps the pumps will operated and pump the water to the surface of the facility.

Finally, the Residue Storage Facility would be operated in accordance with the an Operational Manual to be prepared by the design engineering firm. That manual would describe the relevant procedures to control residue placement, management of the decant pond and the inspection and reporting regime. The Applicant anticipates that inspections by site personnel would be required multiple times per day, with inspection by the Applicant's engineering personnel and independent experts required regularly. In addition, an annual surveillance report would be prepared and submitted to the Dams Safety Committee of NSW.

2.6.4 External Decant Pond

As indicated in Section 2.6.3.6**,** the liquid fraction of the residue would be permitted to separate from the solid fraction within the Residue Storage Facility. This supernatant water would be collected and pumped to the External Decant Pond. During an average rainfall year, approximately 63ML per year of liquid and rainfall runoff would be pumped to the External Decant Pond, with 100% recycled to the process plant for reuse.

The design and construction of the External Decant Pond is presented in Section 2.7.3.

2.7 WATER REQUIREMENTS, SUPPLY AND SECURITY

2.7.1 Introduction

Management of water within the Project Site will be a critical aspect of the Proposal. Section 4.4 and 4.5 provide detailed descriptions of the existing surface water and groundwater environments surrounding the Project Site, as well as a range of commitments in relation to the management of water-related issues and an assessment of anticipated water-related impacts. Those sections also describe the water-related monitoring that would be undertaken throughout the life of the Proposal.

The following subsections provide an overview of operational water requirements, water sources and the security of water supply.

2.7.2 Classes of Water

The Proposal would include five principal classes of water as follows (**Figure 2.6)**.

- Raw water – this water would be transported to site via a buried pipeline installed adjacent to the Site Access Road (see Section 2.2.6 and **Figure 2.1**). All water sourced from the pipeline would be stored within the Raw Water Pond. This water would be transferred to the Processing Plant or used for dust suppression purposes.
- Dirty or sediment-laden water – this water is surface water runoff from sections of the Project Site within the proposed levee bunds that are unlikely to be contaminated with reagents or hydrocarbons. As a result, water within these areas may be dirty or sediment laden, but would not contain chemical contaminants. This water would flow or be directed to one of two sediment basins located to the southeast of the RFS and between the proposed open cuts (**Figures 2.2** and **2.4**). Water within each of the sediment basins would be used for mining-related purposes, including processing operations and dust suppression.

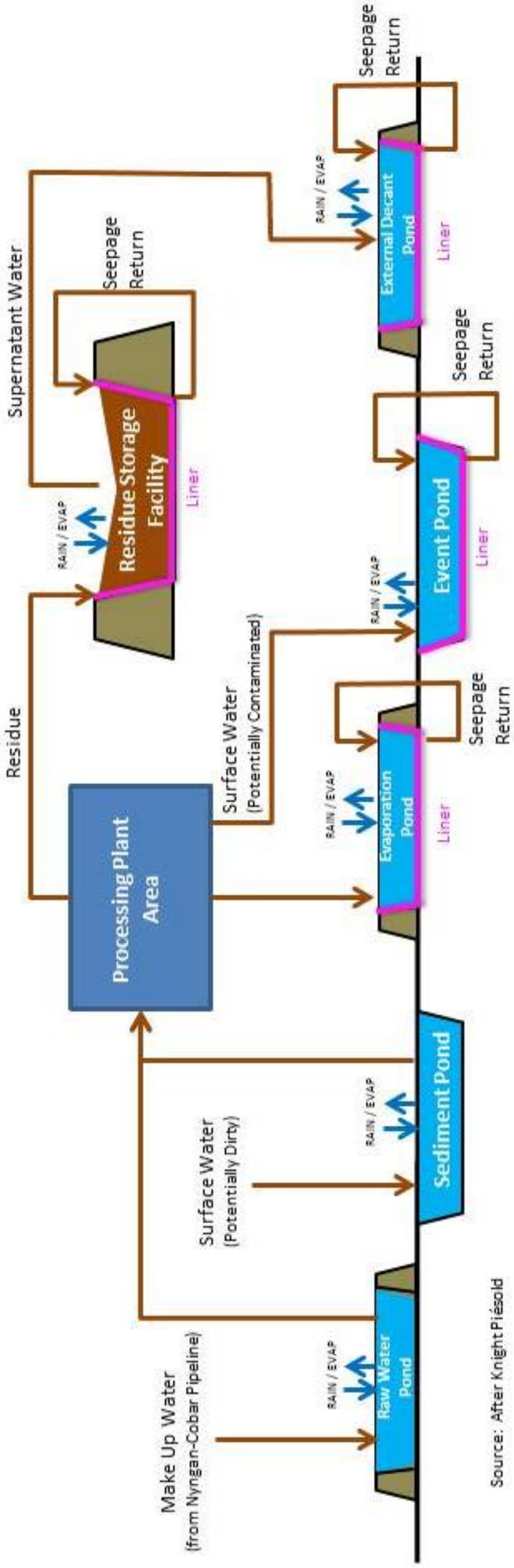


Figure 2.6
CONCEPTUAL WATER FLOW CHART

- Mine, process or contaminated water – this water is water that may contain salt, chemicals or hydrocarbons. It includes:
  - water within the proposed open cuts or the Sediment and Dewatering Pond;
  - process water from the Processing Plant;
  - supernatant and decant water from the Residue Storage Facility; and
  - surface water flows from area surrounding the Processing Plant.
- This water would be stored in lined storages and would be used for processing-related operations.
- Non-recyclable water – this water would be sourced from:
  - blow bleeding of the boiler and cooling tower;
  - backwash from the filtration plant; and
  - brine from the reverse osmosis plant.

  Typically this water would contain levels of contaminants that would result in it being unsuitable for further beneficial use. As a result, that water would be pumped to the Evaporation Pond and permitted to evaporate.
- Potable and ablutions water – this water would be sourced from the reverse osmosis water treatment plant and a potable water treatment facility (incorporating filtration, ultraviolet sterilisation and chlorination) to produce potable water suitable for drinking and ablutions. This water would be stored in potable water tanks placed within the Administration Area.
- Clean water – this water is run off from undisturbed sections of the Project Site. This water would be excluded from the operational sections of the Project Site by the levee bund and would be permitted to flow to natural drainage.

The Proposal has been designed in a manner that would ensure that the maximum volume of water would be harvested within the Project Site, thereby reducing the reliance of the Project on makeup water sourced from the Nyngan – Cobar Pipeline.

2.7.3 Water Storages

2.7.3.1 Design of the Water Storages

There would be six principal water storages within the Project Site. **Table 2.7** presents an overview of the design of each of the facilities. Section 2.6.3 presents a description of the design and operation of the Residue Storage Facility.

Table 2.7
Surface Water Storages

Water Storage	Class of Water	Storage Design	Storage Capacity (ML)	Freeboard (m)	Catchment and Comment
Raw Water Pond	Raw	Turkey's nest	26	0.5	Incident rainfall only.
Event Pond	Contaminated Water	In ground	22	Nil	Potential contaminated sections of the Western Bunded Area. Capacity is sufficient to contain a 1 in 100 ARI 72-hour storm event.
External Decant Pond	Contaminated Water	Turkey's nest	85	0.6m	Residue Storage Facility and incident rainfall. Capacity sufficient to contain a 1 in 1000 ARI 72-hour storm event PLUS a probable maximum flood, 24-hour storm event.
Evaporation Pond	Non-recyclable Water	Turkey's nest	25	0.9m	Incident rainfall only. Capacity sufficient to contain a probable maximum flood, 72-hour storm event.
Sediment Pond	Dirty Water	In ground	38	Nil	Non-contaminated sections of the Western Bunded Area.
Sediment and Dewatering Pond	Dirty Water	Turkey's nest	44	Nil	Eastern Bunded Area, including accumulated water within the open cuts. To be removed during Stage 2 mining operations.

Source: Knight Piésold (2016b) – after Section 7

2.7.3.2 Lining of the Water Storages

In summary, all facilities with the potential to accept contaminated or non-recyclable water would be lined, with the liner installed depending on whether the facilities would hold water on a continuous basis or only intermittently.

