Environmental Impact Assessment
8.1 Introduction
Environmental Impact Assessment

8.1 Introduction

This section of the EES evaluates the potential impacts of the Project on the biophysical or natural environment, as well as the social and economic environment. It also outlines measures for management and mitigation of potential impacts and assesses the overall impacts of the Project expected after implementation of the management and mitigation measures.

The EES investigations underpinning the assessment of potential impacts were conducted by a variety of technical specialists and involved both desktop and field investigations.

Management strategies to mitigate potential impacts associated with the Project have been developed by the relevant specialists in each field based on the final design and proposed method of operation of the Project. The impact assessment and development of management strategies has been an iterative process designed to strengthen each mitigation measure or modify design aspects of the Project until compliance with all relevant statutory standards and guidelines has been demonstrated. SGM believes that compliance with all regulatory requirements has been achieved.

The assessment is presented in the following order for each section so as to meet the assessment requirements set out in Section 4.1 of the Scoping Requirements:

- **Existing conditions** – outlines the existing conditions relevant to the biophysical, social or economic environment being assessed.
- **Impact assessment** – an assessment of the potential impacts of the Project on the environment.
- **Management and mitigation measures** – a description of the measures proposed to manage or mitigate impacts on that aspect of the environment.
- **Conclusions** – assessment of the Project on the environment assuming that identified mitigation measures are implemented.

A semi-quantitative risk assessment of all aspects of the Project on five asset categories (property and infrastructure; environment; social; economic; and public health and safety) is presented in Chapter 9. The risk assessment brings together all of the potential impacts of the Project in a systematic manner and provides a transparent approach to, wherever possible, quantifying the risks and consequences of the Project for community and regulator consideration.

The management and mitigation commitments outlined in each of the environmental impact sections are brought together in Chapter 11 – Environmental Management.
8.2
Flora and Fauna
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8.2 Flora and Fauna

8.2.1 Introduction
This section of the EES describes the potential impacts of the Project on flora, fauna and ecological communities, including measures to manage and mitigate potential adverse impacts; and the overall impacts of the Project following the proposed management and mitigation measures.

It is based primarily on information presented in:

- Ecology and Heritage Partners (2013a) Flora and Fauna Assessment, and Net Gain Analysis for the Big Hill Enhanced Development Project, prepared for URS Australia Pty Ltd.
- Ecology and Heritage Partners (2013b) Targeted Flora Surveys for the Big Hill Enhanced Development Project, prepared for URS Australia Pty Ltd.
- Ecology and Heritage Partners (2014) Biodiversity Offset Report for the Big Hill Enhanced Development Project, prepared for URS Australia Pty Ltd.

These reports are included in Technical Appendix 2 of this EES and should be referred to for more detail on the issues discussed in this section.

Relevant sections of EES Scoping Requirements
This section of the EES addresses the requirements specified in Section 4.3 of the Scoping Requirements as follows:

4.3 Biodiversity

Evaluation Objective
To avoid or minimise adverse effects on native vegetation and listed flora and fauna species and ecological communities, including any relevant species listed under the EPBC Act, and address opportunities for offsetting potential losses consistent with relevant policy.

Key issues
- Direct loss of native vegetation and associated listed flora, including threatened orchid species.
- Direct habitat loss for listed fauna including Brown Treecreeper and Bearded Dragon, and disturbance and/or degradation of adjoining available habitat that may support Swift Parrot.

Priorities for characterising the existing environment
- Describe the biodiversity values that could be affected by the project, including:
  - remnant native vegetation and any ecological communities listed under the FFG Act
  - presence of, or suitable habitats for, flora and fauna species listed under the FFG Act or the EPBC Act
  - use of habitat corridors by wildlife.
- Describe hazards that the project could present to biodiversity values, including:
  - direct removal or destruction of habitat
  - disturbance or alteration of habitat conditions or other sources of increased habitat threat
  - the presence of any declared weeds or pathogens in the project area that could be dispersed.
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**Design and mitigation measures**

- Describe the measures both considered and proposed to avoid and minimise the potential for significant effects on native vegetation, listed flora and fauna species and ecological communities.

**Assessment of likely effects**

- Assess the direct and indirect effects of the project and relevant alternatives on native vegetation, and listed ecological communities and flora species, in particular any relevant species listed under the FFG Act or EPBC Act.
- Assess the direct and indirect effects of the project and relevant alternatives on indigenous fauna, including listed threatened and migratory species.

**Approach to manage performance**

- Describe and evaluate proposed measures to manage residual effects of the project on biodiversity values, including an outline of an offset strategy that sets out the offsets that have been secured or are proposed to satisfy offset policy requirements.'

**Key issues emerging from EES studies and community consultation**

The EES Scoping Requirements outlined above provide a detailed list of the issues requiring attention in the EES. In addition, community concerns arising from the ongoing community engagement and communications program that relates to potential flora and fauna impacts of the Project are:

- the loss of habitat for native species
- disturbance of nuisance animal species (e.g. snakes) which may enter residential properties adjoining the Project area.

**Summary of findings**

- The Project will result in the loss of 15.732 hectares of native vegetation, including 14.537 hectares of remnant vegetation and 17 scattered trees.
- No nationally significant flora or fauna species or ecological communities were found within the study area.
- One state significant flora species (Small-leaf Goodenia Goodenia benthamiana) and two state significant fauna species (Brown Treecreeper Climacteris picumnus victoriae, and Bearded Dragon Pogona barbata) were identified within the study area.
- A Native Vegetation Offset Management Plan will be developed ensure a compliant vegetation removal is offset in accordance with the Native Vegetation Permitted Clearing Regulations: Biodiversity Assessment Guidelines (DEPI 2013). A total of 4.743 biodiversity equivalence units will be required to satisfy the general offset requirement.
- The proposed vegetation removal is not likely to have a proportional impact on any rare or threatened species' habitats above the specific offset threshold, and therefore no specific offsets are required.
8.2.2 Existing Conditions

The Goldfields bioregion

The Project area is within the south western portion of the Goldfields bioregion, adjacent to the Wimmera bioregion (Figure 8-1). A bioregion is a large planning unit used at the National and State scale to capture the patterns of ecological characteristics in the landscape or seascape.

The Goldfields bioregion is dominated by dissected uplands (predominantly a northerly aspect) of Lower Palaeozoic deposits. Low lying corridors of alluvial valleys and basaltic plains are dominated by Plains Grassy Woodland and Low Rises Grassy Woodland / Alluvial Terraces Herb-rich Woodland Mosaic ecosystems. The granitic and sedimentary (with Tertiary colluvial aprons) terrain is dominated by Grassy Woodlands much of which has been cleared. Box Ironbark Forest, Heathy Dry Forest and Grassy Dry Forest ecosystems, dominate the lower slopes or poorer soils. Metamorphic and old volcanic rocks have formed steeply sloped peaks and ridges.

These characteristics influence the flora and fauna species and ecological communities found within the bioregion, some of which are of national or state significance (see subsequent sections).
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Box Ironbark Forest - ecological vegetation class 61

An ecological vegetation class (EVC) is a level of classification, which consists of one or a number of floristic communities that appear to be associated with a recognisable environmental niche. Each EVC is described by a combination of its structure, floristic, life-form and reproductive strategy features, and through an inferred fidelity to particular environmental attributes.

The Department of Environment and Primary Industries (DEPI) EVC mapping for the region shows that prior to European settlement, the entire study area and immediate surrounds contained one EVC, being Box Ironbark Forest (EVC 61). The EVC mapping\(^1\) based on conditions in 2005 shows this is still the only EVC found within the study area, with the exception of a very small portion of Grassy Woodland around the eastern edges of Mt Micke (Figure 8-2). This was confirmed during field assessments, based on vegetation composition, soil types and geographic location.

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Figure 8-2  Box Ironbark Forest (EVC 61), 2005 distribution within Project area

(Source: DEPI 2013)
### Study area

A number of flora and fauna field surveys were undertaken to establish the existing conditions detailed below. The survey area was much broader area than the Project area and included all areas within the mining lease which could have been potentially impacted by the Project, the footprint of which was not fully known at the time of the surveys. The study area in relation to the Project area is shown in Figure 8-3.

Flora and fauna assessments were undertaken on 9 and 10 January 2012, 3 January 2013, 1 and 2 July 2013 to obtain information on the flora values within the study area.

Targeted flora surveys were undertaken on 19 and 20 August, 23 and 24 September, and 17 and 18 October 2013 for national and state significant flora. Targeted surveys focused on likely habitat within high quality areas of Box Ironbark Forest identified during flora and fauna assessments. Surveys were undertaken at Deep Lead Flora and Fauna Reserve prior to each of these targeted surveys. This was to confirm that each species was currently flowering and to observe each species in the field prior to surveying the study site to assist with future identification purposes.

The description of the existing conditions is provided in relation to the study area, while the impact assessment (Section 8.2.3) considers the Project area (i.e. the area to be directly impacted by the Project) only.
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Figure 8-3 Flora and fauna survey area relative to the Project area
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**Flora species**
A total of 227 flora species (150 native and 77 exotic) were recorded across the study area (see Technical Appendix 2, Appendix 2.1). Planted trees and shrubs were not recorded unless they were seen to be naturally spreading on site. Flora species and soil types are representative of Box Ironbark Forest, which is listed as ‘depleted’ within the Goldfields bioregion.

No nationally significant flora species were recorded within the study area. A total of 11 nationally listed flora species have previously been recorded within the local area (within 10 kilometres of the study area). An additional six species, not previously documented within the local area, also have habitat potentially occurring within the vicinity of the study area.

One state significant species, Small-leaf Goodenia *Goodenia benthamiana* was recorded within the study area. It is a sticky shrub to 40 centimetres tall with broad, stem clasping leaves along erect stems that flowers between September and February. There are currently 74 records for this species across Victoria, and is considered rare. This species is generally scattered across western Victoria in an area bounded by Bendigo in the east, Big Desert to the north, Mt Arapiles to the south. This species was only recorded at one location within the study area, along the artificial embankment which is adjacent to the storage yard. Given the lack of other records of this species within 10 kilometres of the study area, this record is considered an outlier.

A further 45 state significant flora species have previously been recorded in the local area. The likelihood of occurrence of state listed threatened species within the study area is outlined in Technical Appendix 2, Appendix 2.2.

**Communities**
No ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the *Flora and Fauna Guarantee Act 1988* (FFG Act) are present throughout the entire study area.

**Fauna species**
A total of 82 terrestrial fauna species comprising nine mammals (five native and four introduced), 64 birds (60 native and four introduced), five reptiles and four frogs (all native) were recorded across the entire study area (see Technical Appendix 2, Appendix 3.1). There have been 199 fauna species documented; the majority of which are birds, with relatively low numbers of mammals, reptiles, frogs and fish.

No nationally significant fauna species were recorded during the present survey. However, 14 nationally significant fauna have previously been recorded from the local area or, are predicted to occur. Swift Parrot *Lathamus discolor* may visit the woodland areas within the study area, while Australian Painted Snipe *Rostratula australis* may utilise dams / artificial waterbodies on rare occasions. However, these areas are unlikely to provide permanent and/or important habitat for these species.
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One state significant bird species, Brown Treecreeper *Climacteris picumnus victoriae*, and one state significant reptile species, Bearded Dragon *Pogona barbata*, were identified within the study area. An additional 19 state significant fauna have previously been documented within 10 kilometres of the study area. Given previous records and the quality of habitat present within the study area, the Brown Treecreeper is likely to regularly visit and forage within the woodland patches. Similarly, some woodland-dependent birds (Hooded Robin, Diamond Firetail, Speckled Warbler) may visit the study area on occasion, however it is unlikely to provide permanent and/or important habitat for these species. Black Falcon *Falco sugniger* may fly over, or forage, within the study area on rare occasions, however it is considered unlikely that this species would utilise the study area other than as a vagrant visitor. There is no suitable habitat within the study area for any other species of state significance.

**Fauna habitat**

Five broad fauna habitat types are found within and around the study area (Table 8-1). Fauna habitat quality varies from high, for remnant woodland, to low, for introduced grassland.

**Table 8-1  Fauna habitats recorded within study area**

<table>
<thead>
<tr>
<th>Habitat type</th>
<th>Overall habitat value</th>
<th>Description</th>
<th>Typical terrestrial fauna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary grassland</td>
<td>Low</td>
<td>Characterised by the removal of woodland overstorey trees, where the remaining understorey behaves as a grassland patch</td>
<td>• Magpie-lark</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Brown Falcon</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Black-shouldered Kite</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• House Sparrow</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reptiles</td>
</tr>
<tr>
<td>Woodland</td>
<td>Moderate to high</td>
<td>Characterised by a Yellow Gum overstorey that provides habitat for avifauna, mammal and reptile species, with some trees supporting hollows</td>
<td>• Bearded Dragon</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Bougainville’s Skink</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Superb Fairy Wren</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Willie Wagtail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Brown Treecreeper</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Ring-tailed Possum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Brush-tailed Possum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Brown Goshawk</td>
</tr>
<tr>
<td>Dams / artificial waterbodies</td>
<td>Low to moderate</td>
<td>A single dam / artificial waterbody is present in the eastern section of the study area.</td>
<td>• Pacific Black Duck</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Masked Lapwing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Spotted Marsh Frog</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Common Froglet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Eastern Great Egret</td>
</tr>
<tr>
<td>Recreation reserve or Arboretum of planted trees</td>
<td>Low to moderate</td>
<td>This habitat type consists of the Apex Arboretum, which consists of mainly gymnosperms (non-flowering plants).</td>
<td>• Long-billed Corella</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Yellow-tailed Black Cockatoo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Native mammal species</td>
</tr>
<tr>
<td>Introduced grassland</td>
<td>Low</td>
<td>Occurs predominantly within the GMWWater-owned land within the TWRS area. Very few native flora species occur within the habitat, which predominantly contains introduced grasses and weeds, which are regularly grazed or slashed/mown</td>
<td>• Australian Magpie</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Galah</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Native raptor species</td>
</tr>
</tbody>
</table>
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**Sites of biological significance (BioSites)**

A BioSite is a physical area of land or water containing biological assets with particular attributes, such as the presence of rare or threatened flora, fauna or habitat required for their survival and/or rare or threatened vegetation communities. BioSites are intended for use by DEPI and other relevant government agencies as a strategic guide for future investment in biodiversity conservation.

No BioSites are recorded within the local area, and as such, no further consideration has been given to this issue.

**Ecological significance**

Considering flora, fauna, significant species and communities and habitats available within the study area, remnant vegetation is considered to be of at least regional conservation significance for the following reasons:

- the occurrence of one EVC, Box Ironbark Forest (EVC 61), which is listed as depleted within the Goldfields bioregion
- the presence of one state significant flora species, Small-leaf Goodenia
- suitable habitat for several state significant flora species
- presence of two state significant fauna species, Bearded Dragon and Brown Treecreeper
- suitable foraging, dispersal and sheltering habitat for a range of native fauna species, including some state and regionally significant species.

8.2.3 Impact Assessment

Any loss of ecological values should be viewed in the overall context of on-going loss, fragmentation, and deterioration in the quality of remnant vegetation throughout the greater Goldfields bioregion. The proposed development is likely to have a localised impact on indigenous flora and fauna species habitats.

