Section 4
Assessment and Management of Key Environmental Issues

PREAMBLE

This section describes the specific environmental features of the Mine Site and its surrounds that would or may be affected during the life of the Ardlethan Tin Mine Rehabilitation and Tailings Reprocessing Project. The proposed design and/or operational safeguards and management measures are presented, followed by an assessment of the predicted level of impact the proposed activities may have after implementation of these measures. Where appropriate, proposed monitoring programs are also described.
4.1 ENVIRONMENTAL SETTING

4.1.1 Introduction

The descriptions of various environmental aspects of the Proposal throughout this section are reliant upon a range of background information common to many of the key environmental issues. In this subsection, the local setting is described and background information is provided on the topography, climate, geological setting and land ownership and land uses of the Mine Site and surrounds. The information presented in this subsection provides a general overview of the environmental setting of the Mine Site. More specific information in relation to particular environmental aspects of the Proposal is presented in the following subsections.

4.1.2 Topography and Drainage

4.1.2.1 Regional Topography and Drainage

The Mine Site is located in an area of generally flat topography which slopes gently to the southeast towards the Murrumbidgee River, with occasional localised hills and ridges (Figure 4.1). Maximum elevations include

- 360m AHD at the Bygoo Hills, approximately 6km to the northeast of the Mine Site;
- 399m AHD at Bolero Mountain, approximately 5km north-northwest of the Mine Site; and
- 400m AHD at the Colinroobie Hills, approximately 25km southwest of the Mine Site (Figure 4.1).

The Mine Site is located within the Murrumbidgee Catchment which drains an area of approximately 84 000km² within the Murray-Darling Basin. The Murrumbidgee River headwaters are situated in the Monaro Plains near Cooma, NSW and the river travels approximately 1 600km west to its junction with the Murray River near Balranald, Victoria. A number of hydraulic controls have been constructed within the Murrumbidgee system with Blowering Dam on the Tumut River (1 628GL capacity) and Burrinjuck Dam on the Murrumbidgee River (1 026GL capacity) the two largest.

4.1.2.2 Local Topography and Drainage

Locally, the Mine Site occupies an area of elevated topography, with Taylors Hill in the southern section of the Mine Site rising to an elevation of approximately 355m AHD (Figure 4.2). The surrounding land typically has elevations of between 200m AHD and 260m AHD.

Local drainage consists of scattered indistinct watercourses converging on Bolaro and Mirrool Creeks, approximately 4km south of the Mine Site (Figures 4.1 and 4.2). These creeks flow in a westerly direction before dissipating into flat land approximately 25km to the west of the Mine Site. The prevailing land use in the region is associated with agricultural and horticultural activity and this has led to the construction of a number of farm dams in the surrounding region that opportunistically capture overland flow for farm use.
Figure 4.1
REGIONAL TOPOGRAPHY AND DRAINAGE

Source: Narrandera 1:250,000 Topographic Map
Figure 4.2
LOCAL TOPOGRAPHY AND DRAINAGE

REFERENCE
Mine Site Boundary

SCALE 1:50 000 (A4)

Source: LPI Topographic Map 1:25 000

R.W. CORKERY & CO. PTY. LIMITED

4-5
4.1.2.3 Mine Site Topography and Drainage

Historic mining activity has significantly influenced topography and drainage features of the Mine Site (Figure 4.3). The maximum elevation is approximately 315m AHD on the Main Waste Rock Emplacement. Three open cuts exist, the Ardwest/Wild Cherry, While Crystal and Stackpool Open Cuts. The largest of these, the Ardwest/Wild Cherry Open Cut has a minimum elevation of approximately 124m AHD or approximately 150m below the natural surface. The smaller White Crystal Open cut has been partially backfilled with tailings and with a minimum elevation of 255m AHD is only 5m lower than the invert of the open cut at 260m AHD. Two Tailings Storage Facilities exist within the Mine Site, with the Main Tailings Storage Facility having a surface elevation between 310 AHD and 270m AHD.

Surface water drainage within the Mine Site is described in detail in Section 4.2.2.1.

4.1.3 Climate

4.1.3.1 Introduction and Data Sources

Meteorological conditions have the potential to influence a range of Proposal-related impacts on surrounding residences and the environment. This subsection provides a brief overview of the meteorological conditions surrounding the Mine Site; focusing particularly on those aspects of the climate that are likely to influence the potential Proposal-related environmental impacts.

Climate data has been sourced from the following Bureau of Meteorology (BoM) weather stations.

- Ardlethan Post Station (BoM ID 074000), situated approximately 5km southeast of the Mine Site – 1909 to present. Temperature data for this station is not continuous after 1975.
- Yanco Agricultural Institute (BoM ID 074037) – situated approximately 55km southwest of the Mine Site.
- Temora Research Station (BoM ID 073038) – situated approximately 65km southeast of the Mine Site.

Climate data sourced from the above stations is presented in Table 4.1.

4.1.3.2 Temperature

January is typically the hottest month, with an average maximum temperature of 33.8°C. July is the coldest month with a mean maximum temperature of 14.3°C and a mean minimum temperature of 5.0°C.
Section 4 – Assessment and Management of Ardlethan Tin Mine
Key Environmental Issues

Figure 4.3
MINE SITE TOPOGRAPHY AND DRAINAGE

REFERENCE
- Mine Site Boundary
- Existing Track
- Site Access Road
- Perimeter Drain
- Watercourse/Drainage Line
- Catchment Boundary
- Mines Water Storage
- Drainage Direction / Overland Flow
- Mill Reclaim Dam Pipeline (indicative only)

SCALE 1:20 000 (A4)

200 0 200 400 600 800 1000 m

Base Photo Source: Google Earth (11 July 2015)
### 4.1.3.3 Rainfall

Rainfall data has been recorded at the Ardlethan Post Office since 1909. Mean annual rainfall is 486.8mm, with rainfall evenly distributed throughout the year ranging between 43.9mm and 35.5mm falling on average each month (Table 4.1). The driest year on record was 1967 when 184.9mm of rain was recorded. By contrast, the wettest year on record was 1956 when 863.9mm of rain was recorded.

The maximum daily rainfall recorded is 122.9mm which was recorded on 17 February 1928. Maximum daily rainfall exceeds monthly average rainfall for all months, with the exception of August, indicating that high intensity storms with significant rainfall over a relatively short duration may occur, particularly in the summer months.

### 4.1.3.4 Evaporation

Mean evaporation at the Temora Research Station throughout the year is 4.5mm per day or 1642mm per year. Mean daily evaporation varies between 1.2mm per day in June and 8.7mm per day in January. Based on the mean daily evaporation, the calculated mean monthly pan evaporation is greater than mean monthly rainfall in all months with the exception of June.

### 4.1.3.5 Wind Speed and Direction

Pacific Environment Limited (PEL) (2016) reviewed local wind data sources and established that limited information was available close to the Mine Site. In the absence of this data, PEL (2016) generated wind data using The Air Pollution Model (TAPM), a three dimensional meteorological and air pollution modelling code developed by the CSIRO.

The annual and seasonal wind roses compiled by TAPM for the local setting are presented as representative wind roses on Figure 4.4. In summary, winds on an annual basis are predominantly from the southwest and the northeast. Seasonally, winds from the southwest feature during autumn and winter whilst in summer, winds from the northeast prevail in summer with spring generally reflecting the annual pattern. The annual average wind speed generated from TAPM was estimated to be approximately 3.3m/s.
Figure 4.4
TAPM - GENERATED WIND ROSES

Source: PEL (2016) - Figure 5.1
4.1.4 Regional and Mine Site Geology

The following description of the regional and Mine Site geology has been drawn from Pitt and Sherry (2016).

The Mine Site is in the western section of the Lachlan Fold Belt[1] within the Wagga Anticlinorial Zone. The oldest rocks are Upper Ordovician clastic sedimentary rocks which have been tightly folded in a north to north-northwest trend, and undergone low-grade regional metamorphism.

The Upper Ordovician sediments have been intruded by two types of Upper granitic rocks, namely:

- the Kikoira or Mine Granite (approximately 417 million years old); and
- the Ardlethan Granite (approximately 410 million years old) (Figure 4.5).

During the Quaternary and Tertiary Periods, erosion produced cassiterite-bearing alluvial deposits emanating from the subdued uplands around the mine site.

4.1.5 Land Ownership, Residences and Land Use

4.1.5.1 Land Ownership

Figure 4.6 presents the existing land ownership and residences surrounding the Mine Site. In summary, land within the Mine Site is largely owned by the Applicant, with small sections of land being Crown Land or road reserves and land owned by BJ, RJ and JC Rush and NG and KC Morris.

4.1.5.2 Residences

Sensitive receivers, such as residences have been identified surrounding the Mine Site (Figure 4.6) and classified as being occupied, unoccupied or uninhabitable.

Table 4.2 identifies the residence identifiers used in this report, the property name and registered landowner.

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Property</th>
<th>Landowner</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Clonmel</td>
<td>B.J, R.J and J.C Rush</td>
</tr>
<tr>
<td>R2</td>
<td>Bungalong</td>
<td>N.G and K.C Morris</td>
</tr>
<tr>
<td>R3</td>
<td>Glenmore</td>
<td>B.J, R.J and J.C Rush</td>
</tr>
<tr>
<td>R4</td>
<td>Coop-I-Noo</td>
<td>B.D Rayment</td>
</tr>
<tr>
<td>R5</td>
<td>Berwick Farm</td>
<td>B Jarema</td>
</tr>
<tr>
<td>R6</td>
<td>Spring Valley</td>
<td>W.S and B.J Wood</td>
</tr>
<tr>
<td>R7</td>
<td>Brooklyn</td>
<td>Estate of L.W Spencer</td>
</tr>
<tr>
<td>R8</td>
<td>Mona Leigh</td>
<td>G Carney</td>
</tr>
<tr>
<td>R9</td>
<td>Hillview</td>
<td>B Jarema</td>
</tr>
</tbody>
</table>

[1] The Lachlan Fold Belt or Geosyncline is a large geological terrain stretching from Tasmania to Queensland along the eastern portion of the Australian continent. It is composed of folded and faulted rocks of Middle Palaeozoic age (450 to 340 million years ago)
ENVIRONMENTAL IMPACT STATEMENT
Section 4 – Assessment and Management of Ardlethan Tin Mine
Key Environmental Issues

Key Environmental Issues
Report No. 754/08


Source: Pitt and Sherry (2016) – Figure 3

Figure 4.5
REGIONAL GEOLOGY
Figure 4.6

LAND OWNERSHIP AND RESIDENCES

<table>
<thead>
<tr>
<th>Ref</th>
<th>Landowner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EOE (No.75) Pty Limited</td>
</tr>
<tr>
<td>2</td>
<td>Crown Land</td>
</tr>
<tr>
<td>3</td>
<td>BJ, RJ &amp; JC Rush</td>
</tr>
<tr>
<td>4</td>
<td>NG &amp; KC Morris</td>
</tr>
<tr>
<td>5</td>
<td>B Jarema</td>
</tr>
<tr>
<td>6</td>
<td>WS &amp; BJ Wood</td>
</tr>
<tr>
<td>7</td>
<td>BD Rayment</td>
</tr>
<tr>
<td>8</td>
<td>PA, FR, ML &amp; RJ Doyle</td>
</tr>
<tr>
<td>9</td>
<td>Graincorp Operations Limited</td>
</tr>
<tr>
<td>10</td>
<td>Emerald Grain</td>
</tr>
<tr>
<td>11</td>
<td>Prospectors Pty Limited*</td>
</tr>
</tbody>
</table>
Land uses surrounding the Project Site include the following (Figure 4.7).

- **Agriculture** – principally grazing and cropping and some areas of rural residential (Zone RU4) to the south and east of the Mine Site.
- **Village residential** – the Ardlethan village is located approximately 5km to the southeast of the Mine Site.
- **Transport** – Road and railway infrastructure exist in the vicinity of the Mine Site, with the Newell Highway and Burley Griffin Way and the Temora – Hilston Railway to the south and east of the Mine Site.

A bulk grain handling and rail loading facility operated by Graincorp Operations Limited is located approximately 4km southeast of the Mine Site.

### SURFACE WATER

#### Introduction

The SEARs require the EIS to include an assessment of the potential impacts of the Proposal on water which include the following requirements relevant to the assessment of surface water resources:

- an annual site water balance for representative years over the life of the development and demonstration that sufficient water supplies would be available to meet operational requirements;
- identification of any licensing requirements or other approvals required;
- an assessment of activities that could cause erosion or sedimentation issues, and the proposed measures to prevent or control these impacts;
- an assessment of the likely impacts of the development on the quality and quantity of surface water resources;
- a description of the proposed water management system, water monitoring program and other measures to mitigate surface water impacts and
- an assessment of the likely impacts of the potential downstream impacts from surface water runoff.

DPI – Water and EPA also identified water related matters for consideration within the EIS. The SEARs and requirements of DPI – Water and EPA are included in full as Appendix 2.

A surface water impact assessment for the Proposal has been undertaken by RW Corkery & Co Pty Limited. The full report is presented as Appendix 4 and is hereafter referred to as RWC (2016). This subsection provides an overview of the existing surface water environment, licencing issues and potential surface water impacts, management and mitigation measures that would be implemented and an assessment of the adequacy of existing site infrastructure to contain sediment-laden or contaminated surface water on site. Section 2.7 presents an overview of the results of the water balance presented in RWC (2016).
Figure 4.7
SURROUNDING LAND USES AND ZONING

REFERENCE
- Mine Site Boundary
- Land Use Zoning
  - RU1
  - RU3
  - RU4
  - RU5
  - SP2
  - Primary Production
  - Forestry
  - Primary Production Small Lots
  - Village
  - Infrastructure

SCALE 1:100 000 (A4)

Base Photo Source: Google Earth (11 July 2015)
4.2.2 Existing Surface Water Environment

4.2.2.1 Drainage and Catchments

Regional, local and Mine Site drainage is described in Section 4.1.2 and Figures 4.1, 4.2 and 4.3. In summary, the Mine Site is located within the Mirrool Creek catchment of the Murrumbidgee River. Historic site water management infrastructure has created a number of catchments on the Mine Site that drain to internal water storages or open cuts, capturing all runoff generated on disturbed catchments. The Mine Site catchments include the following.

- Spring Valley Freshwater Dam: Situated in the southwestern section of the Mine Site. This catchment collects runoff from Spring Valley tailings storage facility and naturally vegetated granite hills via overland flow.
- Mill Reclalm Dam: Centrally located within the Mine Site. This catchment collects runoff from Main, Lower and Horseshoe Tailings Storage Facilities as well as the former processing plant area via overland flow and pipes. Captured runoff is collected in the dam and discharged under gravity to the Ardwest/Wild Cherry Open Cut via pipe.
- Processing Plant Area Catchment: Situated in the eastern section of the Mine Site. This catchment collects runoff from the area surrounding the proposed processing plant area.
- Ardwest/Wild Cherry Open Cut: Located in the central north section of the Mine Site. This catchment collects runoff from cleared areas and the southern face of the Main Waste Rock Emplacement via overland flow. Captured runoff and direct rainfall is stored in the Ardwest/Wild Cherry Open Cut.
- White Crystal Open Cut: Located in the eastern section of the Mine Site. This catchment collects runoff from a waste rock emplacement and former open cut via overland flow.
- Stackpool Open Cut: Located in the eastern section of the Mine Site. This catchment collects runoff from a waste rock emplacement and naturally vegetated areas via overland flow. Runoff is directed to Stackpool Open Cut via perimeter drain and overland flow.
- Eastern Evaporation Ponds: Located in the northeastern section of the Mine Site. This catchment collects runoff from a waste rock emplacement and cleared area via overland flow. Runoff directed to evaporation ponds for natural attenuation.
- Northern Evaporation Ponds: Located in the northern section of the Mine Site. This catchment collects runoff from a waste rock emplacement and cleared area via overland flow and open channel. Runoff directed to sequential evaporation ponds for natural attenuation.

4.2.2.2 Water Quality

Water quality data collected at DPI-Water monitoring station 4100093 (Old Man Creek) 64km south of the Mine Site (Figure 4.1) was reviewed to establish likely water quality in Murrumbidgee River tributaries similar to Bolaro and Mirrool Creeks. In summary, data from
that station for the period 22 July 1976 to 30 November 2016 indicated that the 75th percentile electrical conductivity is 212$\mu$S/cm. This is within the desired range of the water quality objective (35$\mu$S/cm to 350$\mu$S/cm) for uncontrolled streams in the Murrumbidgee River and Lake George catchment (DECCW, 2006).

**Table 4.3** presents the results of the most recent monitoring of water quality within the Mine Site undertaken on 5 July 2016. In summary, surface water quality within the Mine Site, in areas influenced by prior mining operations, is poor, with a very low pH and moderate to elevated conductivity.