For those facilities which would hold contaminated water on a continuous basis, namely the External Decant Pond and the Evaporation Pond, the lining would comprise:

- an upper 1.0mm HDPE liner:
- a flownet drain layer;
- a lower 1.5mm HDPE liner; and
- a 300mm compacted clay liner.

For those facilities that would hold contaminated water only intermittently and which would be pumped out as water accumulates, such as the Event Pond, the lining will comprise:

- a 1.5mm HDPE liner; and
- a 300mm compacted clay sub-base.

Those facilities that would accept clean or dirty (sediment-laden) water, including the Raw Water Pond and the Sediment Basins, the lining would comprise a scarified, moisture conditioned and compacted liner composed of *in situ* clay.

The Applicant would ensure that all in-ground water storages, including the Event Pond and Sediment Basins, would be pumped out and the water used for mining-related purposes as soon as practicable following rainfall. This would ensure that the maximum storage capacity would remain in the event of significant rainfall event.

2.7.4 Water Balance

Knight Piésold (2016b) prepared a detailed water balance for the Proposal. **Figure 2.6** presents a schematic overview of water movements within the Project Site. In summary, the water balance may be summarised as follows.

- Water inputs include the following.
  - Rainfall-associated runoff within the bunded areas.

    All rainfall runoff within the Processing Plant and Residue Storage Facility bunded area would report to either the Event Pond or the Sediment Pond. Rainfall runoff within the open cuts, together with groundwater inflow, would report to a sump within each open cut and would be pumped to the Sediment and Dewatering Pond. Water within the Event Pond, Sediment Pond or Dewatering Pond would be pumped to the External Decant Pond or, in the case of the Sediment Ponds, the Raw Water Pond for use within the Processing Plant. Alternatively, water within the Sediment Basins or the Raw Water Pond may be used for dust suppression.

    Rainfall runoff within the Borrow Pit during Stage 2 of mining operations, excluding water that would accumulate within the open cuts, may be irrigated to land, after testing, in the event that excess water accumulated that cannot otherwise be consumed within the Processing Plant.
  - Groundwater inflow.

    Estimated groundwater inflows are discussed in Section 4.5.5.2, however, for the purpose of the water balance, these have been assumed to be negligible.
  - Imported raw water.

    Raw water would be sourced under licence from the Nyngan – Cobar pipeline. The rate of importation of that water would be controlled, with less or no water imported during periods of high rainfall and more water imported during periods of lower rainfall.
- Water losses or demands include the following.
  - Evaporation from water storages and the Residue Storage Facility.
  - Water contained in residue that not recovered.
  - Dust suppression.

The water balance was undertaken using a daily time step and was run under three rainfall scenarios as follows. Knight Piésold (2016b) undertook an analysis of rainfall records from the Bureau of Meteorology Nyngan Airport Station (No. 51039). That data was compared and supplemented as required using data from the Walgett Station (No. 52026).

- Average rainfall conditions (444.9mm – modelled year was 1945).
- 1 in 100 year Average Recurrence Interval (ARI) wet period (970.5mm – modelled year was 1950).
- 1 in 100 year ARI dry period (149.9mm – modelled year was 1929).

Assumed evaporation was based on average evaporation rates, with the year 1945 selected as the relevant reference year.

Table 2.8 presents the rain fall and evaporation data used for the water balance.

Table 2.8
Water Balance Rainfall and Evaporation Data

Month	Rainfall (mm)			Evaporation (mm)
	Average Conditions	1 in 100 Dry	1 in 100 Wet	
January	50.8	9.0	58.0	245.3
February	46.6	19.6	42.6	199.6
March	42.4	15.1	31.6	199.5
April	34.9	22.9	129.9	111.6
May	35.7	6.3	114.4	78.8
June	33.5	42.8	0.0	53.6
July	29.3	0.0	51.2	49.1
August	29.0	0.0	182.4	72.1
September	27.7	5.9	173.9	108.2
October	34.8	4.8	83.7	167.4
November	35.9	12.0	26.7	234.2
December	44.3	11.4	76.2	274
Total	**444.9**	**149.9**	**970.5**	**1 793.4**
Source: Knight Piesold (2016b) – After Section 5.5				

The water balance was estimated by taking daily rainfall and evaporation data and applying anticipated mining-related water demands over the 21 year life of the proposed mining operations to determine the shortfall in water availability that would be required to be made up using water from the Nyngan-Cobar Pipeline. For each of the scenarios modelled, the annual rainfall and evaporation data was applied for each year of the Proposal, namely, 21 years of 1 in 100 year wet conditions were assumed for the wet scenario. Similarly, 21 years of 1 in 100 year dry conditions were assumed for the dry scenario.

The results of the water balance may be summarised as follows.

- Average conditions – up to 46ML of makeup water per year would be required from the Nyngan – Cobar Pipeline.

- 1 in 100 year ARI dry conditions – up to 163ML of makeup water would be required from the Nyngan – Cobar Pipeline.

  In order to ensure ongoing operation of the Proposal during dry periods, the Applicant proposes to purchase 170ML of high security water licences under the *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources.* The Applicant has been advised by Peter Hennessy Water Broking Service that adequate allocation is available for purchase under that Plan. In addition, the Cobar Water Board has confirmed that the existing pipelines have sufficient capacity to convey the required volume of water.

- 1 in 100 year ARI wet conditions – up to 6ML or makeup water would be required from the Cobar – Nyngan Pipeline. It is noted that in most years modelled, no makeup water would be required. Knight Piesold (2016b) state that sufficient storage would exist within the bunded area that no uncontrolled discharge of surface water would occur under the modelled scenario. However, approximately 166ML per year of potentially dirty water would be required to be pumped from the Sediment Ponds to land to the north of the bunded area. That water would be used to irrigate agricultural land.

  In these circumstances, the Applicant would ensure that discharge of water only occur after testing has confirmed that the quality of the water complies with the following triggers derived from the ANZECC (2000) trigger values for irrigation and stock watering.

  – pH – between 6 and 9.

  – Electrical conductivity – less than 3 100µS/cm.

2.8 TRANSPORTATION

2.8.1 Introduction

This section describes the proposed transportation both within and surrounding the Project Site. An assessment of traffic and transportation-related impacts has been undertaken by Constructive Solutions Pty Ltd. The resulting report, referred to hereafter as Constructive Solutions (2016) is presented as Part 7 of the *Specialist Consultant Studies Compendium* and is summarised in Section 4.7 of this document.

2.8.2 Internal Road Network

Construction of the Project Site entrance, site access road and internal road network is described in Section 2.2.3.

2.8.3 External Road Network

Figure 2.7 presents the road network surrounding the Project Site. In summary, vehicles travelling to and from the Project Site would do so via the Barrier Highway and Gilgai Road.