Direct impacts of the proposed development are likely to include:

- removal and / or disturbance to areas of Box Ironbark Forest
- loss of scattered indigenous trees associated with the Box Ironbark Forest EVC
- degradation of habitat for flora and fauna species
- decreases in population sizes of local flora and fauna species due to loss of habitat
- loss of suitable foraging, dispersal and sheltering habitat for a range of native fauna species
- increased habitat fragmentation through loss of remnant native vegetation, i.e. reduction in potential habitat corridors.

Potential impacts on adjacent areas relating to management of construction activities and drainage include:

- potential for further spread of environmental weeds from on-site activities and subsequent degradation of native vegetation adjacent to the site
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- indirect impacts to adjoining native vegetation/habitat (e.g. potential short-term disturbance to fauna during construction activities and from increased human activity).

Commonwealth assessment requirements
Following referral to the Australian Government Minister for the Environment, Heritage and Water, the Project was determined not to have a significant impact on a matter of national environmental significance and therefore no approval is required under the provisions of the EPBC Act.

Permitted clearing assessment

Biodiversity assessment guidelines
The Victorian government recently integrated the Native Vegetation Permitted Clearing Regulations: Biodiversity Assessment Guidelines (the Guidelines) into the Victoria Planning Provisions, replacing the Native Vegetation Management: A Framework for Action (NRE 2002). The primary objective of the regulation is ‘no net loss in the contribution made by native vegetation to Victoria’s biodiversity’.

The keystone of the new regulations is a risk-based assessment, with all proposals involving the removal of vegetation. Two factors – extent risk and location risk – are used to determine the risk associated with an application for a permit to remove native vegetation.

Extent risk is determined by the extent of native vegetation (in hectares) or number of trees proposed to be removed. This recognises that in general, the level of risk to biodiversity from the removal of native vegetation increases as the extent of native vegetation to be removed increases.

For the purpose of the Guidelines, the extent of native vegetation is defined by two categories:

- a remnant patch of native vegetation, which is either:
  - an area of vegetation where at least 25 per cent of the total perennial understorey plant cover is native
  - any area with three or more native canopy trees where the canopy foliage cover is at least 20 per cent of the area.

- scattered tree, which is a native canopy tree that does not form part of a remnant patch.

Scattered trees are converted to hectares using a standard area calculation of 0.0171 hectares per tree.

Location risk is determined by assessing the likelihood that removing a small amount of native vegetation in a location will have an impact on the persistence of a rare or threatened species. Location risk (A, B and C) has been determined by DEPI for all areas in Victoria based on the potential impact of vegetation removal on the persistence of rare or threatened species.

The combination of the two types of risk is used to determine the risk-based pathway (high, medium or low) for assessing a permit to remove native vegetation (Table 8-2).

The risk-based pathways determine the process for how a permit application is assessed, including the application requirements and the how the decision guidelines are applied.
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Table 8-2  Risk-based pathways for applications to remove remnant patches of native vegetation and scattered trees

<table>
<thead>
<tr>
<th>Extent</th>
<th>Location</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native vegetation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;0.5 hectares</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>≥0.5 hectares &lt; 1 hectare</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>≥1 hectare</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Scattered trees</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15 scattered trees</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>≥15 scattered trees</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

Habitat hectares

The habitat hectare is a site-based measure of the quality and quantity of a given area of native vegetation type. This measure allows the comparison of native vegetation types across the state. If it is assumed that an unaltered area of natural habitat is at 100 per cent of its natural quality, then one hectare of such habitat will be equivalent to one habitat hectare. That is the quality multiplied by the quantity. If an area of habitat had lost 50 per cent of its quality (e.g. through weed invasion and loss of understorey), then one hectare would be equivalent to 0.5 habitat hectares.

The number of habitat hectares represented by an area of native vegetation is calculated by multiplying the extent of native vegetation (in hectares) by the condition score assigned to a vegetation patch.

The condition of native vegetation is a site-based measure of how close the native vegetation is to its mature natural state, as represented by a benchmark reflecting pre-settlement circumstances. Vegetation throughout the entire study area is highly modified, either through historical logging and mining activities, or current recreational uses. As a result, vegetation condition throughout the study area is highly varied.

Strategic biodiversity score

The strategic biodiversity score of native vegetation at a site is a measure of the site’s importance for Victoria’s biodiversity, relative to other locations across the landscape.

The score is derived using a tool that ranks locations in Victoria for their conservation priority on the basis of rarity and level of depletion of the types of vegetation, species habitats, and condition and connectivity of native vegetation. Strategic biodiversity scores are mapped by DEPI and are used to ensure native vegetation losses are offset by vegetation with a similar biodiversity value.

Assessment summary

Figure 8-4 shows the location risk of each of the patches of remnant native vegetation within the Project area. While the majority of the patches are in location A (low risk), the Project is deemed to be in location C (high risk) due to as small number of patches being in this location. Therefore, according to DEPI modelling, there is a high risk that removing a small amount of native vegetation in this location will have an impact on the persistence of a rare or threatened species. However, this is based on the location risk of only a small proportion of the Project area.
Figure 8-5 shows the strategic biodiversity score of each of the patches of remnant native vegetation within the Project area. Most patches have a biodiversity score of between 0.4 and 0.6, with a weighted average of 0.527. This means that the Project area is of moderate importance in terms of its condition, extent, connectivity and the support function it plays for species. This is in keeping with the assessment of the Project area as being of regional significance (see previous section).
Table 8-3 summarises the native vegetation clearance proposed as part of the Project. The Project falls under a high risk pathway, based on the location of the site (location C) and the proposed removal of 15.73 hectares of native vegetation (which includes 14.54 hectares or remnant vegetation and 1.095 hectares of scattered trees). This means that avoidance and minimisation of impact on native vegetation must be considered before considering offsets.
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Table 8-3  Summary of proposed native vegetation clearance required for the Project

<table>
<thead>
<tr>
<th>Location</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic biodiversity score (of vegetation to be removed)</td>
<td>0.527</td>
</tr>
<tr>
<td>Vegetation to be removed</td>
<td>Remnant patch 15.732 hectares</td>
</tr>
<tr>
<td></td>
<td>Scattered trees 17 (1.095 hectares)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15.732 hectares</strong></td>
</tr>
<tr>
<td>Habitat hectares</td>
<td>6.013</td>
</tr>
<tr>
<td>Risk</td>
<td>Vegetation risk High</td>
</tr>
<tr>
<td>Scattered tree risk</td>
<td>Moderate</td>
</tr>
<tr>
<td>Risk pathway</td>
<td>High</td>
</tr>
</tbody>
</table>

**General offset requirement**

When the removal of native vegetation does not have a significant impact on the habitat of a particular rare or threatened species, a general offset must be obtained. A general offset requires that the contribution to Victoria’s biodiversity made by the offset be equal to the loss of the contribution to Victoria’s biodiversity from the removal of native vegetation. The vegetation and habitat attributes of the offset do not, however, need to match closely those attributes of the native vegetation to be removed.

The general offset requirements for the permitted clearance of vegetation proposed as part of the Project are summarised in Table 8-4.

Table 8-4  General offset requirements for the permitted clearance of vegetation

<table>
<thead>
<tr>
<th>General biodiversity equivalence score</th>
<th>Offset risk factor</th>
<th>Offset amount (biodiversity equivalence units)</th>
<th>Offset requirements</th>
<th>Offset attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.162</td>
<td>1.5</td>
<td>4.743</td>
<td>Offset must be within Wimmera CMA or Northern Grampians Shire municipality</td>
<td></td>
</tr>
</tbody>
</table>

The general biodiversity equivalence score is a measure of the relative overall contribution that the native vegetation to be removed makes to Victoria’s biodiversity. This score is calculated by multiplying the number of habitat hectares by the strategic biodiversity score (which in the case of the Project are 6.013 and 0.527 respectively).

To calculate the required offset amount (biodiversity equivalence units), the biodiversity equivalence score is multiplied by the offset risk factor, which in the case of general offsets, is 1.5. This risk factor is applied to the calculation of the offset amount in order to address the risk of offsets failing.
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Specific offset requirement
Where a site is habitat for a particular rare or threatened species, a specific offset is required to ensure there is no net loss of habitat for these species at a state level.

The species-specific offset test found that the proposal does not have a proportional impact on any rare or threatened species’ habitats above the specific offset threshold of 0.005 per cent of the total modelled habitat for each species. No specific offsets are therefore required for the Project.

8.2.4 Management and Mitigation Measures
As the vegetation removal proposed as part of the Project falls under the high risk pathway, the Guidelines require the relevant authorities to consider whether reasonable steps have been taken to avoid impacts on biodiversity have been avoided and minimised.

Avoid impacts
According to the high risk pathway, the Guidelines require relevant authorities to consider whether reasonable steps have been taken to avoid impacts to ‘native vegetation that makes a significant contribution to Victoria’s biodiversity’. This includes consideration of:

- impacts on important habitat for rare or threatened species, particularly highly localised habitat
- proportional impacts on remaining habitat for rare or threatened species
- if the removal of the native vegetation will contribute to a cumulative impact that is a significant threat to the persistence of a rare or threatened species
- the availability of, and potential for offsets to meet the ‘no net loss’ objective.

Avoidance of remnant vegetation, particularly high quality patches, was considered by SGM during the design phase of the Project. In particular, the location of the TWRS was selected so as to avoid the high quality Box Ironbark Forest on land adjoining the former Davis cut overburden dump. The loss of nine hectares of high quality Box Ironbark Forest was a major concern of the Panel reviewing the 1999 proposal. While this option remained open to SGM, it was considered an unacceptable environmental impact. Consequently, SGM designed the Project to avoid any loss of this vegetation.

In addition to minimising the Project footprint, mining activities will be concentrated in areas that have already been cleared or contain poorer habitat so as to avoid native vegetation as far as practicable.

Minimise impacts
In addition to steps taken during the Project design phase to avoid impacts on native vegetation, a number of measures are proposed by SGM in order to minimise impacts during the construction and operation phases of the Project:

- Appropriate soil stabilisation and erosion control measures will be implemented to minimise deterioration in quality of surface water run-off, damage to drainage lines, and flora and habitat both inside and outside the subject land as described in Section 8.11.
- Temporary fencing will be installed to protect adjacent areas of native vegetation and to identify them as ‘no go’ areas (i.e. including the use of signage to highlight the significance of areas immediately adjacent to the Project area).
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- Weed control measures will be implemented in areas of remnant vegetation adjacent to areas proposed to be impacted, as well as management of topsoil stockpiles prior to respreading. This is to be addressed in the EMP as part of the Work Plan.
- Staff and contractors will be informed of the importance of remnant native vegetation that has been identified for retention as a part of the site induction process and as new areas are accessed as a part of the Project.
- Consideration will be taken to relocate habitat which is to be removed such as hollow logs and other large, dead or fallen debris for rehabilitation purposes.
- Where possible, trees will be trimmed (rather than felled) to provide access for vehicles or machinery.
- Where possible, trees approved for felling will be cut at a height approximately equal to the diameter of the tree to facilitate coppicing instead of uprooting (DPI 2008).
- Construction stockpiles or spoil will be placed away from areas of remnant vegetation, natural drainage lines and water bodies.
- Monitoring of flora and fauna populations, especially significant species over a sufficient duration and during appropriate times of the year, both prior to and after mining.
- Provision of bird and bat nest boxes in suitable areas.

The Environmental Management Plan will detail the procedures to minimise vegetation losses.

Offset impacts

The Guidelines require vegetation removal to be offset as the final step in considering the impacts of the Project on native vegetation. Emphasis is placed on avoiding vegetation that makes a significant contribution to Victoria’s biodiversity, and only once these steps have been taken should offsets be considered.

Offset targets must be met as specified in Table 8-4. In determining the appropriate offset responses for permitted vegetation clearance, the Guidelines set out several criteria which must be considered for any offset site, as specified in Table 8-4.

Vegetation offsets must be achieved in accordance with a vegetation Offset Management Plan over the stipulated 10-year offset period (and beyond). The principle of ‘no net loss’ may be satisfied by protecting indigenous vegetation (i.e. onsite-offset) and/or locating a third-party off-site offset.

Additional options to achieve appropriate offsets include:
- purchasing offset credits through DEPI’s ‘BushBroker’ program
- working with ‘Trust for Nature’, a not-for-profit organisation, to identify and secure an offset
- negotiating a financial contribution towards an existing council-managed reserve
- contacting the Over-the-Counter Offsets Scheme to arrange the purchase of native vegetation offsets (credits)
- acquiring land and managing native vegetation elsewhere.
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SGM owns private land near Stawell Rifle Club away from the study site. It is likely that offsets can be met within this site. Field investigations have determined the extent of ecological values available at the offset site.

Should the Project receive approval, an assessment of this potential offset site will be undertaken to establish its suitability in light of the required general biodiversity equivalence units and minimum strategic biodiversity score specified by DEPI.

8.2.5 Conclusion

The flora and fauna survey has established that the Project will result in vegetation and habitat loss. In particular, one state significant flora species and two state significant fauna species were found at the site and may be impacted by the Project. No nationally significant flora or fauna species or ecology communities were recorded within the study area during any of the surveys undertaken, including targeted flora surveys conducted during the flowering periods of a number of species considered likely to occur within the Project site based on the presence of suitable habitat, and no significant impacts on these species are predicted.

The loss of vegetation resulting from the Project can be offset by protecting indigenous vegetation and/or locating a third-party off-site offset. This will be established in the Offset Management Plan, which will be prepared should the Project receive approval.

Potential impacts on state significant species are considered low and acceptable with fauna species able to relocate to suitable nearby habitat and the record of the Small-leaf Goodenia considered an outlier. Potential impacts on nationally significant flora and fauna species or ecological communities are not considered to be significant. No species or communities with this status were identified during data reviews or site surveys, and the Project site is unlikely to provide permanent and/or important habitat for nationally protected fauna that could potentially use the site from time to time.

Overall, the potential impacts of the Project on native flora and fauna species and ecological communities are considered to be modest and acceptable in the context of the benefits of the Project for the Stawell community and the ability of SGM to meet all regulatory requirements in respect of vegetation offsets.
8.3 Cultural Heritage
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8.3 Cultural Heritage Management Plan

8.3.1 Introduction
This section of the EES describes the implications of the Project for cultural heritage, including potential impacts of the Project; measures to manage and mitigate potential adverse impacts; and the overall impacts of the Project following implementation of management and mitigation measures.

This section is based primarily on information presented in:

- TerraCulture Pty Ltd (December 2013) Big Hill Enhanced Development Project, Stawell, Cultural Heritage Management Plan Number 12677, prepared for CGC.

This report is included in Technical Appendix 3 of this EES and should be referred to for more detail on the issues discussed in this section.

Relevant sections of EES Scoping Requirements
This section of the EES covers the following components of the EES Scoping Requirements insofar as they relate to Aboriginal cultural heritage:

‘4.8 Cultural Heritage

Evaluation Objective
To avoid or minimise adverse effects on Aboriginal and historic cultural heritage values, sites and places.

Key issues
- Destruction or disturbance of sites or places of Aboriginal or historic cultural heritage significance.