<table>
<thead>
<tr>
<th>Storage</th>
<th>pH</th>
<th>Electrical Conductivity ($\mu$S/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Valley Freshwater Dam</td>
<td>3.1</td>
<td>2 300</td>
</tr>
<tr>
<td>Mill Reclalm Dam</td>
<td>2.8</td>
<td>2 400</td>
</tr>
<tr>
<td>Ardwest/Wild Cherry Open Cut</td>
<td>3.4</td>
<td>5 300</td>
</tr>
<tr>
<td>Stackpool Open Cut</td>
<td>2.9</td>
<td>2 100</td>
</tr>
</tbody>
</table>

Source: EOE (No.75) Pty Limited

### 4.2.2.3 Flooding

The Mine Site is situated at an elevation well above that considered at risk of flooding.

### 4.2.3 Water Licensing

Clause 3 of Schedule 1 of the *Water Management (General) Regulation 2011* (WM Regulation) identify that;

“Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority to prevent the contamination of a water source, that are located on a minor stream”.

As a result, taking into consideration the contaminated nature of surface water within the Mine Site water storages, the management of runoff generated within the Mine Site does not require an approval or licence under the *Water Management Act 2000* as the site water management infrastructure may be considered to be an “Excluded Work.”

The Applicant will, however require a water supply work and water access licence under the *Water Management Act 2000* for supplementary supply of makeup water as described in Section 2.7.4.7. Those licences would be secured through purchase of appropriate entitlements under the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012*, with that water to be transferred to the Mine Site via the existing Grong Grong Pipeline. The Applicant would ensure that the required entitlements are obtained prior to increasing the proposed production rate above 120tpa or 1Mtpa. In the event that makeup water is required at production rates below this level, the Applicant would either source the required entitlement or would reduce production rates to that required to ensure that all water requirements can be met by existing, onsite supplies.
4.2.4 Potential Impacts

The potential sources of water pollution from the activities within the Mine Site would be as follows.

- Runoff from Tailings Storage Facilities.
- Runoff from historically disturbed catchments.
- Runoff from tailings stockpiled for reprocessing.
- Runoff from roads and hardstand surfaces.
- Surface runoff from rehabilitated areas prior to full stabilisation.
- Leakage or spillage of hydrocarbons.

As identified in Section 4.2.2.2 surface water from disturbed sections of the Mine Site typically has a low pH and moderate electrical conductivity. These waters may also contain suspended sediment. As a result, discharge of these waters is likely to be the major source of surface water pollution arising from the Proposal.

4.2.5 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to minimise the potential for offsite discharge of surface water.

- Ensure that during operations, existing surface water controls, including perimeter drains and pipes and inlets are inspected monthly and following significant rain events (>10mm in 24 hours) and maintained as required to ensure that the hydraulic performance of the site water management system is maintained.
- Ensure that water levels within the Spring Valley Fresh Water Dam are kept as low as possible to minimise the potential for discharge and to minimise the surface area available for evaporation.
- Ensure that the inlet for the transfer pipeline from the Mill Reclaim Dam to the Ardwest/Wild Cherry Open Cut is kept clear of debris and that flow into the pipeline is not restricted.
- Ensure that rehabilitated areas are removed from the contaminated water circuit once monitoring indicates that surface water runoff is suitable for discharge to natural drainage.
- Prepare and implement a Water Management Plan describing the management and mitigation measures and monitoring to be implemented to ensure that sediment-laden and contaminated water is retained on site.

4.2.6 Assessment of Impacts

As described in Section 4.2.2.1, all potentially sediment-laden and contaminated water is captured on site and directed to either the Spring Valley Fresh Water Dam or the Ardwest/Wild Cherry or Stackpool Open Cuts. The Applicant is not aware of any potentially sediment-laden...
or contaminated water being discharged from the Mine Site. RWC (2016) presents assessment of the hydraulic performance of the existing Mine Site water management infrastructure in response to a 1% Annual Exceedance Probability (AEP) rainfall event. In summary, that assessment relied on the following empirical methods.

- Open Channel Capacity: Manning’s formula.
- Pipe Capacity: Hazen-Williams equation.

That assessment determined the following.

- Spring Valley Catchment - The Spring Valley Fresh Water Dam has adequate capacity to store a 1% AEP rainfall event without discharging.
- Mill Reclalm Catchment – the Mill Reclalm Dam and associated discharge pipe to the Ardwest/Wild Cherry Open Cut have sufficient capacity to retain and transfer all surface water from a 1% AEP rainfall event from this catchment to the Ardwest/Wild Cherry Open Cut.
- Ardwest/Wild Cherry Open Cut Catchment – the Ardwest/Wild Cherry Open Cut has adequate capacity to store a 1% AEP rainfall event from the Mill Reclalm and Stackpool Catchments, as well rainfall within the open cut catchment, including once the open cut has been filled with tailings.
- Stackpool Open Cut Catchment – The Stackpool contaminated water channel has adequate capacity to transfer water from a 1% AEP rainfall event to the Stackpool Open Cut.

As a result, RWC (2016) concludes that the Mine Site infrastructure is adequate to retain all potentially sediment-laden and contaminated water up to a 1% AEP rainfall event within the Mine Site until the footprints of the tailings storage facilities have been rehabilitated and surface water flows can be directed off site.

4.2.7 Monitoring

The Applicant would undertake monitoring of pH, electrical conductivity and water levels within the following water storages.

- Spring Valley Fresh Water Dam.
- Mill Reclalm Dam.
- Processing Plant Detention Pond.
- Ardwest/Wild Cherry Open Cut.
- Stackpool Open Cut.

Monitoring would be undertaken monthly during operations using a hand held meter. The results of the monitoring program would be included in internal monthly reporting and in Annual Reviews/Reports. The Annual Reviews/Reports would once accepted by the relevant government agencies, be published on the Applicant’s website.
4.3 GROUNDWATER

4.3.1 Introduction

The SEARs require the EIS to include an assessment of the potential impacts of the Proposal on water which include the following requirements relevant to the assessment of groundwater resources:

- identification of any licensing requirements or other approvals required
- an assessment of the likely impacts of the development on the quality and quantity of groundwater resources; and
- a description of the proposed water management system, water monitoring program and other measures to mitigate groundwater impacts.

As noted in Section 3.2.1.2, DPI – Water and EPA also identified water related matters for consideration within the EIS. The SEARs and requirements of DPI – Water and EPA are included in full as Appendix 2.

Pitt and Sherry (Operations) Pty Ltd (Pitt and Sherry) have prepared a groundwater impact assessment for the Proposal. The resulting report, referred to hereafter as Pitt and Sherry (2016), is presented as Part 1 of the Specialist Consultant Studies Compendium. The following sub-sections consider the existing groundwater environment, the proposed groundwater bores, proposed management and mitigation measures and present an assessment of groundwater-related impacts.

4.3.2 Existing Groundwater Environment

4.3.2.1 Introduction

Geologically, the Mine Site is situated within the Wagga Anticlinorial Zone of the Lachlan Fold Belt which is comprised (in part) of tightly folded clastic sedimentary rocks that have undergone low-grade regional metamorphism (Paterson, 1990). The groundwater resources in the vicinity of the Mine Site are covered by the Water Sharing Plan Murray-Darling Basin Fractured Rock Groundwater Sources: Lachlan Fold Belt Groundwater Source 2012.

4.3.2.2 Regional Groundwater System

Pitt and Sherry (2016) conducted a search of the Department of Primary Industries – Water Registered Groundwater Bore database in September 2016 for bores surrounding the Mine Site. That search revealed 40 registered groundwater bores within a 1,000km² area centred on the Mine Site, of which 13 occur within 10km of the Mine Site (Figure 4.8). A review of pertinent information relating to the bores indicated the following

- The average total depth is 79m (range: 8m to 218m).
- The underlying geology varied, and included limestone, granite and unconsolidated sediments.
- Limited groundwater occurrence was recorded (18 or 45% of the 40 bores registered).
Figure 4.8
Registered Bores in the Vicinity of the Mine Site

REFERENCE
- Mine Site Boundary
- Highest Known Yield (5 L/s)
- Registered Groundwater Bore
- Registered Groundwater Bore (Monitoring)

INSET

Scale

Source: Ardelethan 1:100,000 Topographic Map
- The average reported standing water level in 16 of the 18 bores was 55m below ground (mbg) and ranged from 3mbg to 72mbg. The remaining two bores did not have a reported standing water level.

- Bore yields averaged 0.7L/s (range 0.01L/s to 5L/s). Only one bore yield exceeded 1.5L/s, namely GW416109 with a recorded yield of 5L/s (Figure 4.8), and if this outlier is excluded from the data, the average yield is 0.4L/s.

- Of the five registered bores within 4km of the Mine Site, four have casing diameters of 50mm, indicating that they are monitoring bores, and one, GW000462, has had the casing withdrawn. As a result, there are no known groundwater users within a radius of at least 4km of the Mine Site.

Pitt and Sherry (2016) indicated that, based on the review of the regional groundwater bore inventory, the regional groundwater system is typically an unconfined fractured rock system overlain in part by unconsolidated alluvial aquifers. The reviewed low groundwater yields, coupled with the paucity of groundwater bores over a wide area suggests low groundwater prospectivity in the region.

4.3.2.3 Mine Site Groundwater System

Pitt and Sherry (2016) reviewed historical mine documents, environmental and geotechnical investigations. The following observations of relevance to the groundwater impact assessment were made.

- During open cut and underground mining, no major aquifers were encountered.
- Groundwater was not recorded during production drilling within the Ardwest/Wild Cherry Open Cut.
- Water pumped from the underground workings averaged less than 2L/s.
- Areas exposed by mining such as the open cut wall remained dry for the life of the mine.
- Blasting of wall rocks had no observable effect on water inflow into the open cuts.
- The results of falling head permeability tests conducted on 11 bores within the Mine Site (BH01 to BH09, P581 and P585 – Figure 4.9) returned permeabilities between $5 \times 10^{-10}$ m/s to $4 \times 10^{-9}$ m/s, with a geometric mean of $1 \times 10^{-9}$ m/s. It is noted that many of these bores tested were situated downgradient of water storage or collection dams within the Mine Site.

4.3.2.4 Groundwater Quality

Regional Groundwater Quality

Pitt and Sherry (2016) indicated that, based on the review of the regional groundwater bore inventory, the groundwater quality was variable with Total Dissolved Solids (TDS) ranging between 1 000mg/L and 14 000mg/L. It is noted however, that water quality information was available for only 4 out of the total of 40 groundwater bore records reviewed.
Figure 4.9
HISTORIC AND CURRENT MINE SITE GROUNDWATER MONITORING BORES
Mine Site Groundwater Quality

Pitt and Sherry (2016) reviewed historic groundwater quality monitoring data from the Mine Site collected between 1995 and 2011, as well as data collected in November 2016 which included sampling of the pit lake in the Ardwest/Wild Cherry Open Cut. That data indicated the following (Table 4.4).

- pH of groundwater in all bore holes was near neutral. However, pH of water within the Ardwest/Wild Cherry Open Cut was strongly acidic.

- The salinity of groundwater in BH1, BH5, BH9 and the Ardwest/Wild Cherry Open Cut was elevated with the salinity of water in BH9 increasing markedly, potentially reflecting the fact that this bore is associated with the Northern Evaporation Ponds.

- Groundwater sampled in BH9 (sodium chloride), near the Northern evaporation ponds exhibits a different chemical signature (major ion chemistry) to BH1 (sodium sulphate) and the Ardwest/Wild Cherry Open Cut (sodium, magnesium, sulphate and chloride) which may indicate a lack of connectivity with the Ardwest/Wild Cherry Open Cut.

<table>
<thead>
<tr>
<th>Groundwater Monitoring Bore ID</th>
<th>pH 1995</th>
<th>pH 2016</th>
<th>Total Dissolved Solids (mg/L) 1995</th>
<th>Total Dissolved Solids (mg/L) 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH 1</td>
<td>No data</td>
<td>6.7</td>
<td>No data</td>
<td>6 100</td>
</tr>
<tr>
<td>BH 3</td>
<td>7.4</td>
<td>No data</td>
<td>1 060</td>
<td>No data</td>
</tr>
<tr>
<td>BH 5</td>
<td>7.4</td>
<td>6.2</td>
<td>3 240</td>
<td>7 000</td>
</tr>
<tr>
<td>BH 9</td>
<td>7.1</td>
<td>5.9</td>
<td>1 290</td>
<td>21 000</td>
</tr>
<tr>
<td>Ardwest/Wild Cherry Open Cut</td>
<td>No data</td>
<td>3.1</td>
<td>No data</td>
<td>4 200</td>
</tr>
</tbody>
</table>

Source: Pitt and Sherry (2016) – after Tables 2 and 4

4.3.2.5 Surface Water and Groundwater Interaction

The main zone of interaction between surface water and groundwater with the Mine Site is the Ardwest/Wild Cherry Open Cut. Pitt and Sherry (2016) applied steady-state analytical equations (Marinelli and Niccoli, 2000) to estimate groundwater flow to the Ardwest/Wild Cherry Open Cut that indicated that the Ardwest/Wild Cherry Open Cut is a groundwater discharge zone on the local scale. Groundwater is flowing towards the Ardwest/Wild Cherry Open Cut from all directions. The steady-state calculations indicate that approximately 20ML/year of groundwater enters the Ardwest/Wild Cherry Open Cut. Figure 4.10 displays a cross section illustrating the conceptual hydrogeological model developed by Pitt and Sherry (2016).
Figure 4.10 Conceptual Hydrogeological Cross Section

Source: Pitt & Sherry (2016) - after Figure 13
4.3.2.6 Classification Under the Aquifer Interference Policy

Based on the above, Pitt and Sherry (2016) note that:

- groundwater quality measurements indicate that total dissolved solids in the vicinity of the Mine Site are greater than 1500mg/L; and,
- there are no groundwater registered supply works yielding water at a flow rate greater than 5L/second.

As a result, and in accordance with the Aquifer Interference Policy 2012 (AIP), Pitt and Sherry (2016) classified the groundwater source in the Mine Site as being a less productive porous or fractured rock aquifer.

4.3.3 Assessment Methodology

4.3.3.1 Introduction

Pitt and Sherry (2016) undertook an assessment of groundwater-related impacts associated with the Proposal as follows.

- A conceptual model of groundwater processes within the Mine Site was established based on available groundwater and geochemical data.
- An analytical model was used to quantify groundwater impacts within the Mine Site.

This subsection provides an overview of each of the above assessment methodologies.

4.3.3.2 Conceptual Model

In order to facilitate an assessment of the anticipated groundwater-related impacts associated with the Proposal, Pitt and Sherry (2016) developed a conceptual hydrogeological model based on the information reviewed (Figure 4.10). The main features of the groundwater system that were identified from this model were as follows.

- The Mine Site is situated on elevated, undulating and locally disturbed topographic high, and surrounded by a gently undulating to flat plain.
- Groundwater on the Mine Site is contained within a single unconfined, fractured rock aquifer.
- Unconfined alluvial aquifers are located in the surrounding plains to the southeast, east and northeast of the topographic high.
- Regional-scale groundwater flow occurs beneath the topographic high from the northeast to the southwest.
- Intermediate-scale groundwater flow radiates in all directions from the topographic high, but at very low rates of movement in bedrock due to very low fracture permeability.
Local-scale groundwater occurs with variable flow directions, except in the vicinity of the Ardwest/Wild Cherry Open Cut, where groundwater enters from all horizontal directions with a radius of influence of approximately 350m.

The water surface of the Ardwest/Wild Cherry Open Cut forms a groundwater outflow zone; which would ordinarily constitute conditions supporting a groundwater dependent ecosystem (GDE), except that there are no known GDE to support within the pit lake. All other discharge areas are considered to be localised.

### 4.3.3.3 Numerical Model

Pitt and Sherry (2016) developed a regional and intermediate scale numerical groundwater flow model based on water level data in two bores north and south of the Mine Site, namely GW4022126 and GW0000720 (refer Figure 4.8), and water level records of five bores drilled within the Mine Site in 1995, namely BH 3, BH 5, BH 6, BH 7, and BH 9 (Figure 4.9). The model indicated that groundwater flow directions are from the northeast to the southwest whilst at the local to intermediate scale, flow direction varied. The model also indicated that groundwater flow rates also varied, from very low rates over most of the modelled area, to higher rates on lower, flatter ground. The low flow rates are caused by very low permeability fractured bedrock, whilst the high flow rates were influenced by higher permeability unconsolidated alluvial materials.

### 4.3.3.4 Analytical Model

Pitt and Sherry (2016) used an analytical model developed by Marinelli and Niccoli (2000) to estimate the potential groundwater impacts of the Proposal. That analytical model is presented in detail in Section 5.9 of Pitt and Sherry (2016). In summary, the Marinelli and Niccoli model assumes the following.

- The proposed open cuts are approximated as a cylinder.
- Groundwater flow is horizontal.
- The water table is approximately horizontal.
- Uniform distributed recharge occurs as a result of surface infiltration from rainfall; all recharge within the radius of influence (cone of depression), of the excavation is assumed to be captured by the excavation.
- Groundwater flow toward the excavation is axially symmetric.
- The aquifer is infinite in extent (i.e. the cone of depression does not encounter any zero recharge boundaries).