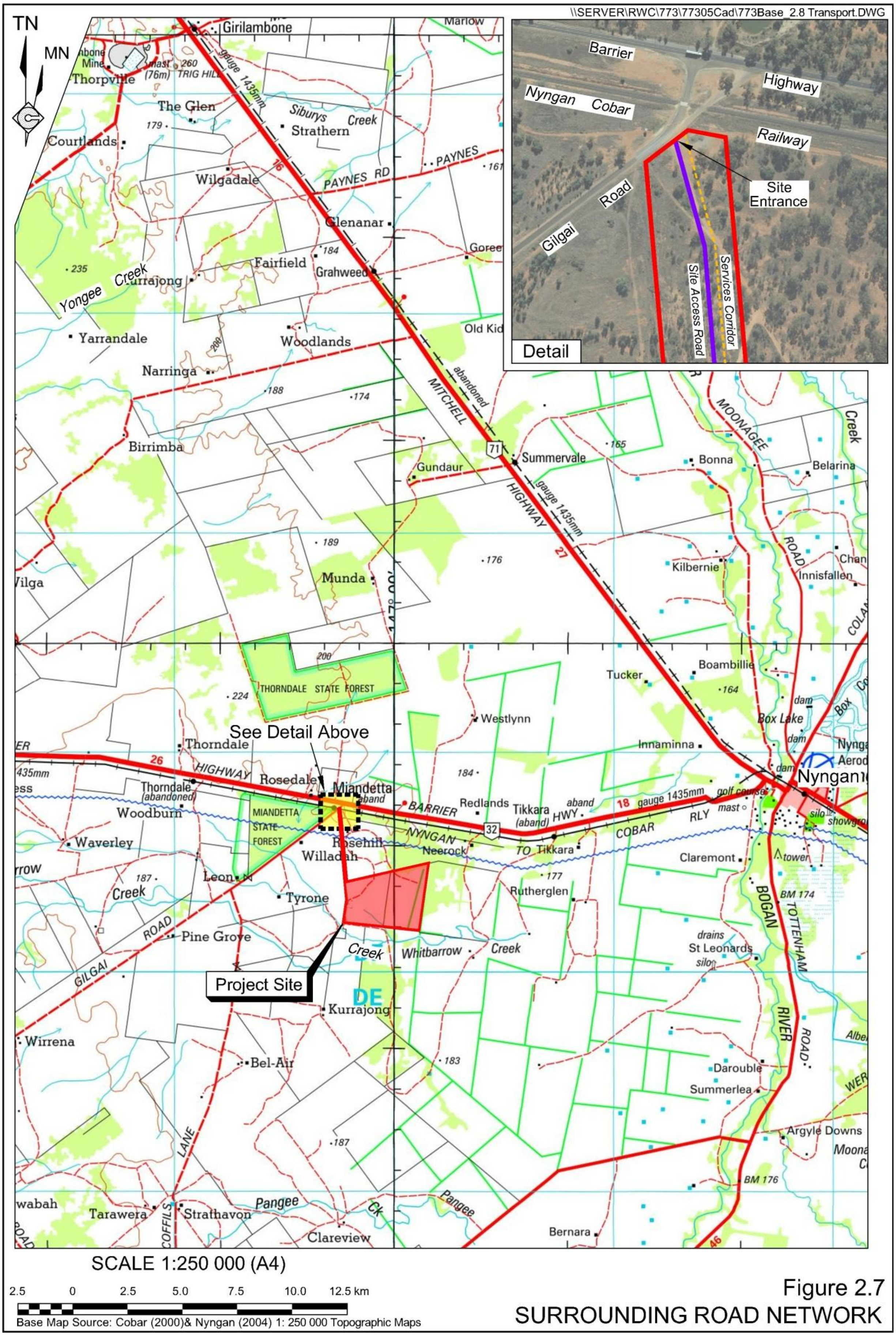


Figure 2.7
SURROUNDING ROAD NETWORK

Barrier Highway

The Barrier Highway is a sealed two lane State road with a sign posted speed limit of 110km/h. In the vicinity of the intersection with Gilgai Road, Constructive Solutions (2016) state that the pavement is in good condition and the lane widths are approximately 3.5m, with a sealed shoulder of approximately 0.25m and a further up to 0.5m unsealed shoulder.

Gilgai Road

Gilgai Road is a sealed two lane local road with a 100km/h speed limit (**Plates 2.2** and **2.3**). The pavement in 95m section of Gilgai Road between the intersection with the Barrier Highway and the Site Access Road is described by Constructive Solutions (2016) as being in good condition. The road has a total sealed width of approximately 6.5m with unsealed shoulders between 0.5m and 1.0m wide.

A level railway crossing for the Parkes – Broken Hill Railway is located approximately 45m from the proposed Project Site entrance and 50m from the intersection with the Barrier Highway (**Plate 2.4**). The level crossing is controlled by a single stop sign on the left of the road at each approach, with painted stop bars and a faded double unbroken centre line at the crossing and approaches. There are no signals in place to warn traffic of approaching trains, however, railway crossing warning signs are provided on Gilgai Road and on the Barrier Highway on both approaches to the Gilgai Road intersection. Constructive Solutions (2016) state that there is sufficient distance for a B-Double truck to queue between the railway crossing and the Barrier Highway intersection.

Intersection between Barrier Highway and Gilgai Road

The intersection between the Barrier Highway and Gilgai Road is a T-intersection, with a give way sign on Gilgai Road (**Plate 2.1**). Constructive Solutions (2016) identify that the configuration of the Barrier Highway at the intersection is as follows. This configuration exceeds Austroads warranted turning treatments.

- A rural auxiliary left turn treatment – short turn lane (AUL(S)) is provided for west bound traffic turning left on to Gilgai Road; and
- A basic right turn treatment (BAR) is provided for east bound traffic turning left on to Gilgai Road.

Estimated safe intersection sight distances (SISD) for vehicles turning right from Gilgai Road are 560m to the east and 200m to the west. The Austroads (2010) Extended Design Domain SISD for the intersection is 195m.

2.8.4 Transportation Routes and Traffic Types and Levels

2.8.4.1 Transportation Routes

The Applicant anticipates that the vast majority of light and heavy vehicles would access the Project Site from the east, namely, to or from Nyngan via the Barrier Highway. Occasional light and heavy vehicles may access the Project Site from the west via the Barrier Highway, but traffic volumes from this direction are expected to be negligible. Finally, occasional light vehicles associated with employees or may live to the southwest of the Project Site may access the Project Site via Gilgai Road from the southwest. No heavy vehicles would access the Project Site from this direction.

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Plate 2.1: View of the intersection of the Barrier Highway and Gilgai Road looking west
(Source - Constructive Solutions (2016) - Plate 6)

Plate 2.2: View of Gilgai Road looking south from the Project Site Entrance
(Source - Constructive Solutions (2016) - Plate 5)

Plate 2.3: View of Gilgai Road looking northeast
(Source - Constructive Solutions (2016) - Plate 3)

Plate 2.4: View of the Level crossing looking north
(Source - Constructive Solutions (2016) - Plate 1)

The Applicant has investigated the potential for use of rail transportation from the Hermidale siding, however, given the volume of materials to be transported and the fact that the materials would be coming from a range of sources and locations, rail transportation was determined to be non-viable at this stage. However, the Applicant will continue to investigate the option of rail transportation throughout the life of the Proposal.

2.8.4.2 Traffic Types

Traffic types associated with the Proposal would include the following.

- Light vehicles – including passenger vehicles and light trucks.
- Heavy vehicles – including rigid trucks, and semi-trailers delivering consumables and supplies.
- Oversize and overweight vehicles – delivering components of the Processing Plant and mobile fleet. The Applicant would ensure that all oversize and overweight vehicles would have the appropriate permits and approvals and would be appropriately escorted, when required.

2.8.4.3 Traffic Levels

The Applicant anticipated that the average traffic levels accessing the Project Site would be as follows. For the purposes of the traffic impact assessment prepared by Constructive Solutions (2016), all traffic has been assumed to access the Project Site from the east via the Barrier Highway and Gilgai Road.

- Light vehicles – 60 vehicle movements or 30 return trips per day.
- Heavy vehicles – 10 vehicle movements or 5 return trips per day.

2.9 FACILITIES AND SERVICES

2.9.1 Facilities

An Administration Area, which forms part of the Processing Plant and Office Area, would be constructed during the site establishment phase of the Project. **Figure 2.4** presents an indicative layout of the Administration Area which would comprise the following components.

- a demountable office complex that would contain the Applicant's site office, ablution facilities, first aid room, security and meeting rooms;
- a stores building, incorporating undercover and hardstand storage areas;
- a security gate and visitors access; and
- an unsealed carpark for 15 light vehicles.

In addition, the Applicant would also establish the following within the Processing Plant Area.

- Plant workshop building(s), including a concrete sealed floor and vehicle inspection bays. A small bund or drain around the perimeter of the building would contain potentially contaminated runoff and an oil/water separator would be incorporated in the drainage plan.

- A number stores facility, including reagent stores constructed in accordance with the following Australian Standards, as applicable.
  - *AS4452 – The storage and handling of toxic substances.*
  - *AS1940 – The storage and handling of flammable and combustible liquids*.
- A hardstand area comprising an unsealed area for storage of excess equipment awaiting use or removal from site, or parking of mobile equipment.
- A fuel bay and refuelling area incorporating a concrete bunded storage area containing fuel tanks, unused oil and grease, waste oil tank and a concrete sealed refuelling area. All potentially contaminated surface water runoff would be directed to an oil/water separator.