Priorities for characterising the existing environment
- Provide contextual information on past and contemporary activities in the project area by Aboriginal people.
- Identify and document any Aboriginal cultural heritage sites or areas of sensitivity within the project area, supported by appropriate consultation and investigations.

Design and mitigation measures
- Describe and evaluate proposed design, construction method or site protection measures which could avoid or minimise direct impacts on Aboriginal and historic cultural heritage values.

Assessment of likely effects
- Assess potential effects of the project and relevant alternatives on:
  - identified sites or places of Aboriginal cultural heritage significance; and

Approach to manage performance
- Outline and evaluate any proposed additional measures to mitigate and manage residual effects on:
  - sites and places of Aboriginal cultural heritage significance, within the framework of a draft Cultural Heritage Management Plan (CHMP)\(^2\).

\(^2\) Refer to EES Advisory Note: Aboriginal Cultural Heritage and the Environment Effects Process for further advice.
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Key issues emerging from EES studies and community consultation:
There were no key issues related to Aboriginal cultural heritage arising from the community during the preparation of EES studies or community consultation process.

Summary of findings

- The Stawell area is the traditional land of the Djab Wurrung people and their name for Big Hill was said to be Kobram.
- The lack of potable water in the Stawell area made it unsuitable for camping and hunting. However the summit of Bill Hill may have been utilised as a strategic vantage point by Aboriginal peoples prior to European arrival. Natural cultural resources such as wood and bark from trees and also ochre and quartz outcrops were likely to have been obtained from Big Hill and surrounding areas.
- A newspaper report of 1858 refers to the discovery of Aboriginal bones in the fork of a tree at Pleasant Creek (Stawell) which is likely to have been in the vicinity of Big Hill.
- There are 44 Aboriginal Places within 10 kilometres of the centre of the activity area. Of these, there are three registered Aboriginal sites within two kilometres, all occurring to the east of Big Hill, including Fox Cave; a rock shelter site containing charcoal and flaked quartz artefacts located 300 metres from the southern end of the activity area.
- One Aboriginal site (an isolated quartz stone artefact) was identified (during a study by Snoek in 1983) within the SGM former tailings storage facility (TSF1) which is outside of the Project area.
- At the time of the commencement of the CHMP there was no Registered Aboriginal Party (RAP) in the vicinity of the Project area. The Barengi Gadjin Land Council Aboriginal Corporation (BGLCAC) has applied to be the RAP for this area.
- Extensive disturbance has occurred in the area as a result of the gold rushes and more recently through modern developments such as roads and other settlement infrastructure and would have resulted in the destruction or disturbance of almost any Aboriginal cultural heritage that may have existed.
- Aboriginal Places containing isolated stone artefacts are possible but unlikely to occur within the Project area, and if they occur it is extremely unlikely that they will be in their original place of deposition.
- The survival of scarred trees (of Aboriginal origin) is unlikely due to the widespread and near total clearance of indigenous trees during the gold rush of the mid-19th century.

No Aboriginal cultural heritage places were identified within the activity area.

8.3.2 Existing Conditions
The history of Big Hill can be divided into five major use phases:
- Djab Wurrung traditional occupation (up to c. 1856)
- Pastoral (c.1841-1856)
- Reef mining (1856-1920)
- Rural/reprocessing/urban/municipal use (1920-present)

Section 8.3 focuses on the traditional occupation of the land and the interaction of the Djab Wurrung people with European settlement.
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8.3.2.1 Djab Wurrung Traditional Occupation

The town of Stawell falls within the Djab Wurrung language area. This language covers a large area of the central western district between Salt Creek to the east, which forms the eastern boundary, and the Wannon River to the west. It also includes the Hopkins River, Lake Bolac and the headwaters of the Wimmera River. In the southwest it includes Mt Abrupt, Mount Sturgeon, Mount Bainbridge and Mount Pierrepoint and Mount Napier. Halls Gap and Stawell fall within the northern western end of the Djab Wurrung language boundary close to the boundary with the neighbouring language area, the Jardwadjali (Clark, 1990).

There was a Djab Wurrung clan to the southwest near Halls Gap, the Tinbalug; one to the south at ‘Allanvale’ Station near Great Western and the headwaters of the Wimmera River, the Poitbalug; and one directly to the west the Jaaleet, ‘part of the La Rose and Mokepilly stations (Clark, 1990). A Djab Wurrung clan is not specifically listed at Stawell.

Their name for Big Hill was said to be Kobram meaning head. Because of the prominence of Big Hill it may have been used as a vantage point. However the lack of potable water in the Stawell area made in unsuitable for camping and hunting. Historian Massola (1970) states that ‘it is even probable that the district was regarded as a no-mans-land, and that it was a boundary between two groups of tribes’ (Massola, 1970).

A newspaper report of 1858 refers to the discovery of Aboriginal bones in the fork of a tree at Pleasant Creek (Stawell) (Argus, 1858) ‘about half-a-mile below the crushing machines’. The precise find location of the remains is not certain as there were two sets of crushing machines at Pleasant Creek at this time: one at Big Hill, the other at Concongella Creek.

By the time the first miners arrived at Pleasant Creek (Stawell) the Aboriginal population of regional Victoria had been devastated by disease and other impacts of European settlement. The last known corroboree in Stawell was held in 1857 and in the years that followed most of the local Aboriginal people were sent to Missions (Pearson, 1998).

8.3.3 Impact Assessment

A Cultural Heritage Management Plan (CHMP) must be prepared when an EES is required, under Section 49 of the Aboriginal Heritage Act 2006. A Notice of Intent (NOI) to prepare a CHMP was submitted to the Office of Aboriginal Affairs Victoria (OAAV) on the 13 June 2013 and the CHMP is included as Technical Appendix 3.

At the time of the commencement of the CHMP, there was no RAP in the vicinity of the Project area. The BGLCAC have applied to be the RAP for this area (the RAP applicant) and were therefore included in the consultation and assessment.

This study has assessed a broad activity area which is defined in the CHMP as the ‘activity area’. The extent of the activity area covers the whole of the Project area, the extent of planned works and any ancillary activities as shown in Figure 8-6.
Figure 8-6  Cultural heritage activity area relative to the Project area
8 Environmental Impact Assessment

8.3.3.1 Desktop Assessment of the Area

A search of the OAAV Victorian Aboriginal Heritage Register (VAHR) was undertaken to determine if there were previously recorded Aboriginal Places within the activity area.

The results indicated that there are no previously recorded Aboriginal Places, with parts of the area having been subject to archaeological surveys on at least three occasions. There are 44 Aboriginal Places within 10 kilometres of the centre of the activity area. Of these, there are three registered Aboriginal sites within two kilometres, all occurring to the east of Big Hill, including:

- Concongella 1 (VAHR 7423-0344) is an earthen mound that was described as destroyed by ploughing
- Fox Cave (7423-0345) is the closest site, recorded some 300 metres from the southern end of the activity area, and is a rock shelter site containing charcoal and flaked quartz artefacts
- Blackburn Park (7423-0349) is an isolated artefact, an edge ground greenstone axe.

There have been several archaeological investigations conducted within the Stawell region and these have generally concluded that the location was not conducive to Aboriginal occupation in the form of campsites that may result in surface scatters of multiple archaeological artefacts. The nature of the rocky outcrop that is Big Hill, combined with a shortage of potable water, makes it doubtful that the area would have been a focus of activity by Aboriginal people in the past, with many more attractive and resource-rich areas in the vicinity. Added to this is the extensive disturbance which has occurred in the area as a result of the gold rushes and more recently through modern developments such as roads and other settlement infrastructure, as well as industry such as gravel extraction which would have resulted in the destruction or disturbance of almost any Aboriginal cultural heritage that may have existed.

There have been three separate investigations on and around Big Hill, related to the gold mining of this area. These all centred on distinct but overlapping activity areas and again, all of these generally considered that the absence of archaeological sites was a result firstly, of a general unsuitability of Big Hill for occupation, but more importantly by the gross disturbance caused by the gold mining industry.

Only one Aboriginal site (an isolated stone artefact) was identified by Snoek in 1983. This quartz artefact was found in the former SGM tailings disposal area (TSF1) (which is outside the area of this assessment). This was considered by the consultant to not have significant archaeological value and was left unregistered.

In summary, the lack of available fresh water in the vicinity, the rocky outcropping nature of Big Hill and the presence of more resource rich areas suggest that Big Hill was not a focus for Aboriginal occupation. However, the summit of Bill Hill may have been utilised as a strategic vantage point by Aboriginal peoples prior to European arrival and natural cultural resources such as wood from scarred trees and also ochre and quartz outcrops may have been exploited within the activity area. The following predictive model was used for the activity area:

- Aboriginal Places containing isolated stone artefacts are possible but unlikely to occur within the activity area, and if they occur it is extremely unlikely that they will be in their original place of deposition
- the survival of scarred trees is unlikely due to the widespread and near total clearance of indigenous trees during the gold rush of the mid-19th century.
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However, as there is potential for Aboriginal cultural heritage to occur within the activity area, further assessment was undertaken.

8.3.3.2 Standard Assessment of the Area

A standard field assessment of the area was undertaken by an archaeologist from TerraCulture and field representatives from BGLCAC. The survey was conducted from a vehicle and on foot depending on current land use. Less time was spent at areas that were highly modified by mining (e.g. the current SGM processing site and Mt Micke) and more detailed investigation was undertaken in areas where there was a higher likelihood of finding Aboriginal cultural heritage.

For the purposes of the assessment, the activity area was divided into five large survey areas based on landform, and current and intended use as shown in Figure 8-7. The survey investigated the cultural heritage sensitivity of the various landforms and determined the potential for Aboriginal cultural heritage site to occur. A summary of the findings is included in Table 8-5 below.
Figure 8-7  Cultural heritage survey areas
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#### Table 8-5 Summary of cultural heritage field assessment findings

<table>
<thead>
<tr>
<th>Survey area</th>
<th>Current use</th>
<th>Landforms</th>
<th>Disturbance</th>
<th>Survey coverage (m²)</th>
<th>Average visibility (%)</th>
<th>Estimate of effective coverage (m²)</th>
<th>Aboriginal cultural heritage</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Pit</td>
<td>Big Hill, public use, regrowth forest</td>
<td>Modified prominent ridgeline including upper and lower flanks</td>
<td>Very high</td>
<td>184,000</td>
<td>10</td>
<td>18,400</td>
<td>None</td>
</tr>
<tr>
<td>South Pit</td>
<td>Abandoned and backfilled open cut pit and lay down area</td>
<td>Modified prominent ridgeline including upper and lower flanks</td>
<td>Very high</td>
<td>181,000</td>
<td>30</td>
<td>54,300</td>
<td>None</td>
</tr>
<tr>
<td>Administrative, mining operations and processing area</td>
<td>Mining operations and ore processing</td>
<td>Modified low ridgeline including upper and lower flanks</td>
<td>Low (west), very high (east)</td>
<td>283,000</td>
<td>15</td>
<td>42,450</td>
<td>None</td>
</tr>
<tr>
<td>Mount Micke</td>
<td>Rock stockpile</td>
<td>Artificial and modified landscape</td>
<td>Very high</td>
<td>288,000</td>
<td>90</td>
<td>259,200m</td>
<td>None</td>
</tr>
<tr>
<td>TWRS area (including the former Davis Pit waste rock dump and GWMWater land)</td>
<td>Agricultural</td>
<td>Modified gently sloping ground</td>
<td>Low to moderate</td>
<td>293,000</td>
<td>10</td>
<td>29,300</td>
<td>None</td>
</tr>
</tbody>
</table>
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North Pit area
This area encompassed the crest and steep surrounding flanks of Big Hill as shown in Figure 8-6. The crest was heavily disturbed by modern and historical developments from the construction of roads, car parks, picnic facilities, a monument as well as telecommunication towers, a fire lookout and previous mining disturbance (Figure 8-8 and Figure 8-9). Similarly the flanks of Big Hill showed evidence of recent and historical disturbance associated with mining activities, landscaping, revegetation and road construction (Figure 8-9).

Despite the lack of permanent water sources in the immediate vicinity, the peak of Big Hill would have likely been used as a strategic lookout providing sweeping view of the surrounding landscape. Additionally the presence of white kaolinitic clays within mine workings on Big Hill (Figure 8-11) may have provided a source for white ochre for the Aboriginal peoples in the area. Outcropping quartz veins on Big Hill area also likely to have provided an accessible raw material source for stone tool making.
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The utilisation of Big Hill for the above cultural activities would likely result in the accumulation of various site types including isolated stone artefacts and stone artefact scatters, as well as the potential for scarred trees within this survey area. No evidence of Aboriginal cultural heritage was located however, due to significant previous subsurface disturbance across the survey area.

South Pit area

This area encompassed the former Davis Pit open cut mine and also a dam in the south and areas of regrowth bushland dominated by grey box and yellow gum (Figure 8-12, Figure 8-13, Figure 8-14 and Figure 8-6).

This survey area appeared to be pervasively disturbed by historic and recent mining activities. Historic mining activities were indicated by old diggings and quartz gravel tailings throughout the landscape. Additional disturbance was most clearly evident from the artificial landscapes associated with the backfilled Davis Pit. Other evidence of recent disturbance was associated with the construction of cleared drill pads and access tracks (Figure 8-15).
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No evidence of Aboriginal cultural heritage was located within this survey area. Deforestation and pervasive ground disturbance associated with mining activities indicate that it is highly unlikely intact Aboriginal cultural deposits would be preserved in this area.

**Administrative and mining operations area**

This survey area encompassed mining operation offices, various car parks, the core shed, part of the ore stockpile and crushing plant, as well other mining related miscellaneous infrastructure (Figure 8-16). This survey area also included regrowth bushland areas to the south down to Albion Road (Figure 8-17 and Figure 8-6).
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An examination of the remainder of the survey area to the south showed vegetation consisting predominantly of yellow gum and lesser grey box regrowth and landscape evidence of old earthworks associated with early mining phases (Figure 8-18).

![Figure 8-18 View of historic mining diggings, facing north](image1)

There was also a large quantity of historic rubbish scattered throughout the southern part of this survey area associated with both domestic and industrial purposes (Figure 8-19). No evidence of Aboriginal cultural heritage was located within this survey area.

**Mt Micke**

The Mt Micke survey area was located at the south eastern end of the activity area and consists almost entirely of waste rock and ore stockpiles associated with open cut mining at the adjacent Wonga Pit (Figure 8-20 and Figure 8-6). This area also contained haul roads and groundwater retention basins (Figure 8-21).

![Figure 8-20 Mount Micke survey area, facing north, showing ground disturbance](image2)

![Figure 8-21 Mount Micke survey area, facing west, showing waste rock stockpiles and groundwater retention reservoirs](image3)
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An inspection of a thin, isolated wooded section along the southern margin of this survey area indicated that the area appeared to have only minimal previous disturbance. This area contained yellow gum and grey box vegetation and was surveyed on foot but no evidence of Aboriginal cultural heritage was located within area or other part of the survey area.