### 4.3.4 Management and Mitigation Measures

The Applicant would implement following management and mitigation measures to minimise the potential for groundwater-related impacts.

- Ensure that the volumes of water pumped through the process water circuit and decant return system are monitored and recorded to inform volumetric calculations.
- Ensure that standing water levels in surrounding monitoring bores and the pit lake are monitored monthly.

- Store all hydrocarbon and chemical products within a bunded area in accordance with AS1940 – The storage and handling of flammable and combustible liquids.

- Ensure that Material Safety Data Sheets and appropriate spill management equipment is available in the vicinity of all chemical storage areas.

- Develop and implement a management plan for the storage and handling of fuels throughout the life of the Project.

- Ensure all relevant personnel are provided with appropriate training in proper handling techniques for hydrocarbon and chemical products.

- Secure the necessary licences and volume of water under the Water Sharing Plan Murray-Darling Basin Fractured Rock Groundwater Sources: Lachlan Fold Belt Groundwater Source 2012 to account for groundwater inflows to the Ardwest/Wild Cherry Open Cut.

- Prepare and implement a Water Management Plan describing the management and mitigation measures and monitoring to be implemented to ensure that groundwater resources are appropriately monitored and groundwater discharge, if it occurs, is measured and appropriate mitigation measures are implemented.

4.3.5 Assessment of Impacts

4.3.5.1 Introduction

A detailed assessment of groundwater impacts was undertaken by Pitt and Sherry (2016) and is presented in Sections 6 and 7 of Pitt and Sherry (2016). The following subsections present a summary of those impacts.

4.3.5.2 Water Table Impacts

Water for reprocessing the tailings would be taken from the Ardwest/Wild Cherry Open Cut. The removed water, with the addition of reprocessed tailings and any makeup water added to the processing stream, would be returned to the Ardwest/Wild Cherry Open Cut in essentially a closed circuit.

In the Ardwest/Wild Cherry Open Cut, the added tailings would increase the water level in the open cut. The increased water level would result in a decreasing rate of groundwater discharge into the Ardwest/Wild Cherry Open Cut. Whilst ever the water level within the open cut remains below the pre-mining groundwater level, the Ardwest/Wild Cherry Open Cut would remain a groundwater inflow zone.

Table 4.5 presents the results of modelling of water levels within the Ardwest/Wild Cherry Open Cut throughout the life of the Proposal. In summary, Pitt and Sherry (2016) determined that the water level within the open cut would be expected to remain below the level of the pre-existing groundwater level until the end of Year 11, at which time, depending on the settled density of the tailings, the water level would be likely to be similar to the level of the pre-existing groundwater level.
Table 4.5
Groundwater Level and Flow Modelling Results

<table>
<thead>
<tr>
<th></th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Tailings reprocessed (Mt)</td>
<td>0.25</td>
</tr>
<tr>
<td>Cumulative tailings reprocessed (Mt)</td>
<td>0.25</td>
</tr>
<tr>
<td>Volume of tailings reprocessed (1 000m³)</td>
<td>150</td>
</tr>
<tr>
<td>Cumulative volume of tailings reprocessed (1 000m³)</td>
<td>140</td>
</tr>
<tr>
<td>Surface area of lake (1 000m²)</td>
<td>47</td>
</tr>
<tr>
<td>Water level (m AHD) at end of year (less evaporation)</td>
<td>191</td>
</tr>
<tr>
<td>Freeboard (m) remaining in excavation</td>
<td>69</td>
</tr>
<tr>
<td>Head difference (m) driving water inflow to Open Cut</td>
<td>69</td>
</tr>
<tr>
<td>Groundwater entering Open Cut based on above input assumptions?</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Source: Pitt and Sherry (2016) – After Table 9

In the event that the water level within the open cut increased above the level of the pre-mining groundwater table, Pitt and Sherry (2016) note that the hydraulic gradient would be reversed. However, Pitt and Sherry (2016) also note that the zone of influence of the open cut is approximately 350m and that groundwater inflows are limited, indicating limited pit flows in the event of a reversal of the groundwater gradient. Accordingly, Pitt and Sherry (2016) concluded that no measures are necessary to protect groundwater conditions outside the radius of influence before, during and after reprocessing operations.

The closest non-Proposal related bore located downgradient of the Mine Site (GW031241) is approximately 7km from the Ardwest/Wild Cherry Open Cut and the closest high priority groundwater dependent ecosystem is more than 40km from the Mine Site. As a result, no impacts on non-Proposal related groundwater users are anticipated.

In light of the above, Pitt and Sherry (2016) state that the Proposal falls within Level 1 Minimal Impact Considerations (water levels) under the AIP.

4.3.5.3 Water Pressure Impacts

Pitt and Sherry (2016) conducted a review of available regional bore data (refer Section 4.3.2.1) which established that no active production bores were situated within at least 4km of the Mine Site.

Pitt and Sherry concluded that, given that the potential area of groundwater impact is restricted to a radius of influence of approximately 350m and, in the absence of any recorded beneficial use, the Proposal falls within Level 1 Minimal Impact Considerations (water pressure) under the AIP.
4.3.5.4 Water Quality Impacts

Pitt and Sherry (2016) identified the Ardwest/Wild Cherry Open as currently being a groundwater inflow zone, with groundwater entering from all sides. On the basis that operations will retain water in the Ardwest/Wild Cherry Open Cut, and that on balance no nett water leaves the excavation other than via evaporation, Pitt and Sherry (2016) considered it unlikely that chemical changes to the contained water would be environmentally significant.

Pitt and Sherry (2016) concluded that the Proposal falls within Level 1 Minimal Impact Considerations (water quality) under the AIP.

4.3.5.5 Groundwater Inflows

Pitt and Sherry (2016) identified the Ardwest/Wild Cherry Open Cut as a groundwater discharge zone on a local scale that currently receives approximately 20ML/year of groundwater inflows. The Applicant would secure the necessary allocations and licences to account for this water under the relevant Water Sharing Plan. It is noted that, groundwater inflows to the Ardwest/Wild Cherry Open Cut can be expected to reduce over the life of the Proposal as the void space in the open cut is reduced as a result of reprocessing operations.

4.3.6 Monitoring

The Applicant would monitor the groundwater levels, pH and electrical conductivity in the vicinity of the Ardwest/Wild Cherry Open Cut and the standing water levels of the Ardwest/Wild Cherry Open Cut monthly. Should an unexpected change in standing water levels or water quality be detected, the advice of a suitably qualified hydrogeologist would be sought.

4.4 AIR QUALITY

4.4.1 Introduction

The SEARs require the EIS to include an assessment of the likely air quality impacts in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC, 2005).

The SEARs requested that particular attention is paid to:

“potential dust impacts on any nearby private receivers due to construction activities, the operation of the mine and/or road haulage”.

Coolamon Shire Council and the EPA also identified air quality related matters for consideration within the EIS. The SEARs and requirements of Council and the EPA are included in full as Appendix 2.

An air quality impact assessment for the Proposal has been undertaken by Pacific Environment Limited (PEL) in accordance with DEC (2005). The full report is presented as Part 2 of the Specialist Consultant Studies Compendium and is hereafter referred to as PEL (2016) and this subsection provides a summary of the methods, recommended mitigation and impacts of PEL (2016).
4.4.2 Existing Air Quality Environment

4.4.2.1 Air Emissions

Dust generation or particulate matter is the main air quality issue relevant to the Proposal. Particulate matter refers to a category of airborne particulates, typically less than 30 microns (µm) in diameter and ranging down to 0.1µm. This type of dust is termed Total Suspended Particulates (TSP).

Emissions of particulate matter less than 10µm (termed as PM$_{10}$ and PM$_{2.5}$ in the following subsections) are considered to be an important influence on human health as it has the ability to penetrate the respiratory system and cause cardiovascular and respiratory diseases, pulmonary and heart diseases, as well as reduced lung capacity.

Particles that are too large to remain in suspension in the air are referred to as ‘deposited dust’ and are typically greater than 35µm in diameter. Even though these particles lack the ability to cause significant harm to human health, they can contribute to reductions in amenity and therefore are considered as part of the air quality assessment, e.g. dust on window sills or cars.

4.4.2.2 Local Emission Sources

There are a variety of land uses within the local setting likely to generate air emissions. The principal sources of emissions in the vicinity of the Mine Site include the following.

- Land cultivation for cropping or pasture improvement.
- The movement of farm vehicles or livestock over unsealed access roads, farm tracks and areas devoid of vegetation.
- Land clearing and earthworks for industrial and commercial development.
- Vehicle movements on local roads.
- Residential wood fire emissions (for heating).
- Wind-blown dust from cleared or heavily grazed areas.

4.4.2.3 Existing Air Quality

As no air quality monitoring data is available locally, PEL (2016) has drawn from available monitoring data across western NSW to establish annual average background concentrations for airborne particulate matter and deposited dust.

- Deposited dust: 2.0g/m$^2$/month
- TSP: 40µg/m$^3$
- PM$_{10}$: 16µg/m$^3$
- PM$_{2.5}$: 7µg/m$^3$
4.4.2.4 Sensitive Receivers

Sensitive receivers in the form of existing residences in the vicinity of the Mine Site have been identified as potentially affected by dust emissions from the Proposal (refer Figure 4.6).

4.4.3 Potential Sources of Air Contaminants

Proposed activities that would generate particulate matter include the following.

- Extraction activities (excavators, front-end loaders, trucks loading and unloading).
- Material blending.
- Transfer of materials into the processing plant.
- Vehicle movements on unsealed roads.
- Rehabilitation activities (unloading and spreading of growth medium).
- Wind erosion from:
  - exposed extraction areas;
  - exposed rehabilitation areas;
  - historically disturbed areas;
  - \textit{in situ} tailings areas; and
  - soil borrow pit areas.

Pel (2016) provides an inventory of predicted dust emission from each of these sources based on various assumptions regarding emission factors, locations and periods of operation or occurrence.

4.4.4 Assessment Criteria

Table 4.6 presents the air quality assessment criteria identified by Pel (2016).

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Period</th>
<th>Criteria</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposited dust</td>
<td>Annual</td>
<td>2g/m2/month1</td>
<td>DEC (2005)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4g/m2/month2</td>
<td></td>
</tr>
<tr>
<td>TSP</td>
<td>Annual</td>
<td>90µg/m³</td>
<td></td>
</tr>
<tr>
<td>PM10</td>
<td>24-hour</td>
<td>50µg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>30µg/m³</td>
<td></td>
</tr>
<tr>
<td>PM2.5</td>
<td>24-hour</td>
<td>25µg/m³</td>
<td>Advisory reporting goal issued by the NPEC in 2016</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>8µg/m³</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Maximum increase
Note 2: Maximum total

Source: Pel (2016) – after Table 4.1 and 4.2
4.4.5 Management and Mitigation Measures

The Applicant proposes to implement management and mitigation practices that limit the generation of dust from the potential sources of air contaminants identified in Section 4.4.3.

- Ensure a water cart is operated and apply water at a rate of at least 0.4L/m²/hr (during operations) during hot and/or windy conditions. The rate of watering would be reduced as appropriate during cooler, wetter periods and ceased during and immediately following rain.
- Ensure that the compacted haul road surface is regularly watered and maintained to reduce the potential for mobilisation of wheel generated dust.
- Ensure that all vehicles travelling on internal unsealed roads are limited to a speed appropriate for the conditions and safety, i.e. less than 40km/hr.
- Ensure that care is taken to avoid spillage during loading.
- Minimise dump heights from trucks and front-end loaders.
- Implement a complaints management system to ensure that all complaints are dealt with through investigation and implementation of corrective treatments.

4.4.6 Assessment Methodology

The overall approach to the assessment undertaken by PEL (2016) follows the published guidelines for the assessment of air pollution sources using dispersal methods (DEC 2005). DEC (2005) specifies how assessments based on the use of atmospheric dispersion models should be completed.

The proposed operations were analysed and estimates of dust emissions for the key dust generating activities made by PEL (2016). Emission factors developed both in Australia, and by the US EPA, were applied to estimate the amount of dust produced by each activity. The emission factors applied are considered to be the most reliable, contemporary methods for determining dust generation rates.

The proposed development sequence of the Proposal was analysed and a detailed dust emissions inventory was developed by PEL (2016) for the worst-case operational scenario. This scenario is representative of Stage 2 of the extraction sequence (refer Section 2.3.3) with the operational locations shown on Figure 4.11 and details on the sources of dust generation presented in Table 4.7.

The dispersion modelling code “AERMOD” was selected as the most suitable model due to the source types, location of the nearest receivers and the nature of the local topography. AERMOD generates predictive TSP, PM₁₀ and PM₂.₅ concentrations and dust deposition rates, both the incremental increase, directly attributable to the Proposal and cumulative, using the existing air quality information presented in Section 4.4.2.3.

To assess the impact of the Proposal, the incremental contribution of dust, TSP, PM₁₀ and PM₂.₅ predicted at each representative residence was compared against the air quality assessment criteria nominated in Section 4.4.4.
Figure 4.11
AIR QUALITY MODEL SCENARIO
Table 4.7
Air Quality Model Scenario

<table>
<thead>
<tr>
<th>Domain Area</th>
<th>Dust Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Loading, unloading, stockpiling and mixing of tailings material</td>
</tr>
<tr>
<td>2</td>
<td>Placement of material during rehabilitation activities</td>
</tr>
<tr>
<td>3</td>
<td>Tailings extraction operations</td>
</tr>
<tr>
<td>4A</td>
<td>Exposed tailings (in situ)</td>
</tr>
<tr>
<td>4B</td>
<td>Exposed tailings (in situ)</td>
</tr>
<tr>
<td>5A</td>
<td>Exposed area as a result of historic disturbance</td>
</tr>
<tr>
<td>5B</td>
<td>Exposed area as a result of historic disturbance</td>
</tr>
<tr>
<td>6</td>
<td>Extraction of growth medium</td>
</tr>
<tr>
<td>7</td>
<td>Reprocessed tailings deposition area</td>
</tr>
<tr>
<td>8</td>
<td>Unprocessed tailings deposition area</td>
</tr>
</tbody>
</table>

4.4.7 Assessment of Impacts

4.4.7.1 Annual Averages

Table 4.8 summarises the annual average predicted particulate matter and deposited dust concentrations at nine representative receivers surrounding the Mine Site (see Figure 4.6) for the worst-case operational scenario shown on Figure 4.11. The predicted incremental contribution of the Proposal to annual average TSP, PM$_{10}$ and PM$_{2.5}$ concentrations and dust deposition rates, as well as cumulative emissions when considering background emissions.

<table>
<thead>
<tr>
<th>Emission Type</th>
<th>PM$_{10}$ (µg/m$^3$)</th>
<th>PM$_{2.5}$ (µg/m$^3$)</th>
<th>TSP (µg/m$^3$)</th>
<th>Dust Deposition (g/m$^2$/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
<td>30</td>
<td>8</td>
<td>90</td>
<td>4</td>
</tr>
<tr>
<td>Receiver</td>
<td>Proposal alone</td>
<td>Cumulative</td>
<td>Proposal alone</td>
<td>Cumulative</td>
</tr>
<tr>
<td>R1</td>
<td>0.2</td>
<td>16</td>
<td>&lt; 0.1</td>
<td>8</td>
</tr>
<tr>
<td>R2</td>
<td>0.4</td>
<td>16</td>
<td>0.1</td>
<td>8</td>
</tr>
<tr>
<td>R3</td>
<td>0.2</td>
<td>16</td>
<td>&lt; 0.1</td>
<td>8</td>
</tr>
<tr>
<td>R4</td>
<td>0.6</td>
<td>17</td>
<td>0.1</td>
<td>8</td>
</tr>
<tr>
<td>R5</td>
<td>0.5</td>
<td>16</td>
<td>0.1</td>
<td>8</td>
</tr>
<tr>
<td>R6</td>
<td>0.2</td>
<td>16</td>
<td>&lt; 0.1</td>
<td>8</td>
</tr>
<tr>
<td>R7</td>
<td>0.2</td>
<td>16</td>
<td>&lt; 0.1</td>
<td>8</td>
</tr>
<tr>
<td>R8</td>
<td>0.1</td>
<td>16</td>
<td>&lt; 0.1</td>
<td>8</td>
</tr>
<tr>
<td>R9</td>
<td>0.3</td>
<td>16</td>
<td>&lt; 0.1</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: PEL (2016) – after Tables 8.1 and 8.2

Figure 4.12 provides contour plots for annual average emissions of the Proposal cumulatively with background emissions.
ENVIRONMENTAL IMPACT STATEMENT
Section 4 – Assessment and Management of Ardlethan Tin Mine
Key Environmental Issues

Figure 4.12
CUMULATIVE ANNUAL AVERAGE PM$_{10}$
The results of the dispersion modelling presented in Table 4.8 and Figure 4.12 presents the annual cumulative emissions. In summary, the emissions attributable to the Proposal would comply with annual average air quality criteria at all surrounding residences.