Finally, a mining contractor's area would be established with the western bunded area. This area would indicatively include the following.

- A transportable building for use as the contractor's office and crib room.
- A workshop building, including a workshop with concrete floor, apron and workshop office, a basic stores facility (containers) plus a fenced storage area, fuel and oils storage facilities (self-bunded tanks), concrete sealed refuelling area and waste oil management facilities.
- An ablutions facility.

2.9.2 Services

2.9.2.1 Electricity Supply

The electricity transmission line from the existing 33kV transmission line to the Processing Plant Area is described in Section 2.2.4. That line would terminate at a transformer/substation within the Processing Plant Area. From the transformer/ substation, power would be distributed throughout the Processing Plant Area and the mine contractor's area via buried or overhead power lines.

2.9.2.2 Communications

External communications for site data and phone service will be provided via existing cellular services from the Nyngan town, with a planned migration to a wireless connection with the National Broadband Network (NBN) when the rollout reaches Nyngan.

Within the Project Site, communications between facilities will be run in a conjunction of buried fibre optic cables and fibre optic cables supported on the site overhead transmission lines.

2.9.2.3 Hydrocarbons

All diesel fuel for the mobile equipment would be stored in above ground tanks with a total indicative capacity of 5 000L. These tanks would be either self-bunded or located within a covered and bunded fuel bays in the vicinity of the workshop within the mining contractor's area (for the mining fleet) or within the Processing Plant Area. Bunding, if required, would be sized to meet the OEH containment requirements and *AS 1940:2004 – Safe storage & handling of flammable & combustible liquids*.

A sealed refuelling area would be located adjacent to both fuel bays, with all drainage directed to oil/water separators. More mobile plant (haul trucks, graders, front-end loaders) would utilise the refuelling areas while less mobile plant (excavators, bulldozers and generators) would be refuelled at their work site using a mobile fuel tanker.

Any bulk oils, greases and waste oils would also be stored within a covered and bunded area.

In addition, the Project would consume approximately 8 700m^3 of LPG per year. As a result, the Applicant would install approximately 350m^3 of LPG storage with the Processing Plant Area. These tanks would be appropriately secured and protected from mobile plant with suitable bollards or bunds.

2.9.2.4 Potable Water

Potable water and water for the ablutions facilities, as well as water for selected activities within the processing plant, would be sourced from the reverse osmosis plant. The reverse osmosis plant would be capable of producing up to 350kL of potable water per day. Produced brine would be transferred to the evaporation pond. Sulphuric acid and sodium hydroxide required for the operation of the plant would be stored within the reagent storage area. The Applicant anticipates that the plant would require 30kW of power. Greenhouse gas emissions associated with consumption of that power has been included in the Greenhouse Gas assessment presented in Section 4.2.6.

2.9.2.5 Operational Water

The source and volume of operational water required for the Proposal is described in Section 2.7.

2.9.2.6 Sewage and Waste Water

Waste water from ablutions facilities within the Processing Plant Area would be treated through an appropriately licenced waste water treatment system. The system would be serviced by a licensed waste collection and disposal contractor, as required.

Chemical toilets would be provided within the mining contractor's area for use during mining campaigns. Alternatively, a similar licenced waste water treatment system would be installed within this area.

2.10 NON-PRODUCTION WASTE MANAGEMENT

The underlying principle for all non-production waste management would be to minimise waste generation, to recover, reuse and to recycle waste materials as much as possible, and to reduce environmental harm in accordance with the principles of ecologically sustainable development.

Table 2.9 lists the non-production wastes that would be generated throughout the life of the Project and briefly describes how each class of waste would be stored or managed on site and subsequently removed from the Project Site.

Table 2.9
Non-Production Waste Management

Waste Type	Storage	Removal Method
General solid waste (putrescible), including food scraps and inert materials	Covered bins located within crib rooms, office and elsewhere as required. Where these bins would be located in open areas, they would be fitted with animal-proof lids.	Collected on a regular basis by licensed waste contractor and transported to a licensed waste disposal facility.
Waste oils and greases	Placed within bunded area(s) within or in the vicinity of the workshop areas.	Collected on a regular basis by a licensed waste contractor and transported to an appropriately licensed facility.
Oily water	All oily water would be collected in sumps (in the case of workshops and wash down bays) or in tanks (in the case of compressors and other plant).	All oily water would be passed through an oil-water separator, with the produced water added to the process water circuit and the produced oily fraction added to the waste oil stream.
Batteries	Batteries would be placed within a covered and marked used battery storage area until removed from site.	Batteries would be collected as necessary by a licensed disposal contractor and recycled.
Tyres	Tyres, where practicable, would be removed from site by the supplier. Where this is not possible, or temporary storage is required, tyres would be placed within a marked used tyre storage area until removed from site or used for another purpose.	Tyres would be removed from site for recycling, where practicable, or reused on site for construction of retaining walls, erosion protection, traffic control, etc.
Scrap Steel /Metal	Stored in a specified areas within the workshop area or elsewhere such as the laydown area, as required.	Collected as necessary by a scrap metal recycler.
General Recyclables	Covered bins located within lunch rooms, offices, camp site and elsewhere as required. Where these bins are located outside a closed building they would be fitted with animal-proof lids.	Collected as necessary by a licensed recycling contractor and transported to an appropriate recycling facility.

In addition, the Applicant would implement a purchasing policy that would take into account waste management and would, where practicable, purchase products that would result in the least waste generation. The Applicant would also ensure that all recyclable materials would, where practicable, be recycled on site or would be transported to an appropriate recycling facility.

2.11 PROPOSAL LIFE AND HOURS OF OPERATION

2.11.1 Proposal Life

Based on the identified resource of 12Mt (see Section 1.4.2) and an extraction rate of approximately 75 000tpa to 80 000tpa, the Applicant anticipates that mining operations could be undertaken for between 160 and 200 years. However, during the life of the Proposal, the Applicant proposes to work with other suppliers of scandium product to substantially increase the annual market for scandium. As a result, the Applicant anticipates that subsequent applications for an increase production rate will be prepared.

In light of the above and in recognition of the fact that development consent for an operational life of 160 to 200 years would be unlikely to be considered reasonable by the community, the Applicant proposes to undertake mining operations for a period of 21 years. In addition, the Applicant would require a period of up to two years for financing and construction of the Proposal and a further period of two to three years for rehabilitation. As a result, the proposed live of the Proposal would be 26 years.

2.11.2 Hours of Operation

Table 2.10 presents the proposed hours of operation for each of the relevant components of the Proposal.

Table 2.10
Proposed Hours of Operation

Activity	Proposed Days of Operation	Proposed Hours of Operation
Land preparation	7 days per week on a campaign basis	Daylight hours
Construction operations	7 days per week for a period of approximately 9 to 12 months	6:00am to 6:00pm
Mining operations	7 days per week	6:00am to 6:00pm
Processing operations	7 days per week	24 hours per day
Transportation operations	7 days per week	24 hours per day
Maintenance operations	7 days per week	24 hours per day
Rehabilitation operations	7 days per week	Daylight hours
Source: EMC Metals Australia Pty Ltd		

Mining operations would be undertaken on a campaign basis, with a mining contractor engaged for each campaign. The Applicant anticipates that mining campaigns would be between 10 and 14 weeks (during site establishment and prestrip phases) and 3 to 4 weeks (during "normal" mining operations). Mining operations would be undertaken on dayshift only, with shift start and finish times at the discretion of the mining contractor. The Applicant anticipates that mining would typically be undertaken between 6:30am and 5:30pm, with a period before and after those times for prestart and shut down activities.

Processing operations would be undertaken 24-hours per day, 7-days per week, with 4 panel roster. Shifts would typically be 12 hours, starting and finishing 6:00am / 6:00pm, with crews rostered on an even time roster such as 7 days on, 7 days off or similar.

Office and managerial staff would typically work a 5 day week, with shifts commencing around 7:00am and finishing between 3:00pm and 5:00pm.