**Temporary waste rock stockpile**

The temporary waste rock stockpile (TWRS) encompasses a disturbed area used previously as a rock stockpile for the Davis open cut pit and also a large cleared paddock managed by GWMWater and used currently for agricultural purposes (Figure 8-22, Figure 8-23 and Figure 8-6). Features within this survey area include the highly disturbed waste stockpile area in the south and a dam and associated stockpiled topsoil in the northwest corner of the survey area and an historic European gravesite (the Moray graves).

The landform within this survey area was flat to gently undulating and sloping to the north. A minor creek gully also occurs along the southeast margin of the area. Outcropping sedimentary rock was noted around the margin of the eastern boundary and the area was entirely cleared of native vegetation aside from a single dead mature eucalyptus tree near the eastern margin and a group of mature dead alive eucalyptus trees in the southeast of the survey area (Figure 8-24 and Figure 8-25). The survey area covered with thick pasture grass which limited visibility to less than five per cent.
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The mature trees within the survey area were located adjacent to the small creek gully in the southeast corner of the area and an inspection of these trees noted the presence of scarring on one yellow gum (Figure 8-26 and Figure 8-27). This tree was used historically as a fence boundary marker and contained two large scars, one at the base and the other on the opposing side approximately 90 centimetres above the ground level. While the scars, particularly that shown in Figure 8-26 appear to be cultural, it is unlikely that the scars are of Aboriginal origin. The primary reason for this is that the area was, by all reports, historically denuded of trees during the gold rush. Also, it is apparent that there has been growth of the tree since the placement of fencing wire around it, together with its relatively small girth, could indicate that this is a younger tree, not old enough to have had substantial slabs of bark removed more than 160 years ago.
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Aside from the pervasively disturbed waste stockpile area, no mine workings were identified in the remainder of the survey area to the north. Aside from historical clearing of the area and disturbance and earthworks associated with the construction of the dam in the northwest corner, the remainder of the GWMWater land managed area appears to have undergone minor obvious disturbance. Despite this lack of disturbance, the potential for archaeologically significant Aboriginal cultural heritage deposits to occur within this area is low, due to the distance from permanent natural water sources and lack of any obvious features likely to be associated with cultural significance.

8.3.3.3 Summary of Assessment Findings

The desktop assessment did not identify any previously registered Aboriginal cultural heritage places within the activity area. The field assessment led to the identification of one culturally scarred tree, but this is not considered to be of Aboriginal origin. The survey supported the results of the desktop assessment, indicating widespread disturbance through most of the activity area.

Therefore, it is concluded that no Aboriginal cultural heritage places were identified within the activity area.

8.3.3.4 Intangible Social or Spiritual Significance

The Aboriginal Heritage Act 2006 provides that a place such as a natural feature, formation or landscape can be an Aboriginal Place if it is of cultural heritage significance to an Aboriginal group. Cultural heritage significance is defined in the Act to mean (a) archaeological, anthropological, contemporary, historical, scientific, social or spiritual significance; and (b) significance in accordance with Aboriginal tradition.

An Aboriginal elder and a representative of the BGLCAC met with SGM and the Cultural Heritage Advisor for the CHMP (TerraCulture) to consider the intangible social or spiritual significance of the Big Hill Project area and significance in accordance with Aboriginal tradition.

The values associated with the Project area related to the landscape viewable from the top of Kobram. Of particular importance is the view towards the Black Range, which contains the important spiritual rock art Place of Bunjil (the Creator’s) Shelter. Adjacent to the shelter is a Women’s area. In the Dreamtime story and song line of the area, Bunjil’s wives would travel from Sisters Rocks to the Black Range to visit their husband. This song line is clearly visible from Kobram.

Also visible from the top of Kobram is an ancient travelling route which arched in a horseshoe shape with Stawell and Big Hill at its centre. This travelling route followed a Dreaming track and song line, which begins in the hills to the north of Kobram, running east towards the Pyrenees, following this range as they curve south immediately west of Beaufort and then running west along the Challicum Hills, through to Gariwerd and the Black Range, then to Mt Arapiles (Djurite), essentially extending from the midlands to the gateway to the Wimmera. The major peaks along this song line served as visual markers as people moved along the travelling route, recounting the Dreaming stories and songs.
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8.3.4 Management and Mitigation Measures

As no Aboriginal cultural heritage places were identified within the activity area during the preparation of the CHMP, there are no specific recommendations for the management of Aboriginal cultural heritage within the activity area.

The CHMP includes a Contingency Plan in the event that Aboriginal cultural heritage is discovered during works and this commitment is included as part of the EMP (refer to Chapter 11). A copy of the EMP will be present on site during all work activities.

The Contingency Plan for Aboriginal Cultural Heritage includes measures to be implemented in the event of:

- the discovery of Aboriginal cultural heritage during works, including:
  - human remains
  - isolated or dispersed Aboriginal cultural heritage
  - stratified occupation deposits
  - cave buried during earlier mining activities

- a requirement for management of Aboriginal cultural heritage discovered during works

- a process for reviewing compliance with the CHMP.

8.3.5 Conclusion

There are no previously recorded Aboriginal places registered with the OAAV Victorian Aboriginal Heritage within the activity area.

The lack of available fresh water in the vicinity, the rocky outcropping nature of Big Hill and the presence of more resource rich areas suggests that Big Hill was not a focus for Aboriginal occupation.

A survey of the activity area confirms that widespread and historic and mining activities are likely to have completely destroyed the integrity of Aboriginal archaeological deposits within most of the activity area and, as a result, there is none to low potential for Aboriginal sites within the survey area.

As a result, the CHMP makes no specific recommendations for the management of Aboriginal cultural heritage within the activity area. However, SGM has developed a contingency plan in the event that Aboriginal cultural heritage is discovered during the Project, which is included as part of the EMP.

Given the limited cultural heritage significance of the Project area, it is considered unlikely that the Project will result in any adverse impacts to the cultural heritage of the site.
8.4
Historic Heritage
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8.4 Historic Heritage

8.4.1 Introduction

This section of the EES describes the implications of the Project for historic heritage, including potential impacts of the proposed development; measures to manage and mitigate potential adverse impacts; and the overall impacts of the Project following implementation of proposed management and mitigation measures.

This section is based primarily on information presented in:

- TerraCulture Pty Ltd (November 2013) *The Big Hill Enhanced Development Project, Stawell, Historic Heritage Assessment*, prepared for CGC.

This report is included in Technical Appendix 4 of this EES and should be referred to for more detail on the issues discussed in this section.

<table>
<thead>
<tr>
<th>Relevant sections of EES Scoping Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>This section of the EES covers the following components of the EES Scoping Requirements insofar as they relate to historic heritage:</td>
</tr>
<tr>
<td><strong>‘4.8 Cultural Heritage</strong></td>
</tr>
<tr>
<td><strong>Draft Evaluation Objective</strong></td>
</tr>
<tr>
<td>To avoid or minimise adverse effects on Aboriginal and historic cultural heritage values, sites/features and places.</td>
</tr>
<tr>
<td><strong>Key issues</strong></td>
</tr>
<tr>
<td>- Destruction or disturbance of sites/features or places of Aboriginal or historic cultural heritage significance.</td>
</tr>
<tr>
<td><strong>Priorities for characterising the existing environment</strong></td>
</tr>
<tr>
<td>- Identify and document known and previously unidentified places and sites/features of historic cultural heritage significance within and adjoining the project area, including any necessary investigations to supplement past studies, having regard to the heritage overlay of the Northern Grampians Planning Scheme and Heritage Victoria guidelines.</td>
</tr>
<tr>
<td><strong>Design and mitigation measures</strong></td>
</tr>
<tr>
<td>- Describe and evaluate proposed design, construction method or site protection measures which could avoid or minimise direct impacts on Aboriginal and historic cultural heritage values.</td>
</tr>
<tr>
<td><strong>Assessment of likely effects</strong></td>
</tr>
<tr>
<td>- Assess potential effects of the project and relevant alternatives on:</td>
</tr>
<tr>
<td>- sites / features and places of historic cultural heritage significance, having regard to the Heritage Council’s Guidelines for Investigating Historical Archaeological Artefacts and Sites / features (2012).</td>
</tr>
<tr>
<td><strong>Approach to manage performance</strong></td>
</tr>
<tr>
<td>- Outline and evaluate any proposed additional measures to mitigate and manage residual effects on:</td>
</tr>
<tr>
<td>- sites / features and places of historic heritage significance, including site investigation and recording procedures.’</td>
</tr>
</tbody>
</table>
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Key issues emerging from EES studies and community consultation

The EES Scoping Requirements outlined above provide a detailed list of the issues requiring attention in the EES. In addition, community concerns arising from the ongoing community engagement and communications program that relate to potential historic heritage impacts of the Project are:

- Strong sense of value attached to the heritage sites / features of Big Hill.
- Some concern is felt within the community relating to the loss of historic mine workings. For those who value the workings they are important insofar as they reflect the historic interactions between the local environment and geology and the miners who founded the town. The historical society members appreciate Big Hill in its current form in a holistic manner and do not welcome any major disturbances.

Summary of findings

- A detailed desktop and field assessment was undertaken which identified fifteen historic heritage sites / features within the survey area, comprising a mix of monuments and memorials, mining, and archaeological relics associated with gold mining activities.
- When considered as a part of a heritage landscape, the historic heritage sites / features form a cultural landscape that has been assessed as having local significance.

8.4.2 Existing Conditions

The history of Big Hill can be divided into five major use phases:

- Djab Wurrung traditional occupation (up to c. 1856)
- Pastoral (c.1841-1856)
- Alluvial and Reef mining (1856-1920)
- Municipal and social use (1920-present)

Section 8.4 focuses on the period of European settlement which is nominally from 1840.

8.4.2.1 Historical Background

Exploration and Pastoral Settlement

Explorers Thomas Mitchell (1836) and Edward John Eyre (1838) both passed through the Stawell district but it was the glowing reports of Mitchell that drew squatters into the region. John Francis took up land on the Wimmera River east of Stawell in 1839 and the land on which Big Hill sits was taken up by John Allan in 1841. The section containing Stawell was disputed and awarded to Dr John Blunden in 1844. It was named “Concongella” (Pearson, 1998).
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Alluvial and Reef Mining

Gold was discovered at Stawell (Pleasant Creek) in about 1853 and a township was laid out close to the diggings. The Quartz reefs rich in gold were discovered on the flanks of Big Hill in the mid-1850s and the large-scale mining industry that developed grew Stawell from a small alluvial gold mining settlement to a regional centre of substance.

The first crushing engine erected on Big Hill was a Chilean Mill in late 1856. More mills were installed both at Concongella Creek and Big Hill, and by 1861 there were at least eight crushing companies on the field, both stamp batteries and Chilean mills. Over time, more were added and by the second half of the 1870s the numbers peaked at 346 head of stamps, with one mill alone having 40 of these. Water shortages were a problem and dams were constructed to supply water for the batteries. In the early years, the quartz was universally roasted prior to crushing, in order to ‘soften’ it to increase throughput. This preparation became entrenched at Stawell and continued long after most areas had ceased the practice due to the availability of heavier, more efficient batteries.

The demand for timber as mine props and to feed the boilers soon stripped Big Hill and the surrounding countryside of its vegetation, and timber had to be brought to the field from further and further distances. The mines themselves were dotted over the flanks of Big Hill with the small claim sizes creating a forest of poppet heads and whims.

The Scotchman’s and Cross Reefs were among the richest of the early reefs. Many small claims gradually amalgamated to free more capital to be invested in plant and the whims were gradually replaced with steam-powered winding plants.

The excellent returns on many operations brought Stawell to the attention of mining investors and activity increased in the late 1860s. A rich find at 800 feet in the Crown Cross shaft in 1872 encouraged deeper exploration and by 1877 the deepest shaft was approaching 2000 feet. The 1870s proved the peak years for employment at the mines, with 1274 miners employed in 1874.

Big Hill, with its elevation above the township, played a pivotal role in the development of Stawell’s ambitious water supply scheme completed in 1881, which drew water from the distant Grampians (Gariwerd) and piped it to tanks and storage dams constructed on the north-west flank of the hill.

Peak years of mining were in the years up to 1880, with enormous quantities of gold won. During the 1880s gold yields declined markedly and the western end of Big Hill was virtually abandoned with operations concentrated to the north-west and south-east. Rock borers were introduced to many mines to increase productivity, but the decline continued. The Magdala Mine to the north-west of Big Hill amalgamated with the Moonlight Company during 1884 to become the Magdala-cum-Moonlight. Diamond drilling revealed a new rich lode in 1886 and enabled the company to continue until 1916. The cyanidation process was introduced to Stawell in the late 1890s with several plants erected and large quantities of battery sands treated.

In 1920 the last phase of reef mining at Stawell came to an end when the Magdala Mine closed (then owned by Sloane and Scotchman’s United Company), and the plant was sold by auction. The estimated total production from reefing at Stawell between 1855 and 1920 is 2.6 million ounces of gold.
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**Municipal and social use**

The Big Hill mines influenced township development, drawing the population up onto the flanks of the hill and creating the irregular grids of streets still seen today.

Community associations with Big Hill grew from an early stage and its proximity to urban development saw it become a place for walks and for childhood play, the latter with sometimes tragic consequences due to the presence of mine shafts in the area. The summit lookout became the place to take visitors to see the views, or to go up and reflect on the changes in the township or district.

Source: Sharpley, 1938

*Figure 8-28  Early photography from Big Hill*

Over time, the lookout became important in local tourism and gradually the site was improved. The community of Stawell recognised the importance of Big Hill in their history and a series of memorials and monuments were added to its summit and flanks, beginning with the Pioneers Memorial Rotunda, constructed at the lookout and opened in 1938 (Figure 8-29). Big Hill was chosen because it overlooked the land where gold was first discovered in 1853 and was within yards of where the first quartz gold was discovered.

The Memorial Arboretum and Memorial Seat & Drinking Fountain followed, all dedicated to the pioneers of Stawell, the arboretum also serving as a beautification exercise which softened some of the ravages of mining for visitors climbing the hill to the Pioneers Memorial. The other monuments and memorials that were later erected relate specifically to historical aspects of Big Hill, and it was the appropriate place to erect them (Gold Discovery monument, Dane Memorial and Water Supply monument).
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Source: Argus, 1938

**Figure 8-29  Newspaper extract announcing dedication of the Pioneers’ Memorial**

Other community uses and associations evolved, including use of the lookout area as a favourite hang-out by the youth of Stawell. Risk mitigation works, quarrying of mullock dumps for road metal and later exploration activity saw the historic mining fabric drastically altered.

**Big Hill today**

On the summit lookout cluster three memorials; the Pioneers Memorial Rotunda, the Dane Memorial Seat and the Water Supply Monument (Figure 8-30). To the north and south of these are two early open cuts, Scott’s and Allen’s. Along the southern flank of the hillside is a degraded mining landscape with a scattering of mining-related archaeological relics, including a cyanide works and sundry machinery footings. Around the north-western flank of the hill are two arboreta, a Memorial Seat & Drinking Fountain and a gateway to the Apex Arboretum. On the northern slopes sit the dams, tanks and other infrastructure of the Stawell Water Supply, and at the top end of the Moray paddock is a small graveyard and traces on the ground of faint water channels which once distributed irrigation water on David Constable’s farm.
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Clockwise from top-left: view of Stawell from Big Hill lookout; Pioneers Memorial Rotunda; brick winding engine beds, Federal Mine; Haulage Tunnel; Quartz Reef Discovery Monument; Mullock dump; Dane Memorial Seat; Allen’s Open Cut

Figure 8-30 Montage of Big Hill photography
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8.4.3 Impact Assessment

Heritage Victoria (HV) is the State Government body that administers the *Heritage Act* (1995). This Act serves to protect historic heritage in Victoria relating to non-indigenous or European settlement of the State. This heritage includes built structures and modifications to the natural landscape, including archaeological sites / features and relics, resulting from its historic use.