4.4.7.2 Cumulative 24-hour Average

Variability in ambient dust levels on a daily basis as result of spatial and temporal variations in natural events and anthropogenic activity, compound the difficulties in predicting the cumulative 24-hour impacts to PM$_{2.5}$ and PM$_{10}$ concentrations. In many cases, the worst-case inferred 24-hour average PM$_{10}$ concentrations are strongly influenced by these external factors. Whilst it is noted that the Proposal would contribute to elevated PM$_{10}$ concentrations, these would be expected to be localised.

As the air quality at the Mine Site is likely to be similar to other rural areas in NSW, a time series of the PM$_{2.5}$ and PM$_{10}$ concentrations, measured at the Office of Environment and Heritage (OEH), Wagga Wagga North rural air monitoring and the predicted 24-hour PM$_{2.5}$ and PM$_{10}$ concentrations at the nearest residence to the Mine Site (R4), are presented in Figure 4.13. In summary, the Proposal’s contributions to the ambient air quality are very minor and would not result in any additional exceedances of the air quality criterion.

4.4.8 Monitoring

The Applicant proposes to implement a program of monthly dust deposition monitoring for the Proposal. The results of all deposited dust monitoring would be documented, compiled and presented in Annual Reports and Returns prepared in compliance with the development consent and Environment Protection Licence.

4.5 NOISE

4.5.1 Introduction

The SEARs require the EIS to include an assessment of the potential impacts of the Proposal on noise, including:

- an assessment of the likely construction and operational noise impacts of the development (including any cumulative impacts) in accordance with the NSW Industrial Noise Policy and the Interim Construction Noise Guideline; and
- an assessment of the likely road noise impacts (traffic and haulage) of the development under the NSW Road Noise Policy.

Coolamon Shire Council and the EPA also identified noise related matters for consideration within the EIS. The SEARs and requirements of Council and the EPA are included in full as Appendix 2.

A noise impact assessment for the Proposal was undertaken by Muller Acoustic Consulting Pty Ltd (MAC). The full report is presented as Part 3 of the Specialist Consultant Studies Compendium and is hereafter referred to as MAC (2016). The following subsections provide a summary of the noise impact assessment, and describe the operational safeguards and management measures to be implemented by the Applicant.
Figure 4.13
CUMULATIVE 24-HOUR AVERAGE PM$_{10}$ AND PM$_{2.5}$ AT R4

4.5.2 Existing Noise Climate and Receivers

The noise climate in the area surrounding the Mine Site is typical of a rural setting, with no significant surrounding industrial noise sources. Noises which are currently audible at surrounding residences include the following.

- Traffic on local roads, particularly Bygoo Road.
- Agricultural and rural noises such as farm machinery, stock, birds and insects.
- Domestic noises such as lawn mowers, pumps, dogs, etc.
- Wind generated noises such as wind in trees.

It is noted that operations at the Graincorp-operated bulk grain handling and rail loading facility would be audible in the vicinity of that facility, particularly during harvest when the facility is likely to be operating for extended periods.

4.5.3 Assessment Criteria

4.5.3.1 Introduction

The noise impact assessment was completed to quantify potential impacts associated with the Proposal on the surrounding community in accordance with relevant policies and guidelines. The criteria adopted for the noise impact assessment and a justification for their use is presented below.

4.5.3.2 Construction Noise Assessment Criterion

The NSW Interim Construction Noise Guideline (ICNG) (DECC, 2009a) nominates construction noise management levels that are the sum of the management level and the rating background level (RBL). As construction activities associated with the Proposal are relatively limited and include the installation of the modular processing plant in existing hardstand areas, it is anticipated that the noise associated with construction activities would be similar to the noise emissions associated with operational activities. The adopted operational noise criterion ($35dBA L_{Aeq}(15\text{ minute})$) is the same as the most conservative construction noise criterion. Therefore, the construction noise criterion adopted for this assessment is $35dBA L_{Aeq}(15\text{ minute})$.

4.5.3.3 Operational Noise Assessment Criterion

The NSW Industrial Noise Policy (INP) (EPA, 2000) establishes the process for identifying noise criteria relevant to the management of noise emissions from premises scheduled under the NSW Protection of the Environment Operations Act 1997. In accordance with the INP, the equivalent continuous noise level ($L_{Aeq}$) from the Proposal should be no greater than $5dB$ above the minimum rating background level (RBL). In accordance with Section 3 of the INP, an RBL of $30dBA$ was adopted with the operational noise assessment criterion being $35dBA L_{Aeq}(15\text{ minute})$. 
4.5.3.4 **Sleep Disturbance Assessment Criterion**

The INP nominates that a sleep disturbance assessment criterion equivalent to an RBL ($L_{Aeq(90\text{ minute})}$) of 30dB plus 15dB calculated one metre from the façade of the nearest residential properties. As the Proposal would conduct processing operations 24-hours per day, the potential for sleep disturbance as a consequence of the Proposal was assessed. The adopted sleep disturbance criterion adopted for this assessment is therefore 45dBA $L_{Amax}$.

4.5.3.5 **Road Noise Assessment Criterion**

The NSW *Road Noise Policy* (RNP) (DECCW, 2011) nominates noise criteria applicable to different road classifications to quantify traffic noise impacts from development. The ‘freeway/sub-arterial road’ category was adopted for Bygoo Road for this assessment. The RNP specifies day and night criteria for assessing this road category as well as ‘relative increase criteria’, whereby the increase in the total traffic noise level experienced at a residential location as a consequence or traffic generation from the Proposal must also be considered. The road noise criteria adopted for this assessment are as follows.

- **Day (7:00am to 10:00pm):** 60dBA $L_{Aeq(15\text{ hour})}$.
- **Night (10:00pm to 7:00am):** 55dBA $L_{Aeq(9\text{ hour})}$.
- **Relative increase:** 12dB (above existing).

4.5.3.6 **Consolidated Assessment Criteria**

The assessment criteria determined by MAC (2016) for the Proposal are presented in **Table 4.9**.

<table>
<thead>
<tr>
<th>Construction noise criteria (Daytime)</th>
<th>Operational noise criteria (All times)</th>
<th>Sleep disturbance criteria</th>
<th>Road noise criteria$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment criteria</td>
<td>$35\text{dBA }L_{Aeq(15\text{ minute})}$</td>
<td>$35\text{dBA }L_{Aeq(15\text{ minute})}$</td>
<td>$45\text{dBA }L_{Amax}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$60\text{dBA }L_{Aeq(15\text{ hour})}$ (external)</td>
</tr>
</tbody>
</table>

Note 1: Transportation operations are not proposed during the night-time period

Source: MAC (2016) – After Section 4

4.5.4 **Assessment Methodology**

4.5.4.1 **Introduction**

The following provides a brief overview of the noise assessment methodology. Section 5 of MAC (2016) includes a full description of the modelling and assessment methodology.

4.5.4.2 **Residential Receivers**

**Figure 4.6** shows the locations of the residential receivers assessed by MAC (2016).
Adverse Weather Conditions

Noise emissions from industry can be significantly influenced by prevailing weather conditions such as source to receiver winds and temperature inversions. Wind has the potential to increase noise at a receiver when it is at low speeds and from the direction of the noise source. The INP specifies that the source to the receiver wind component for speeds up to 3 m/s for 30% or more of the time in any seasonal period (i.e. day, evening or night), are feature winds and must be assessed.

Wind data was obtained from the Bureau of Meteorology’s (BoM) Narrandera Airport weather station and subsequently analysed using the EPA’s Noise Enhancement Wind Analysis (NEWA) program to determine the frequency occurrence for winds of speeds of up to 3 m/s in each season. Table 4.10 presents the results of the NEWA analysis, including the dominant wind direction and seasonal percentage occurrence. In summary, there are no prevailing winds of less than 3 m/s for more than 30% of the time in any season.

In addition, MAC (2016) identified a stability Class F temperature inversion (moderately stable conditions) as being relevant to the Mine Site.

<table>
<thead>
<tr>
<th>Season</th>
<th>Wind Direction (+/- 45º)</th>
<th>Wind Speeds % (0.05/s – 3 m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day</td>
<td>Evening</td>
</tr>
<tr>
<td>Summer</td>
<td>WSW</td>
<td>SSW</td>
</tr>
<tr>
<td>Autumn</td>
<td>WSW</td>
<td>WSW</td>
</tr>
<tr>
<td>Winter</td>
<td>WSW</td>
<td>WNW</td>
</tr>
<tr>
<td>Spring</td>
<td>WSW</td>
<td>SW</td>
</tr>
</tbody>
</table>

Source: MAC (2016) – After Table 7

Construction and Operational Noise Assessment Methodology

Brüel and Kjær Predictor Type 7810 (Version 11.10) noise modelling software was employed to calculate and predict $L_{Aeq}$ noise levels arising from construction activities using methods in accordance with ISO 9613-1. The model utilises relevant noise source data, ground type, acoustic shielding (such as barriers and/or adjacent buildings) and atmospheric information to predict noise levels at the nearest potentially affected receivers.

A worst-case construction noise modelling scenario was adopted to represent maximum noise emissions during construction activities at the Mine Site, with the modelled sound power levels for the construction noise assessment presented in Table 4.11.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Number</th>
<th>Sound Power Level ($L_{Aeq}, L_{15\text{minute}}$)</th>
<th>Period of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backhoe (small)</td>
<td>1</td>
<td>103</td>
<td>Day Only</td>
</tr>
<tr>
<td>Road Truck</td>
<td>1</td>
<td>102</td>
<td>Day Only</td>
</tr>
<tr>
<td>Grader</td>
<td>1</td>
<td>108</td>
<td>Day Only</td>
</tr>
<tr>
<td>Hand Tools</td>
<td>Multiple</td>
<td>97</td>
<td>Day Only</td>
</tr>
</tbody>
</table>

Source: MAC (2016) – After Table 10
Similarly, a range of noise sources representing an assumed worst-case noise emission scenario were modelled for the operational noise assessment, with the assumed equipment locations shown on Figure 4.14 and modelled sound power levels for the operational noise assessment presented in Table 4.12.

### Table 4.12
Modelled Sound Power Levels – Operation

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Number</th>
<th>Sound Power Level (L_w dB(A), L_{eq(15 minute)})</th>
<th>Period of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulldozer</td>
<td>1</td>
<td>110</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Excavator</td>
<td>2</td>
<td>109</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Front End Loader</td>
<td>2</td>
<td>106</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Forklift</td>
<td>1</td>
<td>87</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Generator (small)</td>
<td>1</td>
<td>76</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Generator (large)</td>
<td>1</td>
<td>93</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Haul Truck</td>
<td>2</td>
<td>108</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Water Truck</td>
<td>1</td>
<td>101</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Processing Plant</td>
<td></td>
<td>115</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

Source: MAC (2016) – After Table 9

It is noted that the assessment of sleep disturbance utilised typical L_{A_{max}} noise levels from a front end loader loading the processing plant within the Mine Site assessed to the nearest residential receivers. The use of the L_{A_{max}} noise level provides a worst-case prediction since the L_{A_{1}}noise level of a noise event is likely to be less than the L_{A_{max}}. For the sleep disturbance assessment, a sound power level of 120dBA was adopted, with MAC (2016) considering this to be representative of the maximum noise emissions associated with metallic impact noise (i.e. loader bucket impacts).

### 4.5.4.5 Road Noise Assessment Methodology

Transportation of product from the Mine Site would be to and from the south via Byggo Road, predominantly using standard road trucks. The road noise assessment assumed proposed daily transport movements at maximum production levels as follows:

- Truck movements: 4 trips per day (2 in / 2 out)
- Light vehicle movements: 40 trips per day (20 in / 20 out)

Road traffic noise was modelled using the methods presented in the US Environmental Protection Agency document No. 550/9-74-004 to predict the L_{A_{eq}} noise levels of Proposal related vehicles travelling past residential receivers on public roads.
Figure 4.14
OPERATIONAL NOISE SCENARIO

REFERENCE
- Mine Site Boundary
- Limit of EOE Land Ownership (offset for clarity)
- Existing Track
- Site Access Road
- Watercourse/Drainage Line
- Former Building/Infrastructure (to be removed)
- Former Quarry Area
- Proposed Tailings Extraction Area
- Proposed Tailings Placement Area
- Proposed Borrow Pit
- Proposed Processing Plant Area
- Proposed Cover and Embankment
- Material Storage Area
- Existing Water Management Dams

SCALE 1:20 000 (A4)

Base Photo Source: Google Earth (11 July 2015)
4.5.5 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to minimise the potential noise-related impacts associated with the Proposal.

- Comply with the proposed hours of operation identified in Section 2.11.2.
- Regularly service all equipment on site to ensure sound power levels of each item remains at or below the default/or factory-set values.
- Install frequency modulated reversing alarms to all mobile equipment.
- Ensure that all truck drivers involved in operational or construction activities be required to comply with a Code of Conduct outlining procedures for reducing noise impacts during transportation within the Mine Site and off site.
- Maintain an open dialogue with the surrounding community and neighbours to ensure any concerns over noise or vibration are addressed.

4.5.6 Assessment of Impacts

4.5.6.1 Construction Noise

MAC (2016) determined that potential noise emissions from the proposed construction of the processing plant would be below 20dBA $L_{Aeq(15	ext{ minute})}$. Therefore construction noise levels at all residences would not exceed the construction noise assessment criterion of 35dBA $L_{Aeq(15	ext{ minute})}$.

4.5.6.2 Operational Noise

The predicted operational noise levels at surrounding residences for calm and adverse meteorological conditions are presented in Table 4.13 and noise contours for daytime operations are presented on Figure 4.15. In summary, there are no predicted exceedances of operational noise criteria at any surrounding residences during the worst-case operational noise modelling scenario.

<table>
<thead>
<tr>
<th>Receiver</th>
<th>Prediction for Calm (Day$^1$) dBA $L_{Aeq(15	ext{ minute})}$</th>
<th>Prediction for Temperature Inversion (Night$^2$) dBA $L_{Aeq(15	ext{ minute})}$</th>
<th>Assessment Criteria dBA $L_{Aeq(15	ext{ minute})}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>&lt;20</td>
<td>&lt;20</td>
<td>35</td>
</tr>
<tr>
<td>R2</td>
<td>21</td>
<td>21</td>
<td>35</td>
</tr>
<tr>
<td>R3</td>
<td>21</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>R4</td>
<td>26</td>
<td>22</td>
<td>35</td>
</tr>
<tr>
<td>R5</td>
<td>23</td>
<td>24</td>
<td>35</td>
</tr>
<tr>
<td>R6</td>
<td>25</td>
<td>27</td>
<td>35</td>
</tr>
<tr>
<td>R7</td>
<td>26</td>
<td>27</td>
<td>35</td>
</tr>
<tr>
<td>R8</td>
<td>&lt;20</td>
<td>&lt;20</td>
<td>35</td>
</tr>
<tr>
<td>R9</td>
<td>22</td>
<td>23</td>
<td>35</td>
</tr>
</tbody>
</table>

Note 1: Day period is 7:00am to 6:00pm
Note 2: Based on highest predicted noise levels during night time temperature inversions
Source: MAC (2016) – After Table 11
Figure 4.15
PREDICTED NOISE LEVEL - DAYTIME

REFERENCE
Mine Site Boundary
Cadastral Boundary
R8 Noise Receptor (Occupied)
R9 Noise Receptor (Unoccupied)
R7 Noise Receptor (Uninhabitable)
---30 Predicted Noise Level (dB(A))
---35 Criterion Noise Level 35dB(A)

SCALE 1:40 000 (A4)

Source: MAC (2016) after Appendix E
4.5.6.3 Sleep Disturbance

The predicted noise levels from $L_{A_{\text{max}}}$ events for assessed receivers are presented in Table 4.14. The results identify that sleep the disturbance criterion will be satisfied for all assessed receivers.

### Table 4.14
Predicted Worst-Case Sleep Disturbance Noise Levels

<table>
<thead>
<tr>
<th>Receiver</th>
<th>Predicted $L_{A_{\text{max}}}$ Events dBA</th>
<th>Assessment Criteria dBA $L_{A_{\text{max}}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>&lt;20</td>
<td>45</td>
</tr>
<tr>
<td>R2</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>R3</td>
<td>23</td>
<td>45</td>
</tr>
<tr>
<td>R4</td>
<td>27</td>
<td>45</td>
</tr>
<tr>
<td>R5</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>R6</td>
<td>34</td>
<td>45</td>
</tr>
<tr>
<td>R7</td>
<td>33</td>
<td>45</td>
</tr>
<tr>
<td>R8</td>
<td>&lt;20</td>
<td>45</td>
</tr>
<tr>
<td>R9</td>
<td>28</td>
<td>45</td>
</tr>
</tbody>
</table>

Note 1: Includes assessment of noise emissions during temperature inversions

Source: MAC (2016) – After Table 12

4.5.6.4 Road Noise

The predicted road noise levels from Proposal generated traffic for receivers 15m from the roadway are presented Table 4.15. The results of the calculations indicate that noise levels would remain below the relevant day criteria and that additional traffic on the road network as a consequence of the Proposal would not lead to an increase in noise levels above the relative increase criteria.