2.12 EMPLOYMENT, CAPITAL COST AND ECONOMIC CONTRIBUTIONS

2.12.1 Employment

The Applicant anticipates that it would require the following full time equivalent (FTE) personnel to operate the Proposal.

- Construction – Up to approximately 60 FTE positions.
- Ongoing operations – Approximately 75 FTE positions.

In addition, the Proposal would require mining to be undertaken on a campaign basis. The Applicant anticipates that approximately 10 people would be required during mining operations.

The Applicant also anticipates that numerous indirect positions would be generated for the following.

- Contract truck drivers – 8 to 10 FTE positions.
- Service providers (local, regional and national) – variable.

Finally, the Applicant notes that all positions are planned to be offered on a residential basis, with the majority of employees and other workers expected to reside in Nyngan and surrounding areas. Indeed, the Applicant notes that the Bogan Local Government Area has a high proportion of people with mining and related technical experience. As result, the Applicant anticipates that the majority of employees and other workers would be existing residents of the Bogan Local Government Area.

2.12.2 Capital Cost

As the Applicant's parent company, Scandium International Mining Corporation (SIMC) is listed on the Toronto Stock Exchange. An *Amended Technical Report and Preliminary Economic Assessment on the Nyngan Scandium Project, NSW, Australia* dated May 2015 was compiled by Larpro Pty Ltd in satisfaction of the Applicant's obligations under Canadian law. That document estimates that the capital cost for the Proposal would be US$77.4 million. However, subsequent review by the Applicant during preparation of the *Definitive Feasibility Study* has resulted in the capital cost of the Proposal increasing to US$87.1 million or A$124.4 million[2]. The Applicant contends that this estimate has been prepared by experts in the field of mining feasibility studies and is therefore consistent the methodology described in the planning circular *New definition of capital investment value* dated May 2010 and published by the then NSW Department of Planning.

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[2] Based on an assumed exchange rate of A$1.00 = US$0.70 consistent with the financial modelling for the Proposal.

2.12.3 Economic Contributions

Table 2.11 presents the economic contribution of the Project to the local and regional, NSW and Federal economies. In addition, the Applicant anticipates that a Voluntary Planning Agreement will be negotiated prior to determination of the Proposal.

Table 2.11
Economic Contribution Attributable to the Proposal

	Annual Contribution (A$ million)
Local and Regional Economy	
Wages and salaries (direct employees only).	$8.4
Mining (total cost, including wages, equipment and consumables).	$1.0
Local services and suppliers (local deliveries, local earthmoving, maintenance, etc.).	$3.0
Sub-total	**$12.4**
State and National Economy	
Utilities (power, water, communications).	$1.0
Reagents and consumables.	$11.4
State and National services and suppliers (long distance deliveries, supplies other than reagents and consumables).	$3.1
NSW government royalty.	$4.5
Other Commonwealth and State taxes	$19.0
Sub-total	**$39.0**
Total	**$51.4**
Source: EMC Metals Australia Pty Ltd	

2.13 SITE REHABILITATION AND DECOMMISSIONING

2.13.1 Introduction

The Applicant notes that based on the identified resource and the proposed production rate sufficient resources exist for between 160 and 200 years of mining operations. Indeed, once a suitable market for scandium has been established, potential exists to expand or extend the life of the Proposal through a new application for development consent or a modification of any consent that is granted.

Notwithstanding this, however, rehabilitation of all areas to be disturbed would be an integral part of the Proposal. Emphasis would be placed upon progressively creating the final landform, re-establishing soil profiles and vegetation essential to achieving the preferred land uses.

Rehabilitation activities would be planned and undertaken in accordance with a *Mining Operations Plan* (*Mining Operations Plan*) to be submitted to the DRE and approved following the issue of development consent and prior to the commencement of on-site activities. The *Mining Operations Plan* would also address any rehabilitation-related requirements nominated in the development consent for the Proposal.

In addition to the rehabilitation commitments in the EIS, rehabilitation would be planned and undertaken with reference to the following documentation.

- *Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry* (Commonwealth Government, 2006).
- *Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry* (Commonwealth Government, 2006).
- *Strategic Framework for Mine Closure* (ANZMEC, 2000).

This subsection focusses upon the rehabilitation activities within the Project Site. Section 2.14 describes rehabilitation and habitat establishment activities proposed within the Biodiversity Offset Area.

2.13.2 Rehabilitation Objectives

In the short term, the Applicant's objectives would be to stabilise all earthworks and disturbed areas no longer required for Proposal-related activities. In particular, emphasis would be placed on shaping and stabilising the outer face of the levee bunds and elevated haul road to minimise the potential for erosion of these structures and associated sedimentation.

The Applicant's longer term rehabilitation objectives are to ensure that:

- the rehabilitated landform is safe, stable, non-polluting and suitable for the identified long-term final land uses;
- suitable vegetation is established on the final landform, taking into account the proposed final land use;
- the rehabilitated landform requires levels of maintenance commensurate with surrounding land;
- rehabilitation is undertaken in an efficient and economically sustainable manner;
- the mining lease(s) over the rehabilitated landform can be relinquished and the security returned within a reasonable time after the completion of all mining and rehabilitation activities.

2.13.3 Final Landform

Figure 2.8 presents the proposed final landform. In summary, the final landform would comprise the following.

- Two bunded and fenced open cuts within a revegetated Borrow Pit with side slopes of 1:3 (V:H) or less.
- A free draining, covered and revegetated Residue Storage Facility.