A Notice of Intent (NOI) to carry out a Historical Archaeological Survey was submitted to HV on 13 June 2013. This survey is included in Technical Appendix 4.

This study has assessed a broad study area which is defined as the ‘activity area’. The extent of the activity area encompasses the whole of the Project area (which is the extent of planned works and any ancillary activities) as shown in Figure 8-31.

This assessment has included a review of previous investigations and current heritage listings and a field assessment whereby the findings of previous assessments were verified and heritage significance was re-assessed.
Figure 8-31  Historic heritage activity area relative to the Project area
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8.4.3.1 Previous Investigations

There are several previous heritage investigations that have provided relevant background to the historic heritage assessment, including several prior investigations of Big Hill. These include:

- Iain Stuart (1981), who was engaged by Kinhill Pty Ltd to conduct an archaeological survey for a proposed exploration decline at Stawell. The survey area overlapped the north section of the activity area and identified 15 historical sites / features. The sites / features were not considered ‘significant’ and did not warrant salvage.

- Willem Snoek (1983), who undertook a preliminary survey related to a proposed extension of gold mining at Big Hill. During the survey, 18 archaeological sites / features were recorded. While the preservation of some movable relics was suggested, it was determined that none of the archaeological sites / features were significant enough to warrant their protection.

- David Bannear (1996), who completed a comprehensive survey of mining-related sites / features throughout the south western goldfields of Victoria, including Stawell. The focus of the study was on larger workings, none of which are located within the activity area.

- Pearson (1999), who undertook an intensive survey as part of the 1998/1999 EES for Big Hill which identified 89 historical sites / features. The majority of these sites / features were abandoned and filled mining shafts and associated mullock heaps. Other site types identified included open cuts, races, engine beds, reservoir associated infrastructure, and a variety of more recently constructed memorials and the like commemorating the areas mining heritage. Whilst this report involved a comprehensive identification of Big Hill’s built and historical archaeological inventory, none of the items identified were put forward for heritage listing.

- Jacobs, Johnson, Rowe and Taylor (2004). The Northern Grampians Shire Council (NGSC) commissioned a Heritage Study in two stages between 1999 and 2003, with the report being finalised in 2004. The objectives of this study included the identification assessment and documentation of all post-contact places of cultural significance within the study area, which included Stawell. The Big Hill Historic Precinct is identified within this study as Place No. SL/001. The Statement of Significance for the precinct reads:

  Big Hill in Stawell is a cultural landscape that is characterised by its historical associations with gold mining, the supply of fresh water to the township, remembrance of the town’s pioneers and the ongoing recreational activities of the community. Significant elements of the western portion of Big Hill comprise the hill itself, the Pioneer Memorial, all the remnants of the 1875-1881 water supply system, the Pioneer plantation, the Apex Arboretum and gates and the Quartz Reef Discovery monument (Jacobs et al 2004b).
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8.4.3.2 Heritage Listings

Historic heritage is administered through various statutory processes according to the significance of the heritage site. A search of these listings was undertaken to determine if there were previously recorded historic heritage sites / features within the activity area. Table 8-6 provides a summary of the current heritage listings.

Table 8-6 Summary of statutory and non-statutory heritage listings within the activity area

<table>
<thead>
<tr>
<th>Register / listing</th>
<th>Site ID</th>
<th>Site name</th>
<th>Significance</th>
<th>Statutory protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Victorian Heritage Register</td>
<td></td>
<td>No sites / features</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heritage Inventory</td>
<td>H7423-0058</td>
<td>Big Hill Mine Site</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>HERITAGE INVENTORY H7423-0058</td>
<td>H7423-0057</td>
<td>Stawell District Memorial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HERITAGE INVENTORY H7423-0054</td>
<td>H7423-0034</td>
<td>Scotchmans &amp; Sloane Co.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HERITAGE INVENTORY H7423-0037</td>
<td></td>
<td>Leviathan Mine Cyanide Works*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heritage Inventory 'D' Classification</td>
<td></td>
<td>No sites / features</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Grampians Planning Scheme Heritage Overlay</td>
<td></td>
<td>No sites / features</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Heritage List</td>
<td></td>
<td>No sites / features</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commonwealth Heritage List</td>
<td></td>
<td>No sites / features</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Register of the National Estate</td>
<td>101438</td>
<td>Big Hill (Western Portion)</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Northern Grampians Heritage Overlay recommendation (not effected)</td>
<td></td>
<td>Big Hill (western end)</td>
<td>Local</td>
<td>No</td>
</tr>
<tr>
<td>Land Conservation Council (LCC) Special Investigations AR0081</td>
<td>Public purposes reserve and monuments, Big Hill</td>
<td>Local / Regional</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>LCC Special Investigations AR0209</td>
<td>Big Hill Mine, Stawell (modern operation)</td>
<td>N/A</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>LCC Special Investigations AR0215</td>
<td>Allan’s Open Cut Mine, Big Hill, Stawell</td>
<td>Local</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>LCC Special Investigations AR0217</td>
<td>Scott’s Open Cut Mine, Stawell</td>
<td>Local</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

* Note: this site is outside the Project area and will not be impacted.
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The results indicated that there are no nationally significant heritage listings and four sites / features included on the Heritage Inventory which are partially located within the activity area and have legislative protection, namely:

- Big Hill Mine Site (H7423-0058) is an undefined entry. In consultation with Heritage Victoria, this entry will be defined in terms of extent and description in this study.
- Stawell District Memorial (H7423-0057) is located on a parcel of land which partially overlaps the footprint of the proposed North Pit, and is therefore within the Project area and will be impacted by the proposed mining activities.
- Scotchmans & Sloane Co. (H7423-0054) covers a large area of land which includes the proposed North and South Pits as well as the Temporary Waste Rock Stockpile and the haul road, and is therefore within the Project area and will be impacted by the proposed mining activities.
- Leviathan Mine Cyanide Works (H7423-0034) is outside of the Project area and will not be impacted.

Current listings have assessed the significance of the sites / features as 'locally significant'.

8.4.3.3 Field Assessment

A field assessment of the activity area was undertaken on foot by heritage consultant Robert Kaufmann – an expert in the archaeological assessment of Victorian goldfields.

Historical sites / features identified during previous assessments were re-assessed in context with the current Heritage Victoria legislative definitions for archaeological sites / features.

The historic cultural heritage landscape and its sites / features were mapped to record their locations and assess potential impacts of the Project. Historic sites / features were also identified with respect to available historical resources, described and assessed in terms of cultural heritage significance.

The survey identified fifteen sites / features within the activity area, comprising a mix of monuments and memorials, and mining-related archaeological relics, as outlined below.

Commemoration & other community sites / features:
1. Memorial Arboretum, Memorial Seat & Drinking Fountain
2. Apex Arboretum & Gate
3. Big Hill Lookout, Pioneers Memorial Rotunda, Dane Memorial, Water Supply Memorial
4. Gold Discovery Monument
5. Moray Graves & Races

Well-preserved mining sites / features:
6. Scott’s Open Cut
7. Allen’s Open Cut and Haulage Tunnel
8. Open Cut
9. Ulster Tunnel
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Archaeological sites / features:

10. Engine beds, Scotchmans United Mine
11. Engine bed & probable Battery Site
12. Decantation Tower ruins
14. Albion Cyanide Works
15. Federal Mine Engine Beds and Shaft

These sites / features are shown relative to the Project area in Figure 8-32.

Figure 8-32  Historical sites / features relative to the Project area
Assessment of Impact on Historic Heritage by the Project

The 15 historic sites / features identified within the activity area have been compared with the Project area to identify those where there are potential impacts and those which fall outside the Project boundaries. The potential impact of the Project is summarised Table 8-7 below, where:

- green indicates that the location is outside Project area and will not be impacted
- yellow indicates that the location will be impacted by the Project and the item will require relocation
- blue indicates that the location may be impacted by Project and the heritage fabric will be protected if possible
- purple indicates that location and heritage fabric will be destroyed by the Project.

Table 8-7  Summary of potential impacts of the Project on historic heritage sites or features

<table>
<thead>
<tr>
<th>Survey item #</th>
<th>Site / feature</th>
<th>Located within the Project area?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Memorial Arboretum, Memorial Seat &amp; Drinking Fountain</td>
<td>Y</td>
</tr>
<tr>
<td>2</td>
<td>Apex Arboretum &amp; Gate</td>
<td>Y</td>
</tr>
<tr>
<td>3</td>
<td>Big Hill Lookout, Pioneers Memorial Rotunda, Dane Memorial, Water Supply Memorial</td>
<td>Y</td>
</tr>
<tr>
<td>4</td>
<td>Quartz Reef Discovery Monument</td>
<td>Y</td>
</tr>
<tr>
<td>5</td>
<td>Moray Graves</td>
<td>N (graves)</td>
</tr>
<tr>
<td>5</td>
<td>Moray Races</td>
<td>Y (channel)</td>
</tr>
<tr>
<td>6</td>
<td>Scott’s Open Cut</td>
<td>Y</td>
</tr>
<tr>
<td>7</td>
<td>Allen’s Open Cut and Haulage Tunnel</td>
<td>Y</td>
</tr>
<tr>
<td>8</td>
<td>Open Cut</td>
<td>Y</td>
</tr>
<tr>
<td>9</td>
<td>Ulster Tunnel</td>
<td>N</td>
</tr>
<tr>
<td>10</td>
<td>Engine Beds, Scotchman’s United Mine</td>
<td>Y</td>
</tr>
<tr>
<td>11</td>
<td>Engine Bed &amp; probable Battery Site</td>
<td>Y</td>
</tr>
<tr>
<td>12</td>
<td>Decantation Tower Ruins</td>
<td>N</td>
</tr>
<tr>
<td>13</td>
<td>Shaft Location &amp; Engine Bed, A1 Perthshire Mine</td>
<td>Y</td>
</tr>
<tr>
<td>14</td>
<td>Albion Cyanide Works</td>
<td>Y</td>
</tr>
<tr>
<td>15</td>
<td>Federal Mine Engine Beds and Shaft</td>
<td>N</td>
</tr>
</tbody>
</table>

Table 8-7 shows that there are four historic sites / features that fall outside of the Project area, four community sites / features in which the memorials and monuments will require relocation for the duration of the Project, two sites / features that are outside of the pit area and will be protected and six sites / features that will be destroyed as a result of the Project proceeding.

In addition, the mining, backfilling and rehabilitation of Big Hill, may affect the social heritage resulting from community associations with the landmark. This is further discussed in Section 8.18 as part of the social impact assessment.
Management and mitigation measures to minimise potential impacts are outlined in the sections below.

*Cultural Heritage Significance*

The activity area consists of a nineteenth century mining landscape overlaid with more modern elements associated with the on-going use of the area for recreational, mining and other purposes. The main recommendation of the current assessment is that the various historical and archaeological components of this landscape (Survey Items 5-15) are included under the umbrella of an existing Heritage Inventory, Big Hill Mine Site (H7423-0058). As such, the following significance assessment considers these items as a group and the activity area as a heritage landscape.

The significance of the heritage landscape has been assessed using the criteria set out in Table 8-8 which was derived from the Heritage Council criteria for state significance.

Table 8-8  Assessment of the Big Hill landscape against the Heritage Council criteria (local significance filter)

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Criterion Description</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Importance to the course, or pattern, of Stawell's cultural history</td>
<td>The western end of Big Hill had a major historical impact on Stawell, its mines influencing the layout of the town and generating the wealth that turned the small settlement into a major regional centre. It also contains the delivery point of the ambitious water supply scheme completed in 1881, which drew water from permanent sources in the Grampians (Gariwerd) and piped it to Stawell.</td>
</tr>
<tr>
<td>B</td>
<td>Possession of uncommon, rare or endangered aspects of Stawell's cultural history</td>
<td>NA</td>
</tr>
<tr>
<td>C</td>
<td>Potential to yield information that will contribute to an understanding of Stawell’s cultural history</td>
<td>NA</td>
</tr>
<tr>
<td>D</td>
<td>Importance in demonstrating the principal characteristics of a class of cultural places and objects</td>
<td>NA</td>
</tr>
<tr>
<td>E</td>
<td>Importance in exhibiting particular aesthetic characteristics</td>
<td>The western end of Big Hill rises above the township of Stawell, with a landmark quality that influences the aesthetics of townscapes throughout Stawell and helps define the town.</td>
</tr>
<tr>
<td>F</td>
<td>Importance in demonstrating a high degree of creative or technical achievement at a particular period</td>
<td>NA</td>
</tr>
<tr>
<td>G</td>
<td>Strong or special association with a particular community or cultural group for social, cultural or spiritual reasons</td>
<td>Big Hill is a place with long-standing, diverse and on-going community associations and has been a focus of Stawell community commemorative activities since the 1920s, when the first “Home to Stawell” celebrations were held. These activities are enshrined in the numerous memorials and monuments erected on the flanks and summit of the hill.</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Criterion</th>
<th>Criterion Description</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Special association with the life or works of a person, or group of persons, of importance in Stawell’s history</td>
<td>NA</td>
</tr>
</tbody>
</table>

The western end of Big Hill was nominated to the Victorian Heritage Register and assessed at an appeals hearing by the Heritage Council in 1999. It did not meet the threshold for entry into the Victorian Heritage Register and was found to be of local cultural heritage significance only. Pearson’s assessment of the western end of Big Hill (1999) assigned high local significance.

This historic heritage study also assesses Local cultural heritage significance, meriting inclusion of the Big Hill landscape in the Heritage Overlay of the Northern Grampians Planning Scheme.

8.4.4 Management and Mitigation Measures

It has been determined that some of the fifteen heritage sites / features identified within the Project area will be impacted. The purpose of the adopted management and mitigation measures described below, is to minimise the impact sites / features and where the impact cannot be avoided, to provide a permanent photographic record that will be made accessible to the Stawell community.

**Monuments and Memorials (survey items 1 - 4)**

The various Monuments and Memorials located within the Big Hill Precinct and identified during this assessment (survey items 1, 2, 3 and 4) have previously been recommended for inclusion within the Northern Grampians Heritage Overlay. Whilst this has yet to occur, the future management of these items in relation to the proposed development will be decided in consultation with the NGSC (in order to manage the potential social impacts) and managed through the Approved Work Plan Variation process. With the exception of the Memorial Arboretum and Apex Arboretum, SGM proposes to disassemble and temporarily store these memorials and monuments offsite for the duration of the Project. They will be reinstated at the conclusion of the Project as part of the rehabilitation process in consultation with DEPI or relevant land manager.