### Table 4.15
Predicted Road Traffic Noise Levels

<table>
<thead>
<tr>
<th>Distance to Nearest Receiver</th>
<th>Assessment Criteria $L_{A_{\text{eq}}(15\text{ hour})}$ dBA</th>
<th>Calculated Project Road Noise $L_{A_{\text{eq}}(15\text{ hour})}$ dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>15m</td>
<td>60</td>
<td>44.9</td>
</tr>
</tbody>
</table>

Note 1: Calculated value assuming 44 vehicle trips per day (22 in/ 22 out)

Source: MAC (2016) – After Table 14
4.6 TRAFFIC AND TRANSPORTATION

4.6.1 Introduction

The SEARs issued for the Proposal identified transport as a key issue, requiring that the EIS include:

- an assessment of potential traffic impacts on the capacity, efficiency and safety of the local and State road networks, detailing the nature of the traffic generated, transport routes, traffic volumes and potential impacts on local and regional roads; and

- a description of the measures that would be implemented to maintain and/or improve the capacity, efficiency and safety of the road network (particularly the proposed transport routes) over the life of the development.

Coolamon Shire Council and the RMS also identified traffic and transport as matters for consideration within the EIS. The SEARs and requirements of Council and the RMS are included in full as Appendix 2.

A Traffic Impact Assessment for the Proposal has been completed by Barnson Pty Ltd. That report is presented as Part 4 of the Specialist Consultant Studies Compendium and is hereafter referred to as Barnsons (2016). The following subsection draws on information presented in that report and describes the existing traffic environment, predicted changes to the traffic environment as a result of the Proposal, the proposed management and mitigation measures and an assessment of traffic related impacts.

4.6.2 Mine Site Access

All vehicles accessing the Mine Site would travel via Tin Mines Road and Bygoo Road. The majority of operational vehicles entering and exiting the Mine Site from the external road network are expected to originate or have their destinations within the local area and surrounding towns, including West Wyalong, Griffith and Wagga Wagga. Limited numbers of vehicles, predominantly those transporting concentrate from the Mine Site would originate from or travel outside the local area.

Figure 4.16 presents the heavy vehicle transport route. In summary, heavy vehicles transporting concentrate would exit the Mine Site via Tin Mines Road, turn right (south) onto Bygoo Road and access the Newell Highway via Wilson, Ariah and Mirrool Streets and Burley Griffin Way.

However, Coolamon Shire Council has advised the Applicant that Bygoo Road/Wilson St is to be realigned to allow for more direct heavy vehicle access from Bygoo Road towards Burley Griffin Way, thus bypassing the central section of Ardlethan. The diversion will be designed to facilitate Road Train access, with this vehicle size exceeding the anticipated product transport vehicle size for the Proposal, namely a 19m semi-trailer).

As the construction phase of the realignment project is expected to commence in mid to late 2017 and be completed by late 2018, the existing road design and layout of Mirrool Street and Ariah Street has not been considered for the traffic assessment as the majority of the operational traffic for the Proposal would utilise the realigned route.
4.6.3 Existing Road Traffic Environment

4.6.3.1 Road Network

The following provides a description of the existing road network in the vicinity of the Mine Site (Figure 4.16).

Newell Highway

The Newell Highway (A39) forms a national highway which runs north-south connecting Tocumwal in Victoria to Goondiwindi in Queensland. The highway acts as the primary freight route for inland New South Wales, as well as a route for tourists.

In proximity to Burley Griffin Way, the Newell Highway is a two-way, two-lane undivided road with 3.5m wide lanes and 3m wide sealed shoulders. The posted speed limit is 110km/hr.

Burley Griffin Way

Burley Griffin Way (B94) is a State controlled route running east-west connecting the Hume Highway near Yass with Griffith. The road consists of a two-way, two-lane undivided sealed road with 3.5m wide lanes and between 2m to 3m unsealed shoulders each side. Between the Newell Highway and a point 500m west of the Mirrool Street intersection the road has a posted speed limit of 50km/hr. West of this point, the posted speed limit is 100km/hr.

Mirrool Street/Ariah Street

Mirrool Street is a local road which connects the state (B94) and national highways (A39) with the town of Ardlethan. Mirrool Street has a 24m wide sealed cross-section with kerb and channel which is not line marked.

Mirrool Street merges with Ariah Street via a 90 degree bend to the east. There is a give way “T” intersection at this corner with a small local street to the north of the intersection which services several residential properties.

Bygoo Road

Bygoo Road is a distributor road connecting Ardlethan with West Wyalong. The road is a two-way road with a 7m wide sealed roadway and unsealed shoulders. This road is flat and straight and is not line marked. The posted speed limit for Bygoo Road within the Ardlethan town limits is 50km/hr which reduces to a 40km/hr school zone adjacent to the Ardlethan Primary School. North of the town, the posted speed limit is 100km/hr.

Tin Mines Road

Tin Mines Road is a no through local road which services one rural property, a power substation and the Mine Site. The road has a 5.4m wide sealed cross section with unsealed shoulders. Shoulders range in width of 0.5m to 2m, however it was noted that shoulders in some locations are heavily vegetated. The posted speed limit of Tin Mines Road is 100km/hr.
4.6.3.2 Intersections

Newell Highway/Burley Griffin Way

Burley Griffin Way forms a “T” intersection with the Newell Highway. A channelized right turn (CHR) and Auxiliary Left Turn (AUL) have been provided on the Newell Highway. Traffic controls consist of giveaway signs and hold lines on the Burley Griffin Way approach.

The sight distances provided are suitable and exceed the design guidance for trucks presented in Austroads (2011a).

Burley Griffin Way/Mirrool Street

Mirrool Street forms a “T” intersection with Burley Griffin Way. An Auxiliary Right Turn (AUR) and AUL have been provided on Burley Griffin Way. Traffic controls consist of one giveaway sign on the Mirrool Street approach. The sight distances provided are suitable and exceed the design guidance for trucks presented in Austroads (2011a).

Ariah Street/Bygoo Road

Bygoo Street forms a “T” intersection with Mirrool Street. No give way signs have been provided at this intersection. The sight distances provided are suitable and exceed the design guidance for trucks presented in Austroads (2011a).

Bygoo Road/Tin Mines Road

Tin Mines Road forms a “T” intersection with Bygoo Road. Each road has provisions for a Basic Auxiliary Right (BAR) and Basic Auxiliary Left (BAL) turn treatment. One giveaway sign has been provided on the Tin Mines Road approach.

The sight distances provided are suitable and exceed the design guidance for trucks presented in Austroads (2011a).

4.6.3.3 Condition

The road network was assessed by Barnsons (2016) using Surface Inspection Ratings based upon evaluation methods presented in VicRoads (2009) and Austroads (2011b). The mode of distress, extent and severity of the distress was recorded along the roads identified within the traffic assessment.

Both core and non-core assessment criteria were used to estimate the current condition of road surfaces with core criteria establishing the level of integrity of the surfacing layer and thus providing an indication of the remaining service life of the pavement whilst non-core criteria are secondary criteria used to assess the expected performance of the surfacing with regard to issues of traffic safety and ride quality.

Overall, the Newell Highway, Burley Griffin Way, Mirrool Street/Ariah Street and Bygoo Road were noted to be in good condition with no maintenance required.

Tin Mines Road was also noted to be in reasonable condition. It is noted that the road has not been maintained for a prolonged period, however due to the negligible volumes traversing the road, the pavement was considered to be in good condition with limited distress.
4.6.3.4 Traffic Volumes

Information on traffic volume counts undertaken in 2010, for the Newell Highway and Burley Griffin Way was obtained via the RMS Volume Viewer website and from Coolamon Shire Council. Table 4.16 presents Average Annual Daily Traffic (AADT) by vehicle type for each location.

<table>
<thead>
<tr>
<th>Road</th>
<th>Source</th>
<th>Two-way AADT</th>
<th>Heavy Vehicle (% of AADT)</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newell Highway</td>
<td>RMS Counter 95227</td>
<td>1691</td>
<td>34%</td>
<td>2010</td>
</tr>
<tr>
<td>Burley Griffin Way</td>
<td>RMS Counter 95299</td>
<td>921</td>
<td>19%</td>
<td>2010</td>
</tr>
<tr>
<td>Bygoo Road</td>
<td>Coolamon Shire Council</td>
<td>111</td>
<td>8%</td>
<td>2011</td>
</tr>
</tbody>
</table>

Note 1: See Figure 4.16
Source: Barnsons (2016) – After Table 4

Advice from Coolamon Shire Council suggests that traffic volumes on Bygoo Road increases fourfold during harvest, with the majority of this increased traffic being heavy vehicles.

Whilst no counts have been undertaken on Tin Mines Road, Coolamon Shire Council advises that volumes are not expected to exceed 20 vehicles per day in 2016.

4.6.4 Proposal-related Traffic

4.6.4.1 Light Vehicles

For the purposes of this assessment, Barnsons (2016) assumed that a maximum of 28 staff would be on the Mine Site at any one time. However, the Applicant notes that the maximum number of employees would be expected to be approximately 28 persons, divided across two shifts working an even time roster (i.e. 4 crews, with one crew on dayshift, one on night shift and two on break). As a result, the assumed maximum number of employees, and therefore vehicle movements, is likely to be highly conservative.

The Applicant expects to operate two 12-hour shifts, with start and finish times at 7:00am and 7:00pm. Employees will therefore arrive and leave the Mine Site outside of the peak hours of the external road network.

4.6.4.2 Heavy Vehicles

Site Establishment

Site establishment traffic would consist of heavy vehicles transporting equipment and the modular processing plant to the Mine Site. Site establishment traffic is forecast to be between 12 and 15 heavy vehicles travelling to/from the site over a period of 3 months.
Furthermore, it is anticipated that less than half of these heavy vehicles would be over size and over mass vehicles and that, should they be required, these vehicles would travel outside the peak periods of the surrounding road network, (for example after 6:00pm).

The impact of over size and over mass vehicles on the road pavement would be minimal due to the low volume and speed of the vehicles.

**Operations**

At maximum production rate of 1.5Mtpa the Mine Site would produce 12 semi-trailer vehicle movements per week (6 in / 6 out). Delivery of production consumables, such as diesel fuel, is anticipated to require two semi-trailer movements per week (1 in / 1 out). Fewer heavy vehicle movements would be required at lower production rates.

Therefore, the heavy vehicle traffic generated by the Proposal is considered to be negligible, with a maximum of 4 vehicle trips per day (2 in / 2 out).

**Decommissioning**

Decommissioning traffic would consist of heavy vehicles transporting equipment, infrastructure and plant to and from the Mine Site. This traffic is forecast to be approximately 20 heavy vehicles travelling to/from the Mine Site over a period of 6 months.

Furthermore, it is anticipated that less than half of these heavy vehicles would be over size and over mass vehicles and that, should they be required, these vehicles would travel outside the peak periods of the surrounding road network, (for example after 6:00pm).

The impact of over size and over mass vehicles on the road pavement would be minimal due to the low volume and speed of the vehicles.

**4.6.4.3 Traffic Generation Summary**

Based upon the traffic generation information presented above, the maximum traffic generated per day by the Proposal would be:

- 56 light vehicle movements (28 in / 28 out); and
- 6 heavy vehicle movements (3 in / 3 out).

**4.6.4.4 Vehicle Parking**

On-site vehicle parking would be designed in accordance with AS2890-2004 Parking Facilities – off-street car parking, with abundant hardstand areas available for the required number of car parks.

**4.6.5 Management and Mitigation Measures**

The Applicant would implement the following staged management and mitigation measures to minimise the potential traffic and transport-related impacts associated with the Proposal. Where required, these management measures would be implemented in consultation with Coolamon Shire Council.
Processing up to 500 000tpa

- Implement a suitable Code of Conduct for drivers of heavy vehicles, including subcontractors where applicable. Consult with all relevant road users during preparation of the Code of Conduct, including:
  - surrounding residents;
  - Coolamon Shire Council; and
  - operators of school bus routes on Bygoo Road.
- Ensure all loose loads on public roads are covered to prevent materials falling onto the roadway or the creation of excessive dust.
- Install the following signs would be erected prior to site establishment activities commencing.
  - A ‘Truck Entering’ sign on Bygoo Road on the southern and northern approaches to Tin Mines Road.
  - A ‘Stop’ sign for drivers exiting the Mine Site via the Tin Mines Road.
  - A ‘Call in’ sign for truck drivers entering Tin Mines Road.
- Install holding line road markings would on the Tin Mines Road approach to the Bygoo Road/ Tin Mines Road intersection.

Processing more than 500 000tpa

In addition to the management and mitigation measures presented above, the Applicant would, upon the Prior to the commencement of reprocessing operations, upgrade Tin Mines Road to provide a minimum 7.2m sealed pavement and 0.5m unsealed shoulders.

4.6.6 Assessment of Impacts

Barnsons (2016) determined that traffic volumes generated by the Proposal would have a negligible effect on the operation of the surrounding road network, with no changes to Levels of Service or intersection performance as a result. Implementation of the proposed management and mitigation measures would ensure that the Proposal would not result in significant traffic and transport impacts.

4.7 ECOLOGY

4.7.1 Introduction

The SEARs require the EIS to assess potential impacts to biodiversity within and surrounding the Mine Site, including a description of measures that would be implemented to manage mitigate potential impacts. In addition, the Office of Environment and Heritage (OEH) have requested an assessment of impacts on flora, fauna, threatened species, populations, communities and their habitats. The SEARs and OEH requirements are included in full as Appendix 2.
EnviroKey Pty Ltd prepared an ecological assessment for the Proposal. The resulting report, referred to hereafter as EnviroKey (2016), is presented as Part 5 of the Specialist Consultant Studies Compendium. The following subsections draw on information provided by EnviroKey (2016) and:

- describe the predicted and observed regional and local flora, fauna and vegetation communities, including threatened flora and fauna species within the Mine Site;
- identify potential ecological impacts of the Proposal;
- present proposed management and mitigation measures; and
- determine the potential impact of the Proposal on flora, fauna, threatened species, populations, communities and their habitats.

### 4.7.2 Assessment Methodology

#### 4.7.2.1 Overview and Scope

EnviroKey (2016) combined a desktop analysis to consider the biodiversity of those sections of the Mine Site that would potentially be impacted with a targeted field survey to identify the presence of any species, populations or communities of conservation significance.

#### 4.7.2.2 Desktop Assessment

EnviroKey (2016) conducted a search over an area of 10km radius centred on the Mine Site of the following information sources to develop a predictive model for threatened flora and fauna to be recorded in the Ecology Study Area:

- Aerial photograph interpretation of the landscape and previous vegetation maps.
- Previous assessment within the local setting and the OEH maintained database of Biometric Vegetation Communities.
- The NSW Threatened Species Database (searched 9 October 2016).
- Environmental Protection and Biodiversity Conservation Act (EPBC) Protected Matters Search Tool (searched 11 October 2016).
- DPI Weed Wise and DPI Records Viewer (searched 9 October 2016).
- NSW Bionet GIS data request and website search (searched 11 October 2016).
- Royal Botanical Gardens (PlantNet NSW Flora Online).

#### 4.7.2.3 Field Assessment Methodology

A field survey was completed on 5 and 6 October 2016 to:

- collect species richness and diversity data to classify vegetation communities present;
• determine if species, populations or communities listed under the schedules of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or *Threatened Species Act 1995* (TSC Act) would be, or have potential to be, affected by the Proposal; and

• describe the quality and value of the habitat that would be affected by the Proposal.

The field survey covered an area identified as the Ecology Study Area (*Figure 4.17*).

The field survey techniques used were in accordance with relevant guidelines for flora and fauna surveys (for example DEC, 2004 and OEH, 2014) and are presented in detail in Sections 5 and 6 of EnviroKey (2016). In summary, survey techniques included the following. *Figure 4.18* presents the locations of each of the survey points.

- Use of 20m x 20m quadrats, 50m x 1m transects, 20m x 50m habitat plots and random meander surveys to identify flora and fauna species.
- Habitat surveys, including examination of trees (for hollows, feeding habitat, roosting habitat, and/or nests), and indirect signs of fauna such as scats, calls, fur, feathers, sloughed skins.
- Opportunistic sighting of fauna (birds) during random meanders and habitat surveys.

### 4.7.3 Ecological Setting of the Project Site

#### 4.7.3.1 Vegetation Communities

*Figure 4.17* identifies the vegetation communities within the Ecology Study Area. In summary, the vegetation communities may be described as follows.