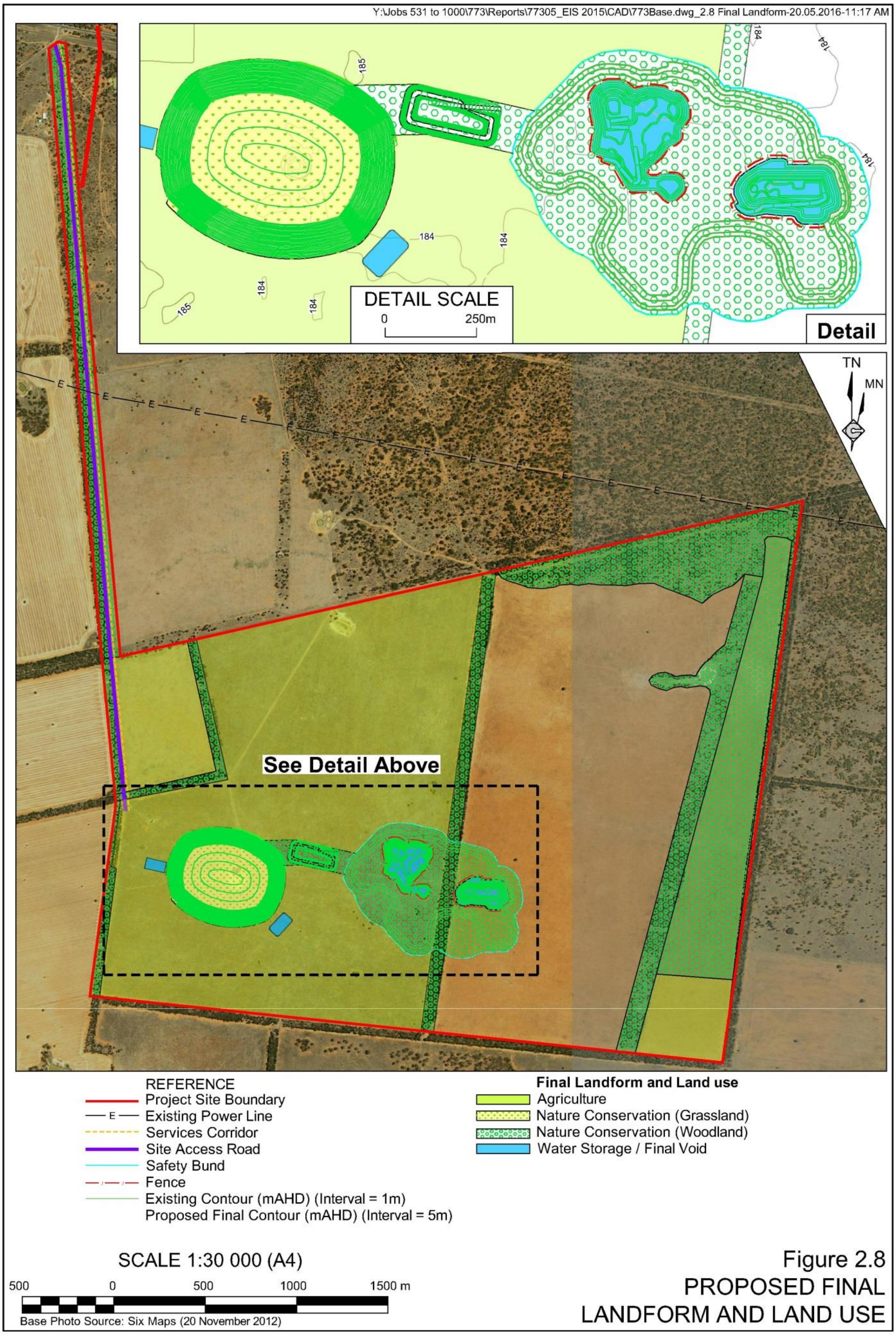

Figure 2.8
PROPOSED FINAL
LANDFORM AND LAND USE

- A shaped, covered and revegetated Low Grade Stockpile with slide slopes of 1:3 (V:H) or less. It is noted, however, that during the life of the Proposal, market conditions may result in low grade ore being reclassified as either:
  – ore, in which case it would be transferred to the Processing Plant; or
  – overburden, in which case it would be used for construction of the Residue Storage Facility.

  In either case, the Low Grade Stockpile may be removed during the life of the Proposal. If that were to occur, the footprint of the stockpile would be shaped to form a generally flat, free draining landform.
- A generally flat Processing Plant Area with all infrastructure not required for the final land use, including the levee bunds, removed.
- Two water storage dams, namely the Event Pond and Sediment Pond, with all other water storages removed.

The Site Access Road would remain for the final land use. Infrastructure within the services corridor not required for the final land use would be removed.

2.13.4 Final Land Use

In proposing an end land use for the Project Site, the Applicant has considered the current land use, the Proposal-related infrastructure that would be developed and the proximity of the Project Site to other industry, the Nyngan – Cobar Railway and Barrier Highway and water and power infrastructure.

End land uses considered included:

- the development of another industry;
- water storage;
- a return to agricultural end land use; and
- the conservation of biodiversity.

In considering an end land use of another industry, the Applicant notes that the Proposal would result in construction of the following items of infrastructure that may potentially be amenable to other industrial land uses.

- A large, flat hardstand area, namely the Processing Plant Area, including a range of buildings, sheds and water storages that may be suitable for non-mining purposes.
- An unsealed Site Access Road and adjacent services corridor with power and water infrastructure.
- An elevated Residue Storage Facility with a largely flat area on top of the facility that may be suitable for a range of uses.

In addition, the Applicant notes that the Project Site is located in an isolated area, but close to transport infrastructure, namely the Barrier Highway and the Nyngan – Cobar Railway.

As a result, potential post-mining industrial land uses for the disturbed sections of the Project Site may include the following.

- Solar farm – The Applicant notes that the Nyngan Solar Plant received development consent on 15 July 2013, with construction completed in mid-2015. As the Project Site would include large flat disturbed areas and power transmission infrastructure, potential exists for a similar facility to be constructed within the Project Site.
- Manufacturing facility – Potential exists for an industrial manufacturing facility that would require separation from surrounding residential receivers while having good access to power, water and transportation. Examples may include chemical manufacturing plants or explosive manufacturing or storage plants.
- Intensive agriculture – Potential exists for an intensive agricultural operation that would require warm to hot conditions, access to water and relatively easy access to markets to be established.

It is noted, however, that each of these proposed land uses would require further development consent to be granted, as well as potential rezoning of the land. As a result none of these land uses are proposed at this stage.

In relation to the proposed open cuts, the Applicant notes that all overburden to be produced would be used to construct the Residue Storage Facility. As a result, backfilling of the voids would adversely impact on the integrity of that facility. Furthermore, the Proposal would only extract a portion of the identified resource. Additional resource would remain adjacent to and below the proposed open cuts. As result, backfilling of those open cuts would result in sterilisation of resources and would be contrary to the objects of the *Mining Act 1992.* Potential does, however, exist for the open cuts to be used to store water, including water sourced from the Nyngan – Cobar Pipeline.

Finally, the Applicant notes that the majority of the Project Site is currently used for agricultural operations, including cropping and grazing. Other sections of the Project Site are used for nature conservation.

In light of the above, the Applicant proposes the following final land uses for the Project Site **(Figure 2.8**).

- Residue Storage Facility – Nature conservation (grassland).

  As the establishment of deep rooted vegetation on the facility could potentially adversely impact on the impermeable cap for the facility, the Applicant would establish a native grassland community on the final landform.

- Open cuts – Water storage / final void.

  As backfilling of the final void would sterilise surrounding resource, the Applicant proposes to use the final open cut voids for water storage or simply retain the open cuts as bunded and fenced voids to facilitate future mining operations.

- Borrow Pit – Nature conservation (woodland).

  The proposed Borrow Pit would be a largely flat area that would be approximately 15m lower than the surrounding landforms. As a result, the landform would be unlikely to be amenable to broad-scale agricultural operations. As a result, the Applicant proposes to establish a native woodland consistent with the existing native vegetation within the Project Site, namely Benson ID 103 – Poplar Box – Gum Coolabah and White Cypress Pine Shrubby Woodland mainly in the Cobar Peneplain Bioregion. The proposed final levee bund would remain to protect the final voids from inundation during flood events.

- Low Grade Stockpile and adjacent areas – Nature conservation (woodland) or agriculture.

  The proposed Low Grade Stockpile would not be amenable for broad-scale agriculture because of the slope of the final landform and the potential for erosion of the placed soil as a result of grazing by hard-hooved animals. As a result, the Applicant proposes to establish a native woodland consistent with the existing native vegetation within the Project Site, namely Benson ID 103 – Poplar Box – Gum Coolabah and White Cypress Pine Shrubby Woodland mainly in the Cobar Peneplain Bioregion.

  In the event that the Low Grade Stockpile is removed during the life of the Proposal, the footprint of the stockpile would be rehabilitated for agricultural purposes.

- Event Pond and Sediment Pond – Water storage.

  The Event and Sediment Ponds would be retained as agricultural dams.

- Processing Plant Area and all other areas of disturbance – Agriculture.

  The Processing Plant Area would be returned to the existing land use, namely agriculture.

2.13.5 Rehabilitation Methods and Procedures

A range of rehabilitation procedures would be adopted throughout the life of the Proposal to achieve the objectives set out in Section 2.13.2. These procedures relate to:

- short-term / temporary stabilisation or progressive rehabilitation of sections of the Project Site not required for mining operations; and
- final rehabilitation of the Project Site should further applications for consent for expanded or extended mining operations not be prepared.

Short-term / Temporary Stabilisation and Progressive Rehabilitation

Short-term / temporary stabilisation of soil stockpiles would be undertaken as soon as practicable following construction and shaping of the stockpiles. Other sections of the Project Site that would require short-term stabilisation and rehabilitation include the outer faces of the levee bunds and the elevated haul road. Proposed rehabilitation methods and procedures would include the following.

- Shape the landform to be rehabilitated to ensure that all slopes are less than 1:3 (V:H) or 18º.
- Spread approximately 300mm of stripped topsoil over the shaped landform.
- Install suitable sediment and erosion control structures in accordance with *Managing Urban Stormwater* (DECC, 2004). This may include establishing sediment fencing, surface water diversions and applying a suitable polymer-based binding agent to stabilise respread soil prior to vegetation becoming established.
- Establish a suitable sterile cover crop on the stockpiles to maintain soil structure and to ensure that that they are not subject to erosion.
- Establish a suitable long-tern vegetative cover. In the case of the proposed soil stockpiles, the long-tern vegetative cover would comprise pasture species. In the case of the levee bunds and elevated haul road, the vegetative cover would comprise species consistent with Benson ID 103 – Poplar Box – Gum Coolabah and White Cypress Pine Shrubby Woodland mainly in the Cobar Peneplain Bioregion.
- Fence the rehabilitated areas to control access by unauthorised personnel and equipment and limit access by livestock or native fauna to that required for management of weed and fuel loads.
- Undertake regular weed management programs to ensure that the soil material to be used for rehabilitation operations does not become weed infested.