**Update the Heritage Inventory listing for Big Hill Mine Site H7423-0058 (survey items 5 - 15)**

The Heritage Inventory listing Big Hill Mine Site (H7423-0058), will be updated to include all the archaeological features and landscapes identified during the historic heritage assessment. Specifically, survey items 5 through 15 will be included within this listing to facilitate their future management via Heritage Victoria’s Consent process.

Consultation with Heritage Victoria has determined that the following existing VHI listing within the activity area should be subsumed within the Big Hill Mine Site (H7423-0058) listing as part of this update:

- Scotchmans & Sloane Co. (H7423-0054).
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Removal of Stawell District Memorial (H7423-0057) from the Heritage Inventory

The Heritage Inventory is reserved for archaeological sites / features i.e. those sites / features which are considered likely to include a significant below-ground component relating to its previous occupation and/or use. As this site is not an archaeological site Heritage Victoria have requested that it be removed from the Heritage Inventory. Its future management should proceed according to the process outlined below for monuments and memorials.

Apply for Consent to Damage Heritage Inventory site Big Hill Mine Site H7423-0058 (survey items 5-8, 10-11, 13-14)

Prior to any works being undertaken which will impact any part of this site, a Consent Application will be lodged with Heritage Victoria; following the issuing of any such Consent, works must proceed according to the conditions outlined within it.

In regards to the various individual archaeological and historical components of this site, any such Consent Application must include the following:

- The water channels within the Moray paddock are within the Project area (also survey item 5) and will be buried under the proposed stockpile. The channels are generally in poor condition, of low relief and appear to relate principally to post-1880s farming, rather than the significant historical themes of Big Hill. In terms of the water channels, the recording undertaken during the historic heritage assessment is deemed sufficient and no protection works are proposed.

- Scott’s Open Cut (survey item 6) is located within the North Pit profile and will be destroyed by the proposed mining development. A detailed survey and additional photography of this item and its features will be undertaken prior to its destruction in order to create a permanent record of the place.

- Allen’s Open Cut and Haulage Tunnel (survey item 7) is located within the North Pit profile and will be destroyed by the proposed mining development. A detailed survey and additional photography of this item and its features will be undertaken prior to its destruction in order to create a permanent record of the place.

- The Open Cut (survey item 8) is located within the South Pit profile and will be destroyed in the proposed mining development. This item has been sufficiently recorded and no further works are required.

- The Engine Beds, Scotchman’s United Mine (survey item 10) appears to be located just outside the profile of the proposed North Pit, but within the defined Project area where impacts may occur. If feasible, the brick engine beds will be buried prior to the commencement of works to ensure their survival beyond the Project. If it is operationally impossible to protect the engine beds, a minimum of archaeological monitoring and recording of the destruction of the site is proposed.

- The Engine Bed & probable Battery Site (survey item 11) appears to be located just outside the profile of the proposed North Pit, but within the defined Project area where impacts may occur. If feasible, the engine bed will be buried prior to the commencement of works to ensure its survival beyond the Project. However, as the engine bed is constructed atop a raised earth platform, burial may not be an option; if it is operationally impossible to protect the engine bed the site will be subject to a test excavation to ascertain whether stone piers exist at the site (as suggested by the surface archaeology), and the site will be subject to archaeological monitoring and recording during its destruction.
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- The Shaft Location & Engine Bed, A1 Perthshire Mine (survey item 13) is located within the South Pit profile and will be destroyed by the proposed mining development. Archaeological monitoring and recording of the destruction of the engine bed site will be undertaken.

- The Albion Cyanide Works (survey item 14) is located within the South Pit profile and will be destroyed by the proposed mining development. The sand dam and slimes from the operation of the cyanide works also appear to be located within the Project area and will presumably be targeted for re-treatment. Archaeological monitoring and recording of the destruction of the site will be undertaken.

- The archaeological and historical features and areas that may or will be lost in the commissioning of the pits (i.e. survey items 6, 7, 8, 10, 11, 13 and 14) will not be disturbed in advance of the operational need for their destruction. This will ensure maximum survival of historic fabric in the event of unforeseen circumstances that may alter the mining proposal.

Protection of heritage inventory sites / features that are outside of the Project area (survey items 5, 9, 12, 13)

The following sites / features are outside of the Project area and will be protected to prevent inadvertent damage or disturbance.

- Establish a 30 metre buffer zone between the Moray Graves (survey item 5) and the TWRS boundary to protect the graves during works.

- The Ulster Tunnel (survey item 9) is located outside the proposed South Pit profile and outside the associated Project area. In the unlikely event that there is any change to the pit area (through relevant statutory approvals) the adit mouth and entry cutting should be isolated from works and protected from damage during the proposed operations.

- The Decantation Tower Ruins (survey item 12) and its associated dam are located outside the pit profiles and Project area. Care will be taken to ensure that this item is isolated and protected from any bund construction works in the vicinity.

- The Federal Mine Engine Beds and Shaft (survey item 15) are located outside the Project area. It is nonetheless recommended that care be taken that this site is isolated from peripheral works and that no machinery be allowed south of the existing dirt track on the south side of the slimes heaps from the Albion Cyanide Works.

Cultural heritage

As outlined earlier in this section, the western end of Big Hill was assessed as to whether it warranted inclusion on the Victorian Heritage Register for cultural reasons due to its long mining history. The assessment concluded that Big Hill did not warrant inclusion on the Register and was considered as only of local significance. While Big Hill will be impacted by the Project, the measures outlined in this section will ensure that the historical elements that make up the local cultural heritage values are variously preserved or recorded prior to impact. Rehabilitation of Big Hill (to a similar height and shape) is addressed in Chapter 10 and will be undertaken in consultation with the future land manager and will most likely involve preparation of an End Use Master Plan. There is the potential for the End Use Master Plan to incorporate the reinstatement of heritage monuments and possibly storyboards to connect both the historic heritage and social heritage of Big Hill, and to make this history accessible to the wider community.
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**Heritage induction**

A heritage induction will be provided to all employees/contractors of SGM involved with the proposed works program at Big Hill and will include consideration of the following:

- the provisions of Part 6 of the Heritage Act 1995 (Vic) specifically in regard to the Consent process, and processes in the event of discovery of previously-unknown archaeological deposits
- visual recognition of archaeological deposits and cultural heritage features during works
- community expectations in regard to the treatment of cultural heritage places on Big Hill
- the need to limit surface disturbance outside the Project area
- the location and nature of key landscape features that have been isolated and recommended for special protection.

**Discovery of further archaeological and/or historical remains**

Should any further potentially significant historical or archaeological remains pertaining to the historical usage of the activity area which have not been identified within this report be uncovered during the proposed works program, works will cease immediately in the vicinity whilst Heritage Victoria is informed and consulted regarding their management as required under section 127 of the Heritage Act.

8.4.5 Conclusion

The archaeological survey has concluded that the mining landscape on Big Hill is highly degraded, with only a few mining sites / features surviving. No undisturbed mullock dumps from large-scale mines of the pre-1920 period survive. Modifiers include quarrying of mullock for road metal, risk mitigation works and later gold exploration activities. The surviving, archaeological relics lack the context of the fabric of the associated mine that produced them and are principally post-1880 in age which means they do not relate to the most historically significant, large-scale mines of the early period of mining on Big Hill.

However, the western end of Big Hill is historically significant to Stawell and district as the place of discovery of the first gold-bearing quartz reefs at Stawell, and the subsequent, early, large-scale gold mining industry that had such a profound impact on the development of the township. The western end of Big Hill is socially significant to Stawell and district as a dominant place in the landscape where the community connects with and celebrates its history through the memorials and monuments erected on the hill and through the scattered reminders of its gold mining past. It is socially significant for the community associations that have grown through over 150 years of use of the hill as a place for walks, play, quiet reflection, meeting, tourism and other purposes, and for the geographical and historical associations that have come to define a sense of place for the town.

This assessment has taken a landscape view, that all of these poorly-preserved sites / features are simply components of a degraded mining landscape that is in turn a component of a wider cultural landscape.

This study also assesses Local cultural heritage significance, meriting inclusion in the Heritage Overlay of the Northern Grampians Planning Scheme.
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As a result of the Project, four memorials and monuments sites / features will be removed for the duration of the Project and reinstated in consultation with NGSC. The Moray graves and the engine beds will be protected from project activities. A photographic record of the six sites / features which will be destroyed will be undertaken to record the history of the area and make it accessible to the Stawell community.

The cultural historic significance of Big Hill, which has been assessed as being of local significance only and not warranting inclusion on the Victorian Heritage Register, will be impacted by removal of the Hill. However, the preservation and post-mining reinstatement of key monuments and memorials, and the recording of elements of the cultural history which will be lost due to mining, will maintain key elements of cultural heritage. Additionally, the opportunity exists for incorporating social history and community associations into an End Use Master Plan for the rehabilitated Big Hill.

In consultation with Heritage Victoria, the impacts of the Project on historic heritage can be managed adequately.
8.5 Noise
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8.5 Noise

8.5.1 Introduction
This section of the EES describes and assesses the potential noise impacts that may result from Project activities; identifies measures to manage and mitigate potential adverse impacts and assesses overall impacts on noise following implementation of the proposed management and mitigation measures.

This assessment is based primarily on information provided in:


This report is included in Technical Appendix 5 to this EES.

<table>
<thead>
<tr>
<th>Relevant sections of EES Scoping Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>This section of the EES covers the following components of the EES Scoping Requirements insofar as they relate to noise:</td>
</tr>
<tr>
<td>‘Evaluation Objective’</td>
</tr>
<tr>
<td>To minimise adverse noise, vibration and other amenity effects on nearby residents and local communities, to the extent practicable.</td>
</tr>
<tr>
<td>Key issues</td>
</tr>
<tr>
<td>Nearby residents potentially exposed to excessive noise or vibration.</td>
</tr>
<tr>
<td>Priorities for characterising the existing environment</td>
</tr>
<tr>
<td>Identify dwellings and any other potentially sensitive receptors that could be exposed to project-related noise or vibration.</td>
</tr>
<tr>
<td>Establish the existing noise setting via baseline monitoring.</td>
</tr>
<tr>
<td>Characterise noise and vibration generation by proposed mine activities.</td>
</tr>
<tr>
<td>Design and mitigation measures</td>
</tr>
<tr>
<td>Describe and evaluate both potential and proposed design responses and/or other mitigation measures (construction and mining equipment and methods, staging and scheduling of works), which could minimise noise and vibration and effects on sensitive receptors.</td>
</tr>
<tr>
<td>Assessment of likely effects</td>
</tr>
<tr>
<td>Predictions of likely noise levels at dwellings adjacent to the project area, and at any other sensitive receptors within the vicinity, including for relevant alternatives, during different stages of mine development and operation and different weather conditions, describing sources of uncertainty associated with the noise modelling.</td>
</tr>
<tr>
<td>Approach to manage performance</td>
</tr>
<tr>
<td>Outline and evaluate proposed additional measures to monitor and manage noise and vibration levels to minimise residual effects and ensure compliance with relevant standards.’</td>
</tr>
</tbody>
</table>
Key issues emerging from EES studies and community consultation:

Community concerns arising from the ongoing community engagement and communications program that relate to potential noise impacts of the Project are:

- the potential loss of amenity caused by noise resulting from the Project.

Summary of findings

- The noise environment surrounding the Project area is characterised by a number of ambient noise sources including; local and highway traffic, local industries (including existing SGM activities) and commercial sites, schools and community activity, and wildlife (insects and birds).

- The daytime noise limits or targets relevant to this Project are:
  - 50 decibel (dB) (Leq) limit - for dwellings currently exposed to mining noise from SGM’s operations, which are located to the south and east of the Project area (Zone 1) (refer to Figure 8-40). This limit was derived from State Environment Protection Policy (Control of Noise from Commerce Industry and Trade) No. N-1 (SEPP N-1) and is part of the site’s existing EMP limit.
  - 46 dB (Leq) target - for dwellings outside of Zone 1 (Zone 2), particularly to the west and southwest of SGM’s current operations (refer to Figure 8-40). This target is derived from the EPA Publications 1411-1413: Noise from Industry in Regional Victoria (2011) (NIRV).

- The average daytime noise level (LAeq) in the streets surrounding the Project area (as measured at ten locations) range from 39 dB to 61 dB, with average noise levels exceeding 50 dB in all but one location, and 60 dB in three locations. Noise levels are attributed to residential, community and environmental contributions.

- Night time, evening and weekend noise as a result of the processing plant will be unchanged as is outside of the scope of this assessment.

- The Project design in regards to mining methods has incorporated best practice measures to reduce noise levels as far as practicable, including restricting Project activities (excluding environmental and maintenance works) to Monday to Friday, daytime hours only (7am – 6pm), optimising mine layout (e.g. through a push-back, multi bench mining arrangement to shield noise generating plant and haul roads), selecting low-noise plant, additional silencing of mobile plant, strategically designed bund walls for acoustic screening, acoustic enclosures around noisy equipment and use of ‘smart alarms’ to minimise annoyance related to traditional reversing alarms;

- Noise levels and impacts will vary throughout the Project with the location of work, the topography of the pits and stockpile, and the equipment used. However:
  - noise levels from mining will decrease as mining moves progressively deeper into the pits and increase again as the pits are backfilled and re-contoured
  - noise impacts will progressively move from north to south as mining and rehabilitation activities move from the North Pit to the South Pit
  - noise levels are potentially heightened during the final stages of rehabilitation.

- In Zone 1, the average daytime noise level is estimated to range between 42 and 49 dB (Leq) and therefore, it is expected that under the modelled conditions there will be no exceedances of the existing EMP noise limit in this area.
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- In Zone 2, the average daytime noise level is estimated to be under 46 dB (L_{eff}) at most locations and at most times throughout the Project. At a few locations, it is estimated that receptors will experience noise levels of up to 50 dB (L_{eff}) for short durations which is above the 46 dB (L_{eff}) target. During site rehabilitation, daytime noise levels may be up to 58 dB (L_{eff}) at three locations, due to equipment working at elevation and without shielding.

- The predicted change in noise level will vary with the fluctuating ambient noise levels present regardless of the Project noise. When ambient noise levels at residential locations are higher (e.g. 50-61 dB), noise from the mine will be less noticeable than at times when ambient noise levels are lower (e.g. 39-50 dB).

8.5.2 Existing Conditions

SGM operates an existing gold mine adjacent to the proposed Project area. Over the past 30 years activities have included extensive underground mining operations and various open-cut pits, ore crushing and processing, and haulage of waste rock and ore. Extraction, haulage and processing plant activity currently occurs 24 hours a day, 365 days per year.

The noise environment surrounding the Project area is characterised by a number of ambient noise sources including; local and highway traffic, local industries (including existing SGM activities) and commercial sites, schools and community activity, and wildlife (insects and birds).

Historically, dwellings within close proximity to SGM activities have been exposed to noise from the mine.
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8.5.2.1 Historic Activities and Noise Monitoring

Davis Pit Open-cut Mining

Open-cut mining of the former Davis Pit occurred from 1987-1988 within the footprint of the current Project’s South Pit (as shown in Figure 8-33). The open-cut mining of Davis Pit involved excavation, blasting and transport of low-grade oxide ore from the mine to the processing plant.