- Cleared/Disturbed Land – these sections of the Mine Site has been subjected to extensive prior mining activity and, as a consequence, vegetation is mostly absent and these areas have little or no ecological value

- MR558 Dwyer’s Red Gum – White Cypress Pine – Currawang shrubby woodland – this community occupies approximately 28% (46ha) of the Ecology Study Area. While EnviroKey (2016) noted some variation within the community attributed to historic mining, the community was assessed as being in Moderate to Good condition

#### 4.7.3.2 Flora

EnviroKey (2016) identified a total of 54 flora species, comprising 45 native species and 9 exotic species. No threatened flora species and one noxious weed species, namely Athel Pine (*Tamarix aphylla*) (*Figure 4.17*) was recorded during field surveys. A full list of identified flora species is presented in *Appendix 4* of EnviroKey (2016).
Section 4 – Assessment and Management of Ardlethan Tin Mine

Key Environmental Issues

Figure 4.17 Vegetation Communities

REFERENCE

Vegetation Community

Ecology Study Area
Cleared / Disturbed Land
MR558 Dywers Red Gum - White Cypress
Pine - Currawang shrubby woodland
Noxious Weeds
Athel Pine

SCALE 1:20 000 (A4)

Source: EnviropKey (2016) after Map 5
Figure 4.18

SURVEY LOCATIONS, FAUNA HABITATS AND THREATENED AND MIGRATORY SPECIES LOCATIONS
4.7.3.3 Fauna

A total of 57 fauna species were recorded within Ecology Study Area by EnviroKey (2016) comprising:

- 39 bird species;
- 8 reptile species;
- 5 frog species; and,
- 5 mammal species (including 2 bat species).

Two threatened or migratory fauna species were identified within or adjacent to the Ecology Study Area (refer Figure 4.18), these being:

- Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) listed as Vulnerable under the TSC Act. This species was recorded along Tin Mines Road, outside the Mine Site.
- Rainbow Bee-eater (*Merops ornatus*) listed as Migratory under the EPBC Act. This species was recorded flying over the Mine Site.

4.7.3.4 Habitat Condition

EnviroKey (2016) recorded two general habitats within the Ecology Study Area, namely:

- Disturbed Woodland (corresponding to MR558); and
- Cleared/Disturbed Land (Figure 4.17).

Field survey of these habitats concluded that they were in moderate to poor condition across the Mine Site.

4.7.3.5 Landscape Connectivity

EnviroKey (2016) concluded that the general landscape in the vicinity of the Mine Site has been significantly compromised by previous large-scale land clearing for agricultural purposes. Whilst linear strips of remnant vegetation traverse the regional landscape and contribute to landscape connectivity, the Mine Site is unlikely to significantly contribute to landscape scale connectivity given more apparent corridors are located to the east and west of the Mine Site.

4.7.4 Potential Impacts

4.7.4.1 Loss of Vegetation and Habitat

Clearing of native vegetation is a key threatening process listed under the TSC Act and the EPBC Act. The Proposal would result in disturbance of approximately

- 9.6ha of MR558 Dwyer’s Red Gum – White Cypress Pine – Currawang shrubby woodland; and
- 83.6ha of Cleared/Disturbed Land.
As no threatened ecological communities listed under the EPBC Act or the TSC Act occur within the Ecology Study Area, none would be impacted by the Proposal.

### 4.7.4.2 Threatened Species Habitat

Based on the field survey conducted, EnviroKey (2016) identified that the Ecology Study Area is unlikely to be utilised by threatened fauna on a permanent basis. The Grey-crowned Babbler, recorded along Tin Mines Road approximately 2km from the Mine Site, generally has small home ranges varying from 1ha to 50ha, dependant on the size of the family ‘troupe’ and the quality of habitat. Four or five birds were recorded within this family troupe. EnviroKey (2016) estimate that the likely home range of this troupe would be approximately 7ha and likely to be contained within the patch of habitat along Tin Mines Road with some movement also occurring along the vegetated road reserve, particularly for dispersal and genetic exchange.

### 4.7.4.3 Injury and Mortality

Fauna injury or mortality may occur during extraction operations leading to habitat removal or as a result of vehicle collision.

### 4.7.4.4 Weeds

There is some potential to disperse seeds and plant material into adjoining areas of native vegetation that are presently (relatively) weed-free. The most likely cause would be through the movement of soil by construction vehicles and machinery involved with any initial clearing and earthworks. There is also some minor potential for disturbance areas to be colonised by weed species. However, this is considered unlikely given the lack of germination to date across the already heavily disturbed areas.

### 4.7.4.5 Pests and Pathogens

#### Pests

A number of pest species are known in the locality and some of these have been recorded within the Mine Site. These species have the potential to increase in abundance as a consequence of further disturbance on the Mine Site. Five key threatening processes as listed by the TSC Act and the EPBC Act relate to the invasion and establishment of these species. The TSC Act key threatening processes relating to these introduced species are listed as follows.

- Competition and grazing by the feral European rabbit.
- Competition and habitat degradation by feral goats.
- Predation by the European red fox.
- Predation by the feral cat.
- Predation, habitat degradation, competition and disease transmission by feral pigs.
The EPBC Act key threatening processes relating to these introduced species are listed as follows:

- Competition and land degradation by rabbits.
- Competition and land degradation by unmanaged goats.
- Predation by European red fox.
- Predation by feral cats.
- Predation, habitat degradation, competition and disease transmission by feral pigs.

The proposed activity may exacerbate these processes across the Mine Site.

**Pathogens**

The following pathogens are known in inland NSW. These are also listed as key threatening processes.

- *Phytophthora* causing vegetation dieback – listed under the TSC Act and EPBC Act.
- Amphibian Chytrid Fungus which infects frogs and causes chytridiomycosis – listed under the TSC Act and EPBC Act.

Only the Phytophthora has the potential to impact flora in the Mine Site given the absence of suitable aquatic habitats for frogs.

### 4.7.4.6 Groundwater Dependent Ecosystems

EnviroKey (2016) considers that the proposed activity is unlikely to result in a significant reduction in both the water flow and water table height given the absence of aquatic habitats.

### 4.7.4.7 Noise and Light

Noise is likely to occur as a result of the proposed activities. EnviroKey (2016), based on previous studies at other mine sites, do not anticipate that operational noise would have a significant effect where threatened species have been recorded foraging and breeding directly adjacent to active mining operations.

Whilst light has the potential to disturb sleeping activity for diurnal fauna and foraging activity for nocturnal fauna, impacts to diurnal fauna would be limited to a small area of the Mine Site and it is not anticipated that these fauna would be significantly affected. For nocturnal fauna, a recent study at an existing mine site near Cobar found that lighting associated with mine operations had provided positive benefits for microchiropteran bat foraging as operational lighting attracted moths and other flying insects (Envirokey, 2012).
4.7.4.8 Cumulative Impacts

EnviroKey (2016) considered the potential for impacts arising from the Proposal to negatively affect biodiversity at the landscape scale. EnviroKey (2016) concluded that, as the majority of Proposal activity would be carried out on Cleared/Disturbed Land and, in the absence of other known projects, the relatively minor impacts to native vegetation are unlikely to contribute to cumulative impacts to biodiversity at any scale.

4.7.5 Management and Mitigation Measures

The Applicant would implement the following management and measures to minimise impacts on threatened species, by firstly avoiding and then mitigating potential biodiversity impacts.

- Prepare and implement a weed and pest animal management plan as part of the Mining Operations Plan targeting the introduced Fox, European Rabbit and Feral Cat as well as noxious weeds
- Ensure that all vegetation to be retained is clearly marked to ensure no accidental clearing occurs.
- Ensure all machinery required for operational activities remains on designated access tracks or within approved disturbance areas
- Speed limits for all motor vehicles within the Mine Site and along Tin Mines Road, would be set and enforced.
- Ensure disturbed areas are revegetated as soon as practicable with native species using locally sourced seed
- Ensure that revegetated areas are monitored to ensure native vegetation regeneration is successful and implement remediation actions if required.

4.7.6 Assessment of Impacts

Significance assessments for each of the species identified during the assessment are presented in full in Section 10 of EnviroKey (2016). In summary, EnviroKey (2016) determined that the Proposal is unlikely to have a significant effect on any threatened species, communities, populations and their habitats under the TSC Act.

In addition, EnviroKey (2016) determined that the Proposal is unlikely to have a significant effect on any listed threatened and migratory species and their habitats identified under the EPBC Act and therefore a referral to the Commonwealth Environment Minister is not warranted.

Wildlife connectivity would not be affected by the Proposal which, if the measures nominated in Section 4.7.5 are implemented, should not result in any increase in weed or pest species distribution or density.

On the basis of the above, the impact of the Proposal on biodiversity is assessed to be relatively minor and mitigated to the greatest extent practical.
4.8 HERITAGE

4.8.1 Introduction

The SEARs identify “heritage” as a key issue for assessment in the EIS requiring “an assessment of the potential impacts on Aboriginal heritage (cultural and archaeological), including evidence of appropriate consultation with relevant Aboriginal communities/parties and documentation of the views of these stakeholders regarding the likely impact of the development on their cultural heritage”.

In addition, OEH have requested an assessment of impacts to Aboriginal cultural heritage sites and objects. The EARs and OEH requirements are included in full as Appendix 2.

Colin Pardoe Bio-Anthropology and Archaeology was engaged to prepare an Aboriginal Cultural Heritage Due Diligence Assessment Report. That assessment was undertaken in accordance with the Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales (OEH 2010) and included a field investigation undertaken on 29 and 30 September 2016. That report is referred to as Pardoe (2016) and is presented as Part 6 of the Specialist Consultant Studies Compendium.

4.8.2 History of the Mine Site

The Mine Site is located within the Murray Darling Basin, which includes the three largest rivers in Australia; the Murray River, the Darling River and the Murrumbidgee River. This region has been occupied by Aboriginal people for over 40,000 years, with early occupation concentrated around the freshwater lakes and rivers and their floodplains.

A number of different land development practices have taken place in the region over the last 200 years. Land clearance in the late 19th and early 20th centuries was widespread in the region surrounding the Mine Site and has had a major impact with most trees in the region being cleared. There were, however, large areas of open grassy plains which would not have been affected in this way, but which were subject to damage from stock and agricultural activities.

Within the Mine Site, mining has had the most significant impact. Early mining exploration in the region may still be seen in some of the small shafts and working in the granite outcrops. More recent mining, including the establishment of three open cuts, two tailings storages, two waste rock emplacements, several dams, haul roads, fire breaks, hardstand areas and buildings has disturbed much of the land within the Mine Site.

4.8.3 Registered Sites of Aboriginal Significance

A number of state and national registers were reviewed as part of the Due Diligence process to obtain information on Aboriginal sites previously documented by archaeologists and cultural heritage workers. These included the following.

- Coolamon Shire Local Environment Plan 2011.
- Aboriginal Heritage Information Management System (AHIMS).
- Commonwealth Heritage List.
• National Heritage List.
• Register of the National Estate.
• Australian Heritage Places Inventory.

The AHIMS database is considered the most comprehensive of these and this was searched on the 22 September 2016. Six Aboriginal sites were documented with one site, 49-3-0001 (ATM-SW/OS-1; Kelton 1996) being situated within the Mine Site boundary. Table 4.17 and Figure 4.19 presents the locations of the AHIMS registered sites within 5km of the Mine Site Boundary.

Table 4.17
AHIMS sites recorded in the vicinity of the Mine Site

<table>
<thead>
<tr>
<th>Site name</th>
<th>AHIMS ID</th>
<th>Distance from Mine Site Boundary (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATM-SW/OS-1</td>
<td>49-3-0001</td>
<td>1001</td>
</tr>
<tr>
<td>ATM-1F-1&lt;sup&gt;2&lt;/sup&gt;</td>
<td>49-3-0002</td>
<td>590</td>
</tr>
<tr>
<td>ATM-OS-1</td>
<td>49-3-0003</td>
<td>910</td>
</tr>
<tr>
<td>ATM-IF-2</td>
<td>49-3-0004</td>
<td>1080</td>
</tr>
<tr>
<td>ATM-ST-1</td>
<td>49-3-0005</td>
<td>3170</td>
</tr>
<tr>
<td>ATM-IF-1&lt;sup&gt;2&lt;/sup&gt;</td>
<td>49-3-0012</td>
<td>590</td>
</tr>
</tbody>
</table>

Note 1: Location is within the Mine Site Boundary with distance to nearest area of disturbance provided
Note 2: ATM-IF-1 and ATM-1F-1 are presumed to be duplicate sites
Source: Pardoe (2016) – After Table 2

No items of Aboriginal heritage significance were identified from the other sources of information reviewed.

No other sites were registered in the wider region to enable further predictions on the likely occurrence of additional sites to be made.

4.8.4 Likelihood of Aboriginal Objects within the Mine Site Boundary

The likelihood of Aboriginal Objects, including features and sites, being present on the Mine Site was considered to be extremely low with the exception of two areas as follows (Pardoe, 2016).

- The granite outcrop known as Taylors Hill (Figure 4.19) includes the AHIMS registered site 49-3-0001. This site consists of a small artefact concentration and rock wells. It should be noted that the landform has been subject to considerable erosion following 19<sup>th</sup> century clearance and is situated beyond any area of activity associated with the Project.
- Areas of flat ground close to watercourses have a low likelihood of Aboriginal objects being present. In addition, these area have typically been heavily disturbed by previous agricultural or mining activities, suggesting that the integrity of the sites would have been damaged. While individual lithic items might be present and undamaged, Pardoe (2016) considers it unlikely that they would be in situ.

R.W. CORKERY & CO. PTY. LIMITED
Figure 4.19
ABORIGINAL HERITAGE VISUAL INSPECTION AREA AND REGISTERED SITES

Key Areas of Visual Inspection
- Northern Evaporation Ponds
- Northwestern Open Plains
- Taylors Hill
- Granite Hills

REFERENCE
- Mine Site Boundary
- Contour (mAHD)(interval=5m)
- Existing Track
- Site Access Road
- Former Building (Partly demolished)
- Former Open Cut
- Tailings Storage Facility
- Water Management Dam
- Heritage Inspection Area

49.3.0005 AHIMS Site
4.8.5 Visual inspection

Figure 4.19 identifies those areas that were the subject of a visual inspection on 29 to 30 September 2016. The visual inspection focused in particular on those areas of the Mine Site that had lower or unknown levels of previous disturbance, or landforms considered archaeologically sensitive under the Due Diligence Code of Practice. Most of the land within the Inspection Area has been completely disturbed by mining activity and any archaeological materials, if present, were likely destroyed. Four areas within the Mine Site Boundary, identified on Figure 4.19 are considered to have higher archaeological potential and are discussed separately.

Northern Evaporation Ponds

The area surrounding the Northern Evaporation Ponds is situated on coluvium, consisting of slope wash from the granite hills to the south. The land in this area has been heavily disturbed, with topsoil removal from the eastern side and significant disturbance on the west from ploughing, channel and dam cutting.

Pardoe (2016) considered it unlikely that any undisturbed Aboriginal heritage objects, features or sites are present in this area. It is possible, however, that disturbed lithic items may be present in soils that have been moved to construct the dams and storages.

Northwestern Open Plains

A small area of open grassland has been cleared historically with two artificial drainage channels also being constructed / excavated at some time in the past. A natural channel was also observed although it had been partially obscured by ploughing or sedimentation. This channel is a minor drainage feature from the adjacent hills, with a correspondingly low likelihood that Aboriginal objects may be present adjacent to the drainage.

Taylors Hill

Taylors Hill is relatively undisturbed except for small diggings, possibly from historic mining activities. Historic tree removal was also noted with some soil loss from subsequent erosion.

The open site and rock well (AHIMS 49-3-0001) is located in this area. Although it is not known whether the rock well was modified by Aboriginal people, made by mining exploration or is simply a gnamma hole, namely a natural cavity commonly found in hard rock, particularly granite outcrops, commonly used by Aboriginal peoples for water supply. Notwithstanding this, recorded artefacts that were located nearby indicate that the place was used in traditional times.

It is possible that other gnamma holes may be located on Taylors Hill and adjacent granite outcrops, however none were observed during the visual inspection conducted for this assessment (Pardoe, 2016).

Granite Hills

There are two low hills on either side of the Spring Valley Fresh Water Dam (refer Figure 4.19). These are similar to Taylors Hill, but have lower elevation and slightly denser vegetation. They are mainly steep sided ridges, with little opportunity for sites of any description. There were no outcrops of bare granite observed.
4.8.6 Management and Mitigation Measures

The Applicant acknowledged its obligations under Section 86 of the *National Parks and Wildlife Act 1974*. In order to ensure compliance with those obligations, the Applicant would implement the following management and measures to minimise the potential to disturb Aboriginal objects.

- Mark out and clearly demarcate approved areas of disturbance to ensure that non-approved areas are not disturbed
- Develop and implement an unanticipated finds protocol to identify and protect unanticipated Aboriginal heritage sites or artefacts within the Mine Site.