Final Rehabilitation

Final rehabilitation of the Project Site would be undertaken following completion of the proposed mining operations and would include the following.

- Decommission and remove all infrastructure not required for a lawful final land use. In particular, this would include removal of the following.
  - The Processing Plant and associated infrastructure, including sheds, reagent and hydrocarbon stores and offices.
  - All pumps and residue management infrastructure, including surface pipelines.
  - All infrastructure within the mine contractor's area.
  - All concrete pads and foundations.
  - All waste water treatment facilities.

  Buried infrastructure that is not exposed at surface such as powerlines and pipelines would remain.

- Scrape and use all hardstand material for rehabilitation-related purposes such as capping of the Residue Storage Facility.
- Undertake a contamination survey of all sections of the Project Site likely to contain contaminated material, including removal or remediation of any identified contaminated material.
- Remove and reprofile the External Decant, Evaporation and Raw Water Ponds, ensuring that any contaminated material is removed from the Project Site to a suitably licenced facility.
- Close and rehabilitate the Residue Storage Facility as follows.
  - Permit the accumulated residue to dry and settle prior to shaping the upper surface of the facility to form a domed, free draining facility.
  - Install a 1.5mm HDPE liner over the shaped landform to prevent infiltration of water into the residue pile.
  - Cover the liner with at least 1m of overburden sourced from the hard stand areas, levee bunds, elevated haul road and Borrow Pit 300mm of stockpiled soil.
  - Establish surface water controls on the final landform.
  - Establish a suitable sterile cover crop to stabilise the placed soil in the short term.
  - Establish a native grassland community on the final landform. Mutable species would be identified through on-site trials and identified in the *Mining Operations Plan* and *Annual Environmental Management Plans* to be prepared throughout the life of the Proposal.
  - Continue to monitor and pump water from the underdrainage and sub-liner drainage sumps until water flows cease, after which all pumping infrastructure would be removed.
  - Continue monitoring of the phreatic surfaces and groundwater chemistry within and surrounding the facility until the system has been demonstrated to have reached steady state conditions.
- Rehabilitate the Processing Plant Area as follows.
  - Remove the levee bund and elevated haul road, as well as all hardstand, sheeting material and use for rehabilitation purposes within the Project Site.
  - Deep rip and reprofile the Processing Plant Area as required to achieve an even, generally flat surface suitable for the operation of the largest sized agricultural header likely to operate on the post-mining landform.
  - Spread approximately 300mm of stockpiled soil and install surface water controls on the final landform.
  - Undertake soil amelioration works in consultation with an agronomist to ensure that the spread soil profile is suitable for the proposed post-mining land use of light grazing and occasional cropping.

- Rehabilitate the open cuts and Borrow Pit as follows.
  - Remove all remaining mining-related infrastructure, including mine contractors facilities, pumps, pipework, etc.
  - Inspect and upgrade, as required, a safety bund around the crest of the East and West Pits, including a bund or gate across the ramp to each open cut.
  - Install a suitable agricultural fence around the safety bunds to exclude livestock and prevent inadvertent access to the open cuts.
  - Shape the walls of the Borrow Pit to ensure that all slopes are less than 1:3 (V:H) or 18º and install suitable surface water controls to prevent erosion of the final landform.
  - Reprofile and deep rip the floor of the Borrow Pit to ensure that surface water flows either to the open cuts or to a suitable storage pond to prevent pooling of water on the surface of the rehabilitated landform.
  - Spread 300mm of soil across the floor and walls of the Borrow Pit.
  - Scarify the surface of the area between the levee bund and the crest of the Borrow Pit.
  - Establish a native woodland community across the floor and walls of the Borrow Pit and between the crest of the Borrow Pit and the final levee bund. The vegetation community would be consistent Benson ID 103 – Poplar Box – Gum Coolabah and White Cypress Pine Shrubby Woodland mainly in the Cobar Peneplain Bioregion.

2.13.6 Rehabilitation Monitoring, Remediation and Performance Criteria

Rehabilitation monitoring and, if necessary, related research, would be described in the *Mining Operations Plan*. Monitoring would focus on the presence and magnitude of erosion, vegetation cover, weed propagation, strike rate, plant growth (for native vegetation) and productivity (for agricultural purposes).

The Applicant's commitment to effective rehabilitation would involve an ongoing maintenance program arising from the results of the monitoring program. This would include, for example, re-seeding and re-topsoiling and/or the application of soil ameliorants or mulch if monitoring identifies deficiencies in rehabilitated areas. Drainage controls would also be maintained. Species-specific weed eradication methods and programs would be undertaken, as required.

Finally, the *Mining Operations Plan* would identify a range of performance criteria for the various phases of rehabilitation operations. These criteria would be progressively updated throughout the life of the Proposal. However, indicative rehabilitation completion criteria for key components of the final landform would be as follows.

- Final open cut voids.
  - Terminal faces stable and free from uncontrolled slips or wall failures.
  - Final bund adequate to prevent inadvertent vehicular access and set back an adequate distance from the open cut crest to cater for any potential break back of the open cut walls.

  - Haul ramps blocked in a manner that would prevent inadvertent to unauthorised access.
  - Perimeter fence and signposts installed.
- Areas to be used for woodland nature conservation, namely the Borrow Pit and surrounds and the Low Grade Stockpile.
  - All slopes reduced to 1:3 (V:H) or 18º or less.
  - Minimum 300m of growth medium spread.
  - Seed of species consistent with Benson ID 103 vegetation community spread.
  - Benson ID 103 vegetation community established and Biometric Vegetation Benchmarks progressing towards those of analogue sites within undisturbed vegetation.
- Areas to be used for grassland nature conservation, namely the Residue Storage Facility.
  - All slopes reduced to 1:3 (V:H) or 18º or less.
  - Suitable impermeable cap and cover installed.
  - Minimum 300m of growth medium spread.
  - Seed of native grassland species spread.
  - Monitoring using Landform Function Analysis methodology indicates that the landform is moving towards a stable, self-sustaining landform.
- Areas to be used for agricultural operations.
  - All hardstand and sheeting material removed.
  - Landform shaped in a manner suitable for the operation of agricultural machinery such as headers and air seeders.
  - Minimum 300m of growth medium spread.
  - Pasture or crop established, with production rates similar to surrounding undisturbed analogue sites.

These performance criteria would be further developed in the *Mining Operations Plan* to be prepared for the Proposal and would be revised following completion and review of progressive rehabilitation of those sections of the Project Site not required for operational purposes, including the outer faces of the levee bunds.

2.14 BIODIVERSITY OFFSET STRATEGY

2.14.1 Introduction

The Secretary's Environmental Assessment Requirements (SEARS) for the Proposal require that this document includes "a comprehensive offset strategy to ensure the development maintains and improves the biodiversity values of the region in the medium to long term." The following subsections describe the Proposal's Biodiversity Offset Strategy.

2.14.2 Residual Biodiversity Impacts

An ecology assessment for the Proposal was undertaken by EnviroKey Pty Ltd (EnviroKey). The resulting report is presented as Part 3 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as EnviroKey (2016). A summary of that assessment is presented in Section 4.3 of this document. In summary, the Proposal would result in disturbance of the following vegetation communities.

- Benson ID 103 – Poplar Box – Gum Coolabah and White Cypress Pine Shrubby Woodland mainly in the Cobar Peneplain Bioregion...................................... 9.3ha.
- Exotic vegetation... 135.7ha.

In addition, EnviroKey (2016) identified the following threatened species within the Project Site.

- Hooded Robin.
- Grey-crowned Babbler.
- Inland Forest Bat.
- Little Pied Bat.
- Eastern Long-eared Bat.