Figure 8-33  Davis Pit footprint relative to the Project area
Historical noise monitoring around Stawell Gold Mines (2005-2012)

Noise around the SGM site was monitored annually between 2005 and 2012 at four residential properties by independent acoustic consultants (refer to Figure 8-34).

The effective noise level ($L_{eq}$) is the noise ($L_{Aeq}$) measured in decibels (dB) over a half-hour period that is assumed to be the contribution from SGM only. It is adjusted for the character of the noise such as tonality, intermittency and impulsiveness. $L_{eq}$ is determined in accordance with State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 (SEPP N-1).
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Table 8-9 presents a summary of the historical noise monitoring results at the four locations shown in Figure 8-34.

### Table 8-9  Historical noise monitoring results (day time period) from 2005 - 2012

<table>
<thead>
<tr>
<th>Location</th>
<th>Effective noise level dB(Leq)</th>
<th>Current EMP day time limit dB(Leq)</th>
<th>Description of noise sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>29 Forrest Hill Road</td>
<td>37-45</td>
<td>50</td>
<td>Noise from processing plant and trucks was generally audible but inaudible on some occasions.</td>
</tr>
<tr>
<td>74 Crowlands Road</td>
<td>40-47</td>
<td>50</td>
<td>Noise from processing plant was generally the dominant noise source.</td>
</tr>
<tr>
<td>Lot 2 O’Regan Street</td>
<td>38-50</td>
<td>50</td>
<td>Noise from processing plant and trucks ranged from ‘not audible’ to ‘dominant’.</td>
</tr>
<tr>
<td>67 Fisher Street</td>
<td>40-45</td>
<td>50</td>
<td>Noise from processing plant and trucks ranged from ‘not audible’ to ‘audible’.</td>
</tr>
</tbody>
</table>

The historical monitoring results shown in Table 8-9 indicate that SGM’s current mining operations comply with the current day time limit (regulated through Earth Resources Regulation Victoria (ERRV)) as part of the site’s EMP) at the four residential monitoring locations and that the dominance of the mine noise is highly variable, most likely due to varying site activities and meteorological conditions.

### 8.5.2.2  Ambient Noise Monitoring around the Project Site

A combination of unattended long-term noise measurements (recorded over a period of nine to 11 days) and attended short-term noise measurements (recorded over 15 minute periods) were undertaken by Marshall Day Acoustics (MDA) (2013) with the aim of characterising the ambient noise level around the Project area. As indicated in Figure 8-35, the measurement locations were generally at sensitive receptors such as residential premises surrounding the existing site and new Project area.

The ambient noise level in this case includes all noise sources without the influence of noise from the Project. Attended ambient noise levels were measured to document noise sources that contribute to the existing noise environment at various locations near to the Project boundary. At all measurement locations, the general ambient noise environment included noise sources such as local traffic, birds, trees rustling in the breeze and general noise from community activity. At some locations, mine noise was audible in the form of truck noise, reversing beepers or mechanical plant noise.

The monitoring locations are shown on Figure 8-35 below.
Figure 8-35  Ambient noise monitoring locations relative to the Project area

Ambient noise monitoring – unattended noise measurements

Noise loggers were placed at ten residential locations (refer to Figure 8-38) for a period of nine to eleven days. A weather monitoring station was located at one of the noise logging sites during the first survey to record a record of weather events throughout the monitoring period and periods of inclement weather were filtered from the data reported. The results of the monitoring are shown in Table 8-10 below. The noise level is measured and reported in decibels as both $L_{A90}$ and $L_{Aeq}$, where:

- $L_{A90}$ is the noise level exceeded for 90 per cent of the measurement period, measured in dB. This is commonly referred to as the background noise level
- $L_{Aeq}$ is the equivalent continuous sound level, measured in dB. This is commonly referred to as the average noise level.
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Table 8-10  Logged long term measurement results around the Project area (unattended)

<table>
<thead>
<tr>
<th>Address</th>
<th>Background noise level average hourly LA90 dB</th>
<th>Average noise level average hourly LAeq dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Day</td>
<td>Evening</td>
</tr>
<tr>
<td>74 Crowlands Road</td>
<td>33-45</td>
<td>27-43</td>
</tr>
<tr>
<td>219 Main Street</td>
<td>32-47</td>
<td>28-43</td>
</tr>
<tr>
<td>7 Fisher Street</td>
<td>32-47</td>
<td>35-45</td>
</tr>
<tr>
<td>6 Crowlands Road</td>
<td>30-41</td>
<td>24-39</td>
</tr>
<tr>
<td>198 Main Street</td>
<td>38-48</td>
<td>35-47</td>
</tr>
<tr>
<td>15 Fisher Street</td>
<td>34-46</td>
<td>32-45</td>
</tr>
<tr>
<td>39 Oregan Street</td>
<td>35-44</td>
<td>36-45</td>
</tr>
<tr>
<td>Hawthorn Street</td>
<td>32-47</td>
<td>31-45</td>
</tr>
</tbody>
</table>

The unattended monitoring results show high variability in the background noise level and the average noise level during each time period.

The background daytime noise level ranged from 29 dB to 48 dB with the highest background noise occurring on streets with the highest levels of traffic (e.g. Main Street).

The average daytime noise level (LAeq) ranged from 39 dB to 61 dB, with average noise levels exceeding 50 dB in all but one location, and 60 dB in three locations.

Figure 8-36 and Figure 8-37 highlight the changes in ambient noise levels measured over a 24-hour period at 219 Main Street and 49 Fisher Street (respectively) on 20 March, 2013. The LAeq descriptor describes the ‘average’ noise level across the day.

---

3 Day, evening and night periods - as defined in SEPP N-1 (State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1)
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In both figures, ambient noise levels are generally higher through the day period, and reduce during night time. It is also noted that everyday noise sources such as passing traffic frequently result in short-term noise levels that are more than 20 dB higher than the average noise level (approximately 52 dB at Main Street and 45 dB at Fisher Street).


Ambient noise monitoring – attended noise measurements

The unattended noise logging was supplemented by short-term (15-minute) attended measurements at 15 locations, which included the 10 unattended logging sites and five additional sets of attended measurements in locations surrounding the Project area. Each site was visited twice during the day period, with at least nine days between each measurement.\(^4\)

Figure 8-38 shows the locations of the attended noise measurements from both site visits and Table 8-11 shows the reported noise levels in terms of average noise levels (L_{Aeq}) and background noise levels (L_{A90}).

\(^4\) Note: 69 Fisher Street had attended measurements taken in March and again in November. There are therefore two sets of data from this location.
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Table 8-11  Attended ambient noise measurement results around the Project area

<table>
<thead>
<tr>
<th>Address</th>
<th>LA90 dB (Background)</th>
<th>LAeq dB (Average)</th>
<th>Mine noise audible on at least one occasion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(first visit/second visit)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>74 Crowlands Road</td>
<td>40/29</td>
<td>47/41</td>
<td>Yes</td>
</tr>
<tr>
<td>219 Main Street</td>
<td>37/34</td>
<td>56/55</td>
<td>No</td>
</tr>
<tr>
<td>7 Fisher Street</td>
<td>41/34</td>
<td>46/48</td>
<td>Yes</td>
</tr>
<tr>
<td>49 Fisher Street</td>
<td>39/35</td>
<td>55/43</td>
<td>Yes</td>
</tr>
<tr>
<td>69 Fisher Street (March)</td>
<td>38/33</td>
<td>42/37</td>
<td>Yes</td>
</tr>
<tr>
<td>Between 24 and 26 Crowlands Road</td>
<td>35/29</td>
<td>58/54</td>
<td>Yes</td>
</tr>
<tr>
<td>5-9 Crowlands Road</td>
<td>35/32</td>
<td>57/59</td>
<td>Yes</td>
</tr>
<tr>
<td>Corner Skene and Clemes Streets</td>
<td>37/35</td>
<td>47/48</td>
<td>No</td>
</tr>
<tr>
<td>Corner Skene and Holt Streets</td>
<td>38/35</td>
<td>57/59</td>
<td>No</td>
</tr>
<tr>
<td>6 Crowlands Road</td>
<td>37/30</td>
<td>44/39</td>
<td>Yes</td>
</tr>
<tr>
<td>198 Main Street</td>
<td>44/39</td>
<td>49/42</td>
<td>No</td>
</tr>
<tr>
<td>15 Fisher Street</td>
<td>43/33</td>
<td>47/44</td>
<td>Yes</td>
</tr>
<tr>
<td>69 Fisher Street (November)</td>
<td>40/35</td>
<td>52/39</td>
<td>Yes</td>
</tr>
<tr>
<td>39 O'Regan Street</td>
<td>37/37</td>
<td>46/51</td>
<td>No</td>
</tr>
<tr>
<td>Hawthorn Street</td>
<td>39/37</td>
<td>49/44</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*The two entries in each column represent readings from the first and second visit to the recording site.

From these results, the existing mine noise was audible at nine of the fourteen measurement locations, during at least one measurement period. These locations were typically closer to the existing mine activity or unshielded by the natural topography.

However, the locations where mine noise was audible do not necessarily experience higher ambient noise levels than locations where mine noise was not audible. For example, mine noise was inaudible at the corner of Skene and Holt Streets, but the measured ambient LAeq noise level (57-59 dB LAeq) was significantly higher than that measured at 69 Fisher Street (37-42 dB LAeq) during March, where mine noise was audible.

In summary, noise measurement data suggests that ambient noise levels are highly variable around the Project area, and depend on relative contributions from nearby noise sources. Locations close to busy traffic routes tend to experience higher ambient noise levels than locations further from busy traffic routes. Many residential locations that are close to the mine site are currently exposed to noise from mining activity during day, evening and night periods.
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8.5.2.3 Historical Noise Complaints

SGM maintains a complaints register to document all complaints from residents in relation to noise from SGM site activities. Over the past 14 years of operation there has been an average of one or two noise complaints per year. Most of these have been related to non-routine activity such as drilling or haul trucks operating during evening or night time hours when background noise levels are lower.

Although the processing plant activities will be unchanged, it is noted that the Project may expose more residents to potential noise impacts because of its proximity to residential areas.

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Sound level (or noise) is measured in decibels (dB), and the pitch (or frequency) is measured in hertz. Sound is typically audible between 20 and 20,000 hertz.

The decibel scale is logarithmic (i.e. a noise measuring 100 dB is 100 times louder than a noise measuring 10 dB) to manage the enormous range of sound pressures able to be detected by the human ear. This means that if two machines emit exactly the same noise level of 80 dB, the total noise level is not 160 dB, but 83 dB.

Response to sound is highly variable and depends on the nature and context of the sound. As a general guide, a change in noise of:

- 1-2 dB: is difficult to perceive
- 3-4 dB: may be just noticeable
- 5-6 dB: is appreciable
- 9-11 dB: is a substantial change or an effective doubling of loudness.

Therefore a doubling of intensity (from two machines as opposed to one) will result in a change in noise of 3 dB, which is considered to be just noticeable.

8.5.3.1 Existing Environmental Management Plan noise limits

The EMP for SGM MIN5260 specifies noise limits for the current SGM operations. These are shown below in Table 8-12.

Table 8-12 Existing EMP MIN5260 licence noise limits for areas previously exposed to noise from SGM

<table>
<thead>
<tr>
<th>Time period</th>
<th>Day of the week</th>
<th>Applicable time period</th>
<th>SGM EMP noise limit, $L_{eff}$ dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>Monday-Saturday</td>
<td>7am-6pm</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Sunday</td>
<td>7am-6pm</td>
<td>44</td>
</tr>
<tr>
<td>Evening</td>
<td>Monday-Sunday</td>
<td>6pm-10pm</td>
<td>44</td>
</tr>
<tr>
<td>Night</td>
<td>Monday-Sunday</td>
<td>10pm-7am</td>
<td>39</td>
</tr>
</tbody>
</table>
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8.5.3.2 Noise Standards, Policies and Guidelines

Noise from Industry in Regional Victoria

The relevant guidelines for noise from industrial operations in regional Victoria are the EPA Publications 1411-1413: Noise from Industry in Regional Victoria (2011) (NIRV).

NIRV is a non-statutory guideline that provides recommended maximum noise targets for existing and proposed industry. This approach is applied in regional Victoria because characteristics such as low ambient noise levels and large location-constrained, resource-based industries mean that it can be more difficult to achieve noise limits in regional areas compared to metropolitan areas.

Residential areas closest to the Project area are zoned:

- Low Density Residential Zone (LDRZ)
- Residential 1 Zone (R1Z)
- Public Use Zone 1 (PUZ1)
- Special Use Zone 1 (SUZ1).

The recommended noise targets set out in NIRV for receivers in the zones listed above are shown below in Table 8-13.

Table 8-13 NIRV recommended maximum noise levels for areas not previously exposed to noise from SGM

<table>
<thead>
<tr>
<th>Time period</th>
<th>Day of the week</th>
<th>Hours</th>
<th>NIRV recommended maximum noise level, $L_{eq}$ dB$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>Monday-Friday</td>
<td>7am-6pm</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Saturday</td>
<td>7am-1pm</td>
<td></td>
</tr>
<tr>
<td>Evening</td>
<td>Monday-Friday</td>
<td>6pm-10pm</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Saturday</td>
<td>1pm-10pm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sunday</td>
<td>7am-10pm</td>
<td></td>
</tr>
<tr>
<td>Night</td>
<td>Monday-Sunday</td>
<td>10pm-7am</td>
<td>36</td>
</tr>
</tbody>
</table>

$^a$ $L_{eq}$ is the noise level that is attributed to the Project only. It does not include background or ambient noise.

According to NIRV, the Project is considered an existing industrial use with proposed changes to activities or equipment, where:

‘the recommended (noise) levels are lower than the levels referenced on the approval’, (and as a result of the Project) ‘the changes will impact upon the same noise-sensitive areas as currently exposed’ and also ‘the changes will impact upon new noise-sensitive areas (e.g. different residences)’
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Based on these guidelines, SGM should only, 

‘apply the recommended levels for noise-sensitive areas not previously exposed to the noise’

The historical and ambient noise monitoring results summarised in Section 8.5.2 demonstrate that there are specific noise-sensitive locations adjoining the Project boundary that are currently, or have historically been, exposed to noise from SGM operations. Therefore, in accordance with NIRV, the existing noise limit (50 dB) continues to apply to areas that have been previously exposed to noise from SGM operations (e.g. residents in proximity to the existing SGM site) as compared to the 46 dB target for residents in others areas (refer to Figure 8-40).

Noise Criteria for the Project

The noise targets for the Project are summarised in Table 8-14. This takes into account the provision in NIRV for existing noise limits to apply to areas previously exposed to noise from existing operations

Table 8-14 Noise criteria for the Project (during 0700 – 1800 Monday – Friday)

<table>
<thead>
<tr>
<th>Operational Area</th>
<th>Noise Target L_{eff} (dB)</th>
<th>Noise Limit L_{eff} (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwellings previously exposed to SGM activity noise (Zone 1)</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Dwellings newly exposed to SGM activity noise (Zone 2)</td>
<td>46</td>
<td>-</td>
</tr>
</tbody>
</table>

Variations and exemptions for periods of construction, site clearing and rehabilitation

Table 4 in NIRV Publication 1411 outlines specific variations to the recommended noise limits for mines for the following activities described as exceptions to normal operations (where noiser work might be considered necessary and variations from the noise limits can be justified). The three that are relevant to this Project include:

- installation of constructed noise-control works (exemption to the noise limit applies)
- site clearing and preparation (exemption to the noise limit applies)
- final site rehabilitation, short projects and necessary unshielded work (variation to the noise limit applies).