4.8.7 Assessment of Impacts

Activities associated with the Proposal are not planned to disturb any areas of previously undisturbed land containing archaeological sites. Activity associated with the Project on the landform containing the AHIMS registered site, 49-3-0001 are not proposed, with the existing fire trail demarcating the boundary of Project related activity. Therefore, as no Aboriginal sites or areas of archaeological potential were observed during the survey, and that no disturbance would occur in the vicinity of the sole AHIMS registered site, it is assessed that the Proposal would not impact significantly on Aboriginal heritage.

4.9 VISUAL AMENITY

4.9.1 Introduction

The SEARs issued for the Proposal identified visual amenity as a key issue, requiring that the EIS include an assessment of the likely visual impacts of the development on any surrounding private landowners and key vantage points in the public domain, paying particular attention to impacts on any nearby private residences and road users.

The following subsections have been prepared by RW Corkery & Co Pty Limited and consider the existing visual environment, the likely changes to the visual amenity of the Mine Site, and the management and mitigation measures that would be implemented, and assesses the visual impact of the Proposal.

It is noted at the outset that the value placed upon visual amenity and the impacts upon surrounding visual amenity varies from person to person and from location to location. As a result, a visual amenity assessment is, by its nature, is highly subjective. Emphasis has therefore been placed on providing a description of the existing visual amenity surrounding the Mine Site and the measures that would be undertaken by the Applicant to minimise potential visual amenity-related impacts on surrounding residents and others.

4.9.2 Existing Visual Environment

The existing visual amenity environment surrounding the Mine Site is typical of rural areas in Western NSW, with the outlook from most rural residences and other vantage points predominantly that of scrubby vegetation within land used for agriculture.
Being elevated in the landscape, the Mine Site is visible from surrounding publicly available vantage points and surrounding residences. In summary, such views may include the following.

- East to southeast of the Mine Site – views of the tailings storage facility embankments, Ardwest/Wild Cherry Open Cut high wall and waste rock emplacements.
- South to west of the Mine Site – views are typically obscured by Taylors Hill and vegetation to the west of the Main and SC Tailings Storage Facilities.
- Northwest to east of the Mine Site – views of the northern faces of the Main and White Crystal Waste Rock Emplacements and associated infrastructure.

It is noted that surrounding residences are typically located more than 2km from the Mine Site and that intervening vegetation obscures views of the Mine Site.

Finally, the Mine Site is located in a landscape with very few artificial light sources.

4.9.3 Management and Mitigation Measure

The Applicant would implement the following management and mitigation measures to minimise the potential visual amenity-related impacts associated with the Proposal.

- Ensure that active dust suppression is undertaken to reduce the potential for the creation of a ‘dust cloud’.
- Construct the Processing Plant using non-reflective, neutral coloured materials.
- Ensure that night-time lighting is the minimum required for safe operations and that lighting is directed towards the ground (minimising the light spill from the Mine Site).
- Ensure that lighting not required would be turned off, particularly in elevated sections of the Mine Site.
- Undertake regular consultation with surrounding residents and address any visual amenity-related concerns to the extent reasonable and practicable.
- Promptly rehabilitate and revegetate disturbed sections of the Mine Site no longer required for tailings extraction operations.

4.9.4 Assessment of Impacts

As the Mine Site is situated in an elevated location, the potential for visual amenity impacts exists.

Notwithstanding the above, given the small scale of the Proposal and the limited night-time lighting that would be required, it is assessed that the proposed activities would not impact significantly on visual amenity, including night-time visual amenity, at surrounding residences or publicly available vantage points.
Furthermore, the Proposal would result in rehabilitation of the existing disturbed sections of the Mine Site, removing an existing visual amenity impact.

As a result, visual amenity-related impacts associated with the Proposal are assessed as negligible.

4.10 SOILS AND LAND CAPABILITY

4.10.1 Introduction

The SEARs require the EIS to include an assessment of the potential impacts of the Proposal on ‘land’, including:

- the potential impacts on the quality and quantity of Mine Site soil and land capability including the likely disturbance of contaminated soils;
- compatibility with other land uses; and
- avoid impacts to adjacent Crown Land.

The following subsections have been prepared by RW Corkery & Co Pty Limited. Reliance in relation to the soils within the borrow pit has been placed on a report entitled Soil Survey Report and Rehabilitation Strategies for the Proposed Ardlethan Mine Rehabilitation and Landfill Project prepared by Global Soil Systems in 1999. That report, referred to hereafter as GSS (1999), is presented as Part 7 of the Specialist Consultant Studies Compendium.

The following subsection review the local setting of the Mine Site soils, identify the potential impacts and specific management issues, propose and describe the operational safeguards and management measures to be implemented by the Applicant, and assess the significance of any residual impacts following the implementation of these.

4.10.2 Existing Soils Environment

4.10.2.1 Disturbed sections of the Mine Site

Historic mining disturbance has severely impacted the soils environment of the Mine Site. In summary, no soils exist within the following disturbed sections of the Mine Site (Figure 2.1).

- Main and Spring Valley Tailings Storage Facility.
- Ardwest/Wild Cherry, White Crystal and Stackpool Open Cuts.
- Former infrastructure area, including the proposed processing plant area.
- Spring Valley Fresh Water Dam and Mill Reclaim Dam.

In addition, leakage of low pH water from the Spring Valley Tailings Storage Facility has resulted in scalding and degradation of soils within and adjacent to the drainage line between the SC Tailings Storage Facility and Fresh Water Dam.
4.10.2.2 Borrow Pit

GSS (1999) undertook an assessment of the soils within the borrow pit for their use as cover and rehabilitation materials for a previous waste-related Proposal. In summary GSS (1999) determined that the soils within the borrow pit may be classified as a “Brown Gradational” soil. GSS (1999) describes the soil profile as follows:

- **Surface to 20cm** – Dark brown loam. The soil is weakly structured and has 20mm to 50mm subangular blocky primary peds. Secondary peds are 10mm to 20mm. The soil has a sandy fabric and crack size is 2mm to 5mm. Stones occur at less than 2%. Many roots are evident. A clear, wavy boundary to the underlying layer was evident.

- **20cm to 60cm** – Dark brown sandy loam. The soil is weakly structured. Peds are 50mm to 100mm, are rough-faced and are sub-angular blocky in shape. Crack size is 10mm to 20mm. Sub-rounded, 2mm to 6mm strongly weathered granite stones occur at 10% to 20% in a dispersed manner. Roots are common. A clear, wavy boundary to the underlying layer was evident.

- **60cm to more than 1.5m** – Dark greyish brown sandy clay which is apedal and massive. Sub-rounded 2mm to 20mm strongly weathered granite stones are dispersed at 10% to 20%. Few roots are present.

Table 4.18 presents an overview of the laboratory testing of the soils within the borrow pit.

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Topsoil (0cm to 20cm)</th>
<th>Subsoil (&lt;20cm below surface)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texture</td>
<td>Sandy loam to loam</td>
<td>Sandy clay</td>
</tr>
<tr>
<td>Structure</td>
<td>Weak</td>
<td>Apedal Massive</td>
</tr>
<tr>
<td>Dispersiveness</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Available Water Capacity</td>
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<td>High</td>
</tr>
<tr>
<td>Chemical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>Acidic</td>
<td>Alkaline</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Cation Exchange Capacity</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Exchangeable Cation Ratio</td>
<td>Desirable</td>
<td>Undesirable</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Trace Elements</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

GSS (1999) determined that the soils within the borrow pit were suitable for use during rehabilitation operations provided that the soils are amended physically and chemically to enhance their capacity to and that suitable rehabilitation techniques are utilised to ensure optimum vegetative establishment and sustainability.
4.10.3 Land and Soil Capability

The Mine Site’s Land and Soil Capability is assessed by considering its biophysical features and individual hazards in accordance with the document *The Land and Soil Capability Assessment Scheme* (OEH, 2012). In summary, the land and soil capability of soils within the Mine Site may be classified as follows.

- **Disturbed Sections of the Mine Site** – Class 8 land or “Extremely low capability land: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation.”

- **Borrow pit** – Class 6 land or “Low capability land: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation.”

4.10.4 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to minimise the potential soil and Land capability-related impacts associated with the Proposal. These measures have been largely drawn from Section 6 of GSS (1999).

- Engage a suitably experienced soils expert to prepare a detailed *Growth Medium Management Plan* for the Proposal prior to commencing extraction of material from the borrow pit. That report would:
  - review and update the findings of GSS (1999); and
  - provide further recommendations in relation to the measures to be implemented during stripping and placement of growth medium to ensure that the final land use of nature conservation is achieved.

- Install suitable sediment and erosion controls prior to commencing extraction operations.

- Directly place a minimum of 150mm of stripped growth medium within areas to be rehabilitated.

- Revegetate the placed growth medium as soon as practicable following placement.

4.10.5 Assessment of Impacts

Based on the highly disturbed nature of the Mine Site and the proposed management and mitigation measures, it is assessed that the Proposal would not result in significant soil or land capability impacts.
4.11  SOCI-O-ECONOMIC ENVIRONMENT

4.11.1  Introduction

The socio-economic assessment has been prepared by RWC Corkery & Co Pty Limited. This subsection provides an overview of the existing socio-economic setting, describes the economic contribution of the proposal, outlines the proposed management and mitigation measures and reviews the potential impacts upon the local and wider communities.

The SEARs require the EIS to assess the likely social and economic impacts of the Proposal, including:

- consideration of the significance of the resource; and
- the costs and benefits of the project.

4.11.2  Community Profile

4.11.2.1  Surrounding Communities

The Project Site is located approximately 5km northwest of the village of Ardlethan in southern NSW. The Project Site is located within the Coolamon Local Government Area (LGA), approximately 1km south of the boundary with Bland LGA and approximately 2km east of the boundary with the Narrandera LGA. As a result, all three LGAs have been be considered for the purpose of the socio-economic assessment.

Communities surrounding the Project Site include the following.

- Immediate neighbours and local residents surrounding the Project Site (Figure 4.6).
- Residents of the towns of Ardlethan, Moombooldool, Barellan, Beckom, Mirrool, Ariah Park, Temora and other towns surrounding the Project Site.
- Residents of surrounding rural properties and other areas within the Coolamon, Bland and Narrandera LGAs.

Each of these communities would be impacted to a greater or lesser degree depending on their proximity to the Mine Site and the size, resilience and cohesiveness of the relevant community and its economy. For the purpose of this assessment, particular focus is placed on those communities most likely to be impacted by the Proposal, including the regional towns of Ardlethan and Beckom, and the Coolamon, Bland and Narrandera LGAs.

Ardlethan is a town of approximately 360 people located approximately 400km west-southwest of Sydney. The town was originally established in the 19th century following the discovery of gold nearby. Tin mining commenced in 1912 and continued until closure in the 1980s.

The Coolamon LGA is located in the Riverina region of southern NSW and is surrounded by the Bland LGA to the north, the Termora LGA to the northeast, the Junee LGA to the east, the Wagga Wagga LGA to the southeast, the Lockhart LGA to the south, the Urana LGA to the southwest and the Narrandera LGA to the west (Figure 1.1). Coolamon is the largest populated town within the Coolamon LGA, with the population recorded in the 2011 Census as 1 589. The LGA is generally supported by agricultural production.
The Bland LGA is also located in the Riverina region of southern NSW. West Wyalong is the largest populated town within the Bland LGA, with the population recorded in the 2011 Census as 2 643. The LGA is generally supported by agricultural production and mining.

The Narrandera LGA is also located in the Riverina region of southern NSW. Narrandera is the largest populated town within the Narrandera LGA, with the population recorded in the 2011 Census as 3 871. The LGA is generally supported by agricultural production.

4.11.2.2 Community Statistics

The following demographic data was sourced primarily from the Australian Bureau of Statistics (ABS) 2011 census data, with limited supporting data from the 2006 census (where available). All data has been gathered from the community profile tables and quick data sets from the ABS website (http://www.abs.gov.au/). Information is provided for the “Ardlethan State Suburb” (Ardlethan SS), the “Beckom State Suburb” (Beckom SS), and the Coolamon, Bland and Narrandera LGAs (Figure 4.20) as well as utilising NSW data for comparison purposes.

Population and Age Characteristics

Table 4.19 presents the population data from both the 2006 and 2011 census. In summary, the population of Ardlethan SS and Beckom SS in 2001 were 364 and 218 respectively, and the population of Coolamon LGA, Bland LGA and Narrandera LGA were 4 099, 5 865 and 5 902 respectively.
Population growth between 2006 and 2011 within the Ardlethan SS (-22%), the Coolamon LGA (1.8%), the Bland LGA (3.9%) and the Narrandera LGA (1.8%) was significantly lower than the NSW average, including population declines within the Ardlethan SS, the Bland LGA and the Narrandera LGA, compared with a 5.3% gain for NSW as a whole.

Table 4.20 presents the 2011 Census population data broken down by age. In summary, the Beckom SS, the Coolamon LGA, the Bland LGA and the Narrandera LGA age statistics are generally comparable to the whole of NSW. In contrast, Ardlethan SS had a lower proportion of people aged 0 to 14 years old and 15 to 54 years old, and a higher proportion of people aged over 65 years old. This potentially reflects limited economic and employment opportunities for those in the early stages of their working life and with young families.

Employment

Table 4.21 presents employment statistics from the 2011 Census. These indicate that the Beckom SS (65.5%), the Coolamon LGA (55.3%), the Bland LGA (58.8%) and the Narrandera LGA (55.2%) have equivalent levels of full-time and part-time employment in comparison to NSW (59.7%). In comparison the Ardlethan SS (38.8%) has a substantially lower equivalent level of full-time and part-time employment.

Industry of Employment

Table 4.22 presents employment by industry statistics from the 2011 Census. The most significant industry of employment in the Beckom SS (58.7%), the Coolamon LGA (23.7%), the Bland LGA (28.2%) and the Narrandera LGA (19.0%) is agriculture, forestry and fishing, compared to the State average of 2.2%. Ardlethan SS also has a higher percentage of workers (9.7%) in the agriculture, forestry and fishing industry. Importantly, mining comprised 5.8% of employment within the Ardlethan SS, compared with the State average of 1.0%. This reflects the importance of mining within the local community and the reliance that the community places on the off-farm income that the industry provides.

Income

Table 4.23 presents income statistics from the 2011 Census. The data indicates that the median individual, family and household incomes in the Ardlethan SS are less than the Beckom LGA, the Coolamon LGA, the Bland LGA and the Narrandera LGA which are in turn less than for NSW as a whole.

Housing Cost

Table 4.24 presents housing cost statistics from the 2011 Census. The data indicates that the median housing loan payments and rent in the Ardlethan SS are less than the Coolamon LGA, the Bland LGA and the Narrandera LGA, which are in turn less than for NSW as a whole.