EnviroKey (2016) state that the abundance of Grey-crowned Babblers within and surrounding the Project Site was considered significant. As a result, a supplementary survey was completed and 29 troupes or family groups were identified within and surrounding the Project Site (see Section 4.3.5.4).

EnviroKey (2016) undertook an assessment of significance of the anticipated impacts associated with the Proposal and determined that there would be no significant impacts on threatened species.

Notwithstanding the above, EnviroKey (2016) undertook an assessment of the proposed disturbance of approximately 9.3ha of Benson ID 103 using the OEH Biobanking Calculator and identified that 652 credits would be required to offset the proposed disturbance of native vegetation.

2.14.3 Proposed Biodiversity Offset Area and Strategy

In light of the above, the Applicant determined to establish a Biodiversity Offset Area in cleared land within the eastern section of the Project Site (**Figure 2.1**). EnviroKey (2016) determined that an offset area of 64ha would be required to generate the requisite number of credits using the OEH Biobanking Calculator.

The Biodiversity Offset Area would be established in an area that is currently used for agricultural purposes, including cropping and grazing. The Applicant would prepare a detailed *Biodiversity Offset Strategy and Management Plan* for the Proposal following the receipt of development consent. The objectives of the Strategy would be as follows.

- Secure an area for the establishment of habitat suitable for threatened species, in particular, Grey-crowned Babbler, for the life of the anticipated project-related impacts.

- Establish a native vegetation community consistent with Benson ID 103 – Poplar Box – Gum Coolabah and White Cypress Pine Shrubby Woodland mainly in the Cobar Peneplain Bioregion.
- Manage the Biodiversity Offset Area in a manner that would maintain and improve the biodiversity values of the region in the medium to long term.

In order to achieve the proposed Biodiversity Offset Strategy objectives, the Applicant would implement the following. These measures would be described in detail in the *Biodiversity Offset Strategy and Management Plan* to be prepared for the Proposal.

- Fence and exclude stock from the proposed Biodiversity Offset Area.
- Re-establish native vegetation consistent with Benson ID 103 – Poplar Box – Gum Coolabah and White Cypress Pine Shrubby Woodland mainly in the Cobar Peneplain Bioregion through a combination of active plantings and natural regeneration.
- Undertake weed and pest management.
- Undertake routine monitoring of vegetation establishment and use of the Biodiversity Offset Area by threatened species.

Finally, the Applicant notes that the Biodiversity Offset Area would be established during Year 1 of the Proposal. However, disturbance of the existing native vegetation would only occur as follows (**Figure 2.3**).

- Stage 1 – approximately 0.9ha of Benson ID 103 would be disturbed, indicatively during Year 3.
- Stage 2 – approximately 8.4ha of Benson ID 103 would be disturbed, indicatively between Years 11 and 15.

As a result, the Applicant notes that the Biodiversity Offset Strategy would be well established prior to the majority of the disturbance to native vegetation occurring. In addition, the Applicant notes that the final landform would include approximately 45.8ha of re-established Benson ID 103 within the Borrow Pit and on the Low Grade Stockpile. As a result, the Project Site and the end of the life of the Proposal would include substantially more native vegetation than currently exists.

2.14.4 Long Term Security

The Applicant proposes to secure the Biodiversity Offset Area through a Biobanking agreement consistent with the *NSW Biodiversity Offsets Policy for Major Projects*.

2.15 PROJECT RATIONALE AND ALTERNATIVES CONSIDERED

2.15.1 Introduction

This sub-section identifies the feasible alternatives considered and rejected during the design and planning phase of the Proposal. The alternative of not proceeding with the Proposal is considered in Section 5.2.3.5 and an evaluation of the Proposal in terms of Ecologically Sustainable Development and biophysical, socio-economic and planning considerations is provided in Sections 5.2.2 and 5.2.3.

2.15.2 Alternative Open Cut and Borrow Pit Layout

The Applicant originally considered a single open cut option for the Proposal. That open cut would have been located in the vicinity of the West Pit. However, following the completion of further resource drilling in 2015 and optimisation of the proposed mining operations, limiting mining operations to the area surrounding the West Pit provided a substantially less robust operation. As a result, that option was rejected.

The Proponent also considered a range of other locations for the Borrow Pit, including to the south and southeast of the proposed Residue Storage Facility. That option would have provided the required material for construction of the Residue Storage Facility at marginally lower costs due to its proximity to the Residue Storage Facility. However, the proposed Borrow Pit layout results in pre-stripping of overburden from future resources areas, potentially lowering the barrier to development of that ore should a subsequent application to mine it be submitted. As a result, the alternative location for the Borrow Pit was rejected.

2.15.3 Alternative Mining Schedule

The Applicant considered a range of alternative mining schedules, including continuous mining operations. However that option was rejected because the proposed rate of processing (and the mining rate that would be required to support it) would be too low to support efficient operation of a mining fleet.

2.15.4 Alternative Low Grade Mining

The Applicant considered the option of classifying low grade ore as overburden and using that material for construction of the Residue Storage Facility. However, such use of that material would prevent it being processed by future generations, effectively sterilising resources contrary to the object of the *Mining Act 1992*. As a result, the Applicant proposes to establish a Low Grade Stockpile at surface that will be available for the Applicant or future generations to process should economic conditions permit.

2.15.5 Alternative Processing Methodology

The Applicant investigated a very large number of alternative processing methodologies. The proposed processing methodology was determined through an extensive series of tests and progressive refinements, including refinements to manage the potential risk of adverse environmental impacts. As a result, the Applicant contends that the proposed processing methodologies represent the optimal methodology for processing the metallurgically-challenging scandium-bearing ore within the Project Site.

2.15.6 Alternative Rate of Processing

The Applicant considered an alternative rate of processing within the Project Site, including a substantially higher rate of processing that that proposed. The Applicant determined that as the annual worldwide market for scandium in 2015 was approximately 15t, that substantial growth in that market would be required before a production rate substantially greater than the proposed 45tpa of scandium oxide could be justified. As a result, the Applicant determined that the proposed rate of processing of up to 80 000tpa of ore to produce up to approximately 45tpa of scandium oxide is the optimal rate of processing. However, the Applicant notes that it intends to facilitate a substantial growth in the market for scandium over the life of the Proposal and that future applications to increase the rate of processing may be prepared.

2.15.7 Alternative Residue Storage

The Applicant investigated the option of in-pit storage of tailings. That option would result in the need for a smaller Residue Storage Facility, with less overburden required for construction and an associated reduction in the proposed size of the Borrow Pit. However, the Applicant notes that lower-grade scandium-bearing saprolite occurs below the base of the proposed open cuts and that placement of tailings into those open cuts would result in potential sterilisation of those resources. In addition, the Applicant notes that the proposed processing methodology relies on a number of processes that, while well understood at a bench-top or pilot plant scale, have yet to be widely used in an operational scenario. As a result, and in accordance with the Precautionary Principle, the Applicant proposes to place all tailings in an out-of-pit Residue Storage Facility where the material may be more easily managed and monitored until sufficient information in relation to the behaviour of the tailings has been collected.

2.15.8 Alternative Transport Arrangements

The Applicant considered transportation of reagents via rail, with a siding to be constructed in the vicinity of the intersection between Gilgai Road and the Barrier Highway. However, the Applicant was advised that limited train paths are available and that the volume of reagents required for the Proposal was not such that rail transportation was economically feasible.

2.15.9 Alternative Life of the Proposal

The Applicant notes that the Nyngan Scandium Deposit includes sufficient mineralisation to support a mining operation for between 160 to 200 years. However, the current application is for a period of 26 years only. The Applicant determined that a longer period would not be consistent with reasonable community expectations. As a result, a further application for approval to mine the remaining resource may be prepared in due course.

2.15.10 Alternative Final Land Use

The Applicant considered a range of alternative final land use options (see Section 2.13.4). Those options included the following.

- A solar farm.
- A manufacturing facility.
- Intensive agriculture.

However, as each of the proposed final land uses would require further approvals, the proposed combination of agriculture and nature conservation was considered to be the most appropriate final land use.