It is noted that the median weekly rent in the Beckom LGA ($25) is 8% of the NSW average ($300), while the median housing loan ($1,029) is 52% of the NSW average ($1,993). This is likely to be either data error or a result of the ownership trends of farms and large rural properties in the Beckom LGA.
### Table 4.19
**2006 and 2011 Census Population Statistics**

<table>
<thead>
<tr>
<th></th>
<th>Ardlethan SS</th>
<th>Beckom SS</th>
<th>Coolamon LGA</th>
<th>Bland LGA</th>
<th>Narrandera LGA</th>
<th>NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>468</td>
<td>364</td>
<td>-22.2</td>
<td>170</td>
<td>218</td>
<td>28.2</td>
</tr>
<tr>
<td>Males</td>
<td>237</td>
<td>173</td>
<td>-27.0</td>
<td>91</td>
<td>114</td>
<td>25.3</td>
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<tr>
<td>Females</td>
<td>231</td>
<td>191</td>
<td>-17.3</td>
<td>73</td>
<td>104</td>
<td>42.5</td>
</tr>
</tbody>
</table>

Source: ABS 2011 and 2006 Census

### Table 4.20
**2011 Census Age Statistics**

<table>
<thead>
<tr>
<th></th>
<th>Ardlethan SS</th>
<th>Beckom SS</th>
<th>Coolamon LGA</th>
<th>Bland LGA</th>
<th>Narrandera LGA</th>
<th>NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td><strong>Children</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-4</td>
<td>15</td>
<td>0.8</td>
<td>12</td>
<td>5.5</td>
<td>254</td>
<td>6.2</td>
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<tr>
<td>5-14</td>
<td>47</td>
<td>2.4</td>
<td>36</td>
<td>16.5</td>
<td>665</td>
<td>16.2</td>
</tr>
<tr>
<td><strong>Studying or Working</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-19</td>
<td>20</td>
<td>4.1</td>
<td>8</td>
<td>3.7</td>
<td>260</td>
<td>6.3</td>
</tr>
<tr>
<td>20-24</td>
<td>11</td>
<td>5.8</td>
<td>11</td>
<td>5.0</td>
<td>174</td>
<td>4.2</td>
</tr>
<tr>
<td>25-34</td>
<td>23</td>
<td>7.4</td>
<td>13</td>
<td>6.0</td>
<td>314</td>
<td>7.7</td>
</tr>
<tr>
<td>35-44</td>
<td>37</td>
<td>9.1</td>
<td>26</td>
<td>11.9</td>
<td>492</td>
<td>12.0</td>
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<tr>
<td>45-54</td>
<td>56</td>
<td>10.8</td>
<td>42</td>
<td>19.2</td>
<td>595</td>
<td>14.5</td>
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<tr>
<td><strong>Approaching Retirement or Retired</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>56</td>
<td>12.4</td>
<td>28</td>
<td>12.8</td>
<td>514</td>
<td>12.5</td>
</tr>
<tr>
<td>65-74</td>
<td>70</td>
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<td>18</td>
<td>8.3</td>
<td>456</td>
<td>11.2</td>
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<tr>
<td>75-84</td>
<td>20</td>
<td>15.7</td>
<td>21</td>
<td>9.6</td>
<td>275</td>
<td>6.7</td>
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<tr>
<td>85+</td>
<td>9</td>
<td>17.4</td>
<td>3</td>
<td>1.4</td>
<td>100</td>
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<tr>
<td><strong>Total</strong></td>
<td>364</td>
<td></td>
<td>218</td>
<td></td>
<td>4 099</td>
<td>5 865</td>
</tr>
</tbody>
</table>

Source: ABS 2011 Census
**Table 4.21**

2011 Census Employment Statistics

<table>
<thead>
<tr>
<th></th>
<th>Ardlethan SS</th>
<th>Beckom SS</th>
<th>Coolamon LGA</th>
<th>Bland LGA</th>
<th>Narrandera LGA</th>
<th>NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Employed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time¹</td>
<td>60 (50.8%)</td>
<td>76 (67.9%)</td>
<td>1 102 (62.5%)</td>
<td>1 765 (63.2%)</td>
<td>1 556 (60.4%)</td>
<td>2 007 925 (63.1%)</td>
</tr>
<tr>
<td>Part-time</td>
<td>31 (26.3%)</td>
<td>27 (24.1%)</td>
<td>479 (27.2%)</td>
<td>735 (26.3%)</td>
<td>694 (27.0%)</td>
<td>939 464 (29.9%)</td>
</tr>
<tr>
<td>Employed, away from work</td>
<td>12 (10.2%)</td>
<td>6 (5.4%)</td>
<td>74 (4.2%)</td>
<td>104 (3.7%)</td>
<td>123 (4.8%)</td>
<td>120 121 (3.8%)</td>
</tr>
<tr>
<td>Employed, hours not stated</td>
<td>3 (2.5%)</td>
<td>3 (2.7%)</td>
<td>45 (2.6%)</td>
<td>91 (3.3%)</td>
<td>68 (2.6%)</td>
<td>70 821 (2.2%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>106</td>
<td>112</td>
<td>1 700</td>
<td>2 695</td>
<td>2 441</td>
<td>3 138 331</td>
</tr>
<tr>
<td><strong>Unemployed, Looking for</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time work</td>
<td>9 (7.6%)</td>
<td>0 (0%)</td>
<td>42 (2.4%)</td>
<td>57 (2.0%)</td>
<td>90 (3.5%)</td>
<td>116 697 (1.7%)</td>
</tr>
<tr>
<td>Part-time work</td>
<td>3 (2.5%)</td>
<td>0 (0%)</td>
<td>19 (1.1%)</td>
<td>42 (1.5%)</td>
<td>44 (1.7%)</td>
<td>79 829 (1.2%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>12</td>
<td>0</td>
<td>61</td>
<td>99</td>
<td>134</td>
<td>196 526</td>
</tr>
<tr>
<td><strong>Labour Force Participation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total labour force</td>
<td>118</td>
<td>112</td>
<td>1 761</td>
<td>2 794</td>
<td>2 575</td>
<td>3 334 857</td>
</tr>
<tr>
<td>Not in labour force</td>
<td>171</td>
<td>44</td>
<td>1 239</td>
<td>1 610</td>
<td>1 764</td>
<td>1 933 275</td>
</tr>
<tr>
<td>Labour force status not stated</td>
<td>15</td>
<td>15</td>
<td>182</td>
<td>180</td>
<td>327</td>
<td>317 017</td>
</tr>
<tr>
<td><strong>Total Persons</strong></td>
<td>304</td>
<td>171</td>
<td>3 182</td>
<td>4 584</td>
<td>4 663</td>
<td>5 585 149</td>
</tr>
<tr>
<td>Labour force participation</td>
<td>38.8%</td>
<td>65.5%</td>
<td>55.3%</td>
<td>58.8%</td>
<td>55.2%</td>
<td>59.7%</td>
</tr>
</tbody>
</table>

Source: ABS 2011 Census
### Table 4.22

2011 Census Industry of Employment Statistics

<table>
<thead>
<tr>
<th>Section</th>
<th>Ardlethan SS</th>
<th>Beckom SS</th>
<th>Coolamon LGA</th>
<th>Bland LGA</th>
<th>Narrandera LGA</th>
<th>NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, forestry &amp; fishing</td>
<td>10</td>
<td>9.7</td>
<td>64</td>
<td>58.7</td>
<td>404</td>
<td>23.7</td>
</tr>
<tr>
<td>Mining</td>
<td>6</td>
<td>5.8</td>
<td>0</td>
<td>0.0</td>
<td>8</td>
<td>0.5</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0</td>
<td>0.0</td>
<td>3</td>
<td>2.8</td>
<td>127</td>
<td>7.5</td>
</tr>
<tr>
<td>Electricity, gas, water &amp; waste services</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
<td>16</td>
<td>0.9</td>
</tr>
<tr>
<td>Construction</td>
<td>6</td>
<td>5.8</td>
<td>0</td>
<td>0.0</td>
<td>96</td>
<td>5.6</td>
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<tr>
<td>Wholesale trade</td>
<td>3</td>
<td>2.9</td>
<td>0</td>
<td>0.0</td>
<td>72</td>
<td>4.2</td>
</tr>
<tr>
<td>Retail trade</td>
<td>12</td>
<td>11.7</td>
<td>6</td>
<td>5.5</td>
<td>135</td>
<td>7.9</td>
</tr>
<tr>
<td>Accommodation &amp; food services</td>
<td>9</td>
<td>8.7</td>
<td>3</td>
<td>2.8</td>
<td>70</td>
<td>4.1</td>
</tr>
<tr>
<td>Transport, postal &amp; warehousing</td>
<td>12</td>
<td>11.7</td>
<td>3</td>
<td>2.8</td>
<td>85</td>
<td>5.0</td>
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<tr>
<td>Information media &amp; telecommunications</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
<td>15</td>
<td>0.9</td>
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<tr>
<td>Financial &amp; insurance services</td>
<td>3</td>
<td>2.9</td>
<td>3</td>
<td>2.8</td>
<td>19</td>
<td>1.1</td>
</tr>
<tr>
<td>Rental, hiring &amp; real estate services</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
<td>3</td>
<td>0.2</td>
</tr>
<tr>
<td>Professional, scientific &amp; technical services</td>
<td>6</td>
<td>5.8</td>
<td>3</td>
<td>2.8</td>
<td>55</td>
<td>3.2</td>
</tr>
<tr>
<td>Administrative &amp; support services</td>
<td>0</td>
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<td>0</td>
<td>0.0</td>
<td>29</td>
<td>1.7</td>
</tr>
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<td>Public administration &amp; safety</td>
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<td>0.0</td>
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<tr>
<td>Education &amp; training</td>
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<td>12.6</td>
<td>18</td>
<td>16.5</td>
<td>176</td>
<td>10.3</td>
</tr>
<tr>
<td>Health care &amp; social assistance</td>
<td>11</td>
<td>10.7</td>
<td>0</td>
<td>0.0</td>
<td>159</td>
<td>9.3</td>
</tr>
<tr>
<td>Arts &amp; recreation services</td>
<td>3</td>
<td>2.9</td>
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<td>0.0</td>
<td>16</td>
<td>0.9</td>
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<tr>
<td>Other services</td>
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<td>3</td>
<td>2.8</td>
<td>50</td>
<td>2.9</td>
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<tr>
<td>Inadequately described/Not stated</td>
<td>3</td>
<td>2.9</td>
<td>3</td>
<td>2.8</td>
<td>41</td>
<td>2.4</td>
</tr>
<tr>
<td>Total</td>
<td>103</td>
<td>109</td>
<td>1 702</td>
<td>2 696</td>
<td>2 443</td>
<td>3 138 330</td>
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Source: ABS 2011 Census
Table 4.23
2011 Census Income Statistics

<table>
<thead>
<tr>
<th></th>
<th>Ardlethan SS</th>
<th>Beckom SS</th>
<th>Coolamon LGA</th>
<th>Bland LGA</th>
<th>Narrandera LGA</th>
<th>NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median individual income (weekly)</td>
<td>$334</td>
<td>$480</td>
<td>$452</td>
<td>$459</td>
<td>$453</td>
<td>$561</td>
</tr>
<tr>
<td>Median family income (weekly)</td>
<td>$558</td>
<td>$1,264</td>
<td>$1,037</td>
<td>$1,072</td>
<td>$1,013</td>
<td>$1,477</td>
</tr>
<tr>
<td>Median household income (weekly)</td>
<td>$552</td>
<td>$1,208</td>
<td>$857</td>
<td>$879</td>
<td>$810</td>
<td>$1,237</td>
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Source: ABS 2011 Census

Table 4.24
2011 Census Cost of Housing and Household Size Statistics

<table>
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<tr>
<th></th>
<th>Ardlethan SS</th>
<th>Beckom SS</th>
<th>Coolamon LGA</th>
<th>Bland LGA</th>
<th>Narrandera LGA</th>
<th>NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median housing loan repayment (monthly)</td>
<td>$607</td>
<td>$1,029</td>
<td>$1,192</td>
<td>$1,070</td>
<td>$1,075</td>
<td>$1,993</td>
</tr>
<tr>
<td>Median rent (weekly)</td>
<td>$90</td>
<td>$25</td>
<td>$125</td>
<td>$130</td>
<td>$140</td>
<td>$300</td>
</tr>
<tr>
<td>Average number of persons per bedroom</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Average household size</td>
<td>2.1</td>
<td>2.8</td>
<td>2.6</td>
<td>2.4</td>
<td>2.4</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Source: ABS 2011 Census

Education

Table 4.25 presents post-school education statistics from the 2011 Census. The data indicates that fewer people hold bachelor degrees, graduate diplomas and postgraduate degrees (university level education) in the Ardlethan SS, the Beckom SS, the Coolamon LGA, the Bland LGA and the Narrandera LGA than for NSW as a whole. By contrast, people with certificate levels and advanced diplomas (TAFE level education) were more common in the Ardlethan SS, the Beckom SS, the Coolamon LGA, the Bland LGA and the Narrandera LGA when compared to NSW. This may reflect the general lack of accessible universities for residents and limited professional opportunities for those with such qualification. By contrast, the higher proportion of TAFE-based qualification identifies that the TAFE locations at Griffith, West Wyalong, Leeton and Narrandera are critical infrastructure for the local population.

4.11.3 Potential Socio-Economic Impacts

Potential exists for both positive and negative socio-economic impacts associated with the Proposal. Potential adverse socio-economic impacts include the following.

- Increased competition for skilled and semi-skilled labour.
- Increased demand for housing and associated community services.
Table 4.25
2011 Census Post School Level of Education

<table>
<thead>
<tr>
<th></th>
<th>Ardlethan SS</th>
<th>Beckom SS</th>
<th>Coolamon LGA</th>
<th>Bland LGA</th>
<th>Narrandera LGA</th>
<th>NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postgraduate Degree Level</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>42 (2.8%)</td>
<td>21 (1.0%)</td>
<td>32 (1.5%)</td>
<td>238 851 (7.5%)</td>
</tr>
<tr>
<td>Graduate Diploma and</td>
<td>3 (2.5%)</td>
<td>3 (4.4%)</td>
<td>32 (2.2%)</td>
<td>31 (1.5%)</td>
<td>44 (2.1%)</td>
<td>82 617 (2.6%)</td>
</tr>
<tr>
<td>Graduate Certificate Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor Degree Level</td>
<td>16 (13.3%)</td>
<td>10 (14.7%)</td>
<td>239 (16.2%)</td>
<td>289 (14.3%)</td>
<td>280 (13.1%)</td>
<td>787 336 (24.6%)</td>
</tr>
<tr>
<td>Advanced Diploma and</td>
<td>15 (12.5%)</td>
<td>15 (22.1%)</td>
<td>177 (12.0%)</td>
<td>224 (11.1%)</td>
<td>210 (9.8%)</td>
<td>462 059 (14.4%)</td>
</tr>
<tr>
<td>Diploma Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certificate Level</td>
<td>53 (44.2%)</td>
<td>19 (27.9%)</td>
<td>585 (39.6%)</td>
<td>961 (47.7%)</td>
<td>860 (40.1%)</td>
<td>986 704 (30.9%)</td>
</tr>
<tr>
<td>Level of education</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>49 (3.3%)</td>
<td>66 (3.3%)</td>
<td>66 (3.1%)</td>
<td>100 290 (3.1%)</td>
</tr>
<tr>
<td>inadequately described</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of education not</td>
<td>33 (27.5%)</td>
<td>21 (30.9%)</td>
<td>354 (24.0%)</td>
<td>424 (21.0%)</td>
<td>652 (30.4%)</td>
<td>539 067 (16.9%)</td>
</tr>
<tr>
<td>stated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>68</td>
<td>1 478</td>
<td>2 016</td>
<td>2 144</td>
<td>3 196 924</td>
</tr>
</tbody>
</table>

Source: ABS 2011 Census

Potential positive or beneficial impacts associated with the Proposal include the following.

- The Proposal would provide direct full-time employment for up to 28 people. As it is the Applicant’s intention to offer all positions on a residential basis, these positions would be based in Ardlethan or the surrounding towns. As many of the positions would be on an event time (e.g. 4-on / 4-off or similar) roster, opportunity exists for local farmers and others to generate an off-farm income while continuing to manage their properties.

- The Proposal would also contribute up to approximately $4.2 million per year to the local and regional economies through the purchase of consumables and payment of wages. This expenditure is likely to generate additional economic activity and flow on effects within the Coolamon, Bland and Narrandera LGAs, providing further employment opportunities. The Proposal would also generate ongoing support for training and education of employees.

- The Project would also contribute to the national and State economies through the payment of taxes and royalties and the purchase of goods and services from outside the local area.

4.11.4 Management and Mitigation Measures

In addition to the mitigation measures and management procedures relating to amenity aspects such as noise, air quality, visibility, transportation, etc. described previously in Section 4, the Applicant would implement the following management and mitigation measures to ensure that...
Proposal-related benefits for the community surrounding the Project Site are maximised and adverse impacts are minimised, particularly given the small size of the surrounding communities.

- Engage in regular dialogue with surrounding residents in relation to the Applicant’s activities and implement and maintain an “open door” policy for interested parties to discuss aspects of those activities that may be perceived as problematic.
- Negotiate a Voluntary Planning Agreement with Coolamon Shire Council to ensure an equitable contribution to the local community, without adversely impacting on the financial robustness of the Proposal.
- Support community organisations, groups and events, as appropriate, and review any request by a community organisation for support or assistance.
- Maintain a community complaints telephone line and ensure that the existence of the number is advertised widely.
- Give preference when engaging new employees, where practicable, to candidates from the surrounding communities over candidates with equivalent experience and qualifications from elsewhere and ensure that the mining and other contractors do so as well.
- Facilitate seasonal, part time and casual work that takes into account the requirements of surrounding agricultural operations.
- Encourage the involvement of the local Aboriginal community in the workforce.
- Encourage and support participation of locally-based employees and contractors in training or education programs to impart the appropriate skillsets and qualifications in them for continued development and economic growth within the surrounding communities following completion of the Proposal.
- Give preference, where practicable and cost-competitive, to suppliers of equipment, services or consumables located within the surrounding communities.
- Encourage and support, in consultation with the local community, the provision of services to the community. These may include health, education, transportation and other services.

4.11.5 Impact Assessment

Section 2.12 describes Proposal’s employment and economic contributions that would result in a range of socio-economic benefits to the community surrounding the Project Site. These benefits would include the following.

- Ongoing employment for up to 28 persons on a full time equivalent basis.
- Contribution to the local, Regional, State and National economies, including contributions of up to approximately $4.2 million per year within the local and regional economy through wages and salaries and purchase of goods and services, with additional indirect contributions. A further up to approximately $1.3 million per year would be contributed to the State and national economy.
• Maintenance and upgrade of Tin Mines Road and contributions to the maintenance of Bygoo Road through a Voluntary Planning Agreement with Coolamon Shire Council.

• Continued support for local Community Organisations and Services.

Assessment of the potential socio-economic impacts demonstrates the beneficial impacts of the Proposal far outweigh any minor adverse impacts associated with the operations.