For a noise exemption, there is no recommended noise limit. For a noise variation, the regulator may allow works during the daytime to be up 10 decibels greater than the recommended level, up to a maximum of 68 decibels.

Potential variations or exemptions to the recommended levels are discussed in Section 8.5.3.8.

8.5.3.3 Best Practice Noise Control included in the Project Design

Due to the proximity of the Project to residential areas, the Project design has incorporated a range of best practice measures to reduce noise levels as far as practicable. These measures (which are further detailed in Section 8.5.4) are included in the subsequent noise modelling to assess potential impacts, and include:
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- restricting Project activities (other than environmental and maintenance works) to Monday to Friday, daytime hours only (7am-6pm)
- Optimising mine layout (e.g. through a push-back, multi bench mining arrangement to shield noise generating plant and haul roads)
- selecting low-noise plant
- additional silencing of mobile plant
- strategically designed bund walls and barriers for acoustic screening
- providing acoustic enclosures around the rock-breaker
- use of ‘smart alarms’ to minimise annoyance related to traditional reversing alarms
- regular maintenance of equipment to manufacturer standards
- regular and relevant community consultation.

8.5.3.4 Impracticable Noise Control Measures

The following provides a list of potential ‘best practice’ noise control measures that were considered, but not included in the Project design for various reasons:

Construction of a permanent noise barrier between the pits and residential areas

The 1999 Big Hill EES considered a seven metre high noise barrier located along the southwest edge of the pits. Permanent noise barriers were also considered in multiple locations as a possible mitigation measure for this Project, but were considered inappropriate for the following reasons:

- Modelling predicted that the noise barrier height would need to be in excess of eight metres before any screening is provided from the highest noise sources. Further, due to the natural topography of the site, this eight metre barrier would have limited effectiveness.
- Due to the changing nature of operations at the site, the effectiveness of a permanent noise barrier would be limited to specific periods over the life of the Project, rather than provide continuous, effective noise reduction.
- Noise impacts from the construction of such a barrier would be significant and extended.
- A barrier of this size and extent would require the further removal of a substantial area of vegetation and likely be visually imposing and possibly create visual amenity impacts.

Reducing equipment requirements or duration of activities

The effective noise level from site activities may be reduced through the following means:

- reduction in activity time
- reduction in equipment numbers.

While reductions in activity time have already been implemented through restricting extraction activity to week days only and no night time activity, any further time restrictions would have a significant impact on the duration of the Project and hence, viability of mining operations.
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Halving the equipment requirements on-site would only result in a marginal noise level reduction of approximately 3 dB and may extend the Project duration from five years to up to 10 years. The Project would be economically unviable as a result, and would have a much greater impact on amenity as it would double the duration of noise impacts.

Additional equipment mitigation packages

Proprietary noise attenuation packages for equipment have been incorporated in the Project.

Due to the high number of plant operating at the site, further removal or reduction in the noise level of one item of plant would not have a perceivable effect on the overall noise level.

8.5.3.5 Noise Modelling Approach and Assumptions

Noise modelling approach

The Project involves the progressive mining of the North Pit and South Pit along the south western side of the Big Hill ridge line, with haulage to the ROM pad for ore processing and to the TWRS for waste rock stockpiling. The pits are progressively backfilled and re-contoured with waste rock from the South Pit, TWRS and Mt Micke (or a suitable alternative).

Noise levels and the location of their impact will vary throughout the Project, given the location of work, the topography of the pits and stockpile, and the equipment used. However:

- noise levels from mining will decrease as mining moves progressively deeper into the pits and increase again as the pits are backfilled and re-contoured
- noise impacts will progressively move from north to south as mining and rehabilitation activities move from the North Pit to the South Pit.

Therefore, different stages of works will result in different noise levels and affect different receptors around the Project area.

Noise modelling was completed for periods during which noise impacts of the Project are expected to be at their greatest based on:

- intensive equipment requirements or use of particularly noisy equipment items, such as the rock breaker
- the distance between the location of the mining or rehabilitation activity and the nearest residential property
- periods in which reduced shielding is available to residential locations from site equipment (e.g. from natural topography and pit walls).

The four periods of the Project during which noise impacts are expected to be highest are described in Table 8-15.
### Table 8-15 Descriptions of scenarios that were modelled for noise

<table>
<thead>
<tr>
<th>Stage of mining</th>
<th>Extraction activity</th>
<th>Stockpiling arrangement</th>
<th>Material movements</th>
<th>Rock-breaker in use?</th>
<th>Processing plant operating?</th>
</tr>
</thead>
</table>
| Quarter 1, Month 1 (Q1M1) | Mining commences at the top of Big Hill (the North Pit). Overburden removal is in progress and benches and bunds are being established. Therefore activities are elevated with minimal shielding from pit walls, benches or topography. (one haul truck for waste rock, two haul trucks for ore) | Waste rock is hauled to the TWRS to construct a noise control bund along the northern boundary of the TWRS as a priority.  
|                  |                                                                                                                                                                                                                     | No noise control bunds and screens will be constructed along the haul road to provide up to 5 dB noise reduction for haulage traffic.                                                                                     | No                                                                                                                                                    | Yes                 | Yes                         |
| Quarter 2, Month 1 (Q2M2) | Mining in the North Pit continues with increased intensity. (Two haul trucks for ore compared to one in Q1M1, two haul trucks for waste rock). Work activities will occur behind multiple 5 metre pit benches which will provide up to 5 dB of noise reduction. | The TWRS noise control bund will be completed and a dozer working at the TWRS.  
|                  |                                                                                                                                                                                                                     | Material movement from North Pit to TWRS and ROM Pad will occur behind noise control bunds and screens.                                                                                                                 | Yes. The rock breaker will operate at the ROM pad and operate behind a screen that is 1.5 metres higher than the top of noise source. | Yes                 | Yes                         |
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<table>
<thead>
<tr>
<th>Stage of mining</th>
<th>Extraction activity</th>
<th>Stockpiling arrangement</th>
<th>Material movements</th>
<th>Rock-breaker in use?</th>
<th>Processing plant operating?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter 5, Month 3 (Q5M3)</td>
<td>Final material from the North Pit will be extracted and mining will commence at the top of South Pit. Benches and push backs in the South Pit will be established as a priority. The excavator and South Pit equipment will operate behind one 5 metre pit bench, all other North and South Pit plant will operate below two pit benches. (Two haul trucks for ore, two haul trucks for waste rock).</td>
<td>The TWRS is operating at 275 metres AHD or 10 metres above the GWM Water water storage 7, with a 5 metre noise control bund above that.</td>
<td>Material movement North and South Pits to TWRS and ROM Pad.</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Quarter 8, Month 3 (Q8M3)</td>
<td>South Pit mining is in progress. Backfilling of North Pit in nearing completion and there is no landform shielding available. A compactor is in use at the top of the surface to reinstate the land form. South Pit plant will operate below two pit benches, at a height of 240 metres AHD. (Three haul trucks for ore and three haul trucks for waste rock)</td>
<td>TWRS noise control bund in place. However most waste rock from the South Pit is being used as backfill in the North Pit.</td>
<td>Material movement from South Pit to TWRS, ROM Pad and North Pit.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

---

5 This scenario is considered to be similar to the rehabilitation phase of the South Pit (Quarter 20), when the use of the compactor will also be unshielded.
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Three-dimensional noise model
A three dimensional (3-D) noise model was developed using proprietary noise mapping software (SoundPlan v7.2), which enables the calculation of noise levels over a wide area and accounts for reflected noise, terrain conditions and location of noise sources. The model calculates noise levels at key receptor locations in accordance with the standard ISO9613-2:1996 Attenuation of sound during propagation outdoors – Part 2: General method of calculation (ISO 9613-2). The ISO 9613-2 propagation model is a general purpose noise propagation method that is the primary international standard for calculating industrial noise impacts on the environment.

The noise model considers the following critical inputs for each of the four stages described in Table 8-16:

- topographical data to represent the mine and surrounding footprint, including depth of pits, location of haul roads, height of the stockpile and the Big Hill topography
- location of all plant and equipment producing noise (equipment and plant has been conservatively located at the typical worst-case position for each key stage)
- meteorological conditions, including a conservative assumption that the receiver is always downwind of the noise source.

Noise level data
Sound power levels for equipment have been derived from:

- on-site noise measurements of equipment
- manufacturer data
- measurement data from the MDA database.

Derived sound power levels were reviewed against the following standards:


For each piece of equipment, the derived sound power level was assumed to be in the upper range quoted by AS2436:2010 and BS5228-1:2009, and is therefore considered to be conservative. A list of octave band sound power level data used in the model, including mitigation, is contained in the Technical Appendix 5.
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**Noise model validation**

The noise levels predicted by the model for the existing SGM processing plant were compared to measured noise levels taken within the site. This comparison is provided in Table 8-16 and shows good correlation between the measured and model-predicted noise levels.

**Table 8-16** Comparison between measured and model predicted noise levels from the SGM processing plant

<table>
<thead>
<tr>
<th>Location</th>
<th>Noise level, $L_{Aeq}$ dB</th>
<th>Difference, dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest of processing plant</td>
<td>72</td>
<td>70</td>
</tr>
<tr>
<td>Southwest of processing plant</td>
<td>67</td>
<td>66</td>
</tr>
<tr>
<td>Southeast of processing plant</td>
<td>63</td>
<td>64</td>
</tr>
</tbody>
</table>

Given the ISO 9613-2 noise propagation model is considered to be accurate to ± 3 dB, predicted noise levels are considered to be consistent with actual levels, confirming the model is appropriate for the prediction of future noise levels.

Also, the way sound levels are logarithmically added means that small inaccuracies in noise level assumptions are not compounded due to the large number of noise sources operating. For example, using logarithmic addition, if all sources changed level by 1 dB, the net result would be a change of 1 dB overall.
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8.5.3.6 Noise Receptors around the Project Area

Noise levels have been predicted at the closest residential locations from the Project boundary in all directions. A map of the 82 receptors that have modelled is shown below in Figure 8-39.

To assist with discussion and interpretation of results, noise impacts have been broadly categorised into two zones (Figure 8-40):

- Zone 1 is the area surrounding the existing SGM site where dwellings have previously been (and still are) exposed to noise from the site (as shown from historical noise monitoring). In this zone, the existing EMP noise limit is 50 dB for day-time operations.

- Zone 2 is the area beyond Zone 1. In this area, most residents have been currently or previously exposed to some noise from the existing operations (as shown in the attended ambient noise monitoring results Figure 8-38), but to a lesser extent than Zone 1 and is difficult to quantify. Despite the occasional audibility of mine noise within Zone 2, the NIRV guideline of 46 dB has conservatively been adopted as the target for day-time operations.
This zone is further broken down geographically into residents located to the north, south or west of the Project area for the purposes of discussion of impacts.

Figure 8-40  Proposed noise zones (zone 1 and zone 2)

8.5.3.7  Range of Predicted Noise Levels for the Daytime Period

Although noise impacts from the Project will be variable during the daytime period, the predicted results consider the upper range of values that may be experienced and therefore present the ‘worst case’ for each scenario.

The predicted noise levels take into account the varying terrain profiles due to the extent of extraction and stockpiling expected under each scenario. As most of the Big Hill ridgeline remains for the duration of the Project, residents in the north and west areas will not experience increased noise from the existing processing plant operations. That is, the ridge-line and hill will continue to provide acoustic shielding from process plant sources.
Table 8-17 and Table 8-18 show the predicted range of noise levels for each of the model scenarios.

Table 8-17  Range of predicted noise levels for Zone 1 (day-time operations)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Range of predicted noise levels, $L_{eff}$ dB</th>
<th>Predicted exceedance of EMP noise limit (50dB $L_{eff}$)</th>
<th>No. of locations predicted to exceed EMP noise limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1M1</td>
<td>44-48</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Q2M1</td>
<td>44-49</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Q5M3</td>
<td>42-48</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Q8M3</td>
<td>42-49</td>
<td>Nil</td>
<td>Nil</td>
</tr>
</tbody>
</table>

In Zone 1 (the area immediate to existing SGM operations where dwellings have previously been exposed to noise from SGM activity), the average noise levels are estimated to range between 42 and 49 dB. Although the Project will contribute to ambient noise levels, there will be no exceedance of the existing EMP limit and therefore no unacceptable noise levels in this area.

Table 8-18  Range of predicted noise levels in Zone 2 (day-time operations)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Range of predicted noise levels, $L_{eff}$ dB</th>
<th>Predicted exceedance of NIRV target (46dB $L_{eff}$)</th>
<th>No. of locations predicted to exceed NIRV target</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>North</td>
<td>South</td>
<td>West</td>
<td>Predicted exceedance</td>
</tr>
<tr>
<td>Q1M1</td>
<td>43-48</td>
<td>41-45</td>
<td>40-46</td>
<td>Up to 2dB</td>
</tr>
<tr>
<td>Q2M1</td>
<td>42-47</td>
<td>42-45</td>
<td>43-46</td>
<td>Up to 1dB</td>
</tr>
<tr>
<td>Q5M3</td>
<td>41-48</td>
<td>43-50</td>
<td>44-50</td>
<td>Up to 4dB</td>
</tr>
<tr>
<td>Q8M3</td>
<td>41-47</td>
<td>42-46</td>
<td>46-58</td>
<td>Up to 12dB</td>
</tr>
</tbody>
</table>

These results show that during these periods of operation, there are expected to be a number of exceedances of the NIRV target of 46 dB in each of the modelled scenarios. These results are discussed in the following sections relative to the zones in which impacts occur and the ambient noise levels observed within those zones during ambient noise monitoring.

The noise contour maps shown below provide an indication of the spread of noise to other residential locations further from the Project boundary.

**Predicted noise levels (Quarter 1, Month 1)**

The predicted worst case noise contours that may occur at the beginning of the Project during the first month of Quarter 1 are shown in Figure 8-41 below.
Figure 8-41  Predicted worst case noise contours during the Project (Quarter 1, Month 1)

The range of predicted noise levels relative to NIRV and the existing EMP limit are shown in Table 8-19 below.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Range of predicted noise levels, $L_{eq}$ dB</th>
<th>Predicted exceedance of NIRV target (46 dB $L_{eq}$)</th>
<th>No. of locations predicted to exceed NIRV target</th>
<th>Predicted exceedance of EMP noise limit (50 dB $L_{eq}$)</th>
<th>No. of locations predicted to exceed EMP noise limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>44-48</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zone 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North</td>
<td>43-48</td>
<td>Up to 2 dB</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>South</td>
<td>41-45</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>West</td>
<td>40-46</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

In the north area of Zone 2, two locations are expected to experience noise levels up to 48 dB due to noise sources working at height with limited screening provided by the intervening topography. One premise is located on Hawthorn Street and one premise is located on Main Street. Main Street experiences average ambient day time noise levels in the range of 51-56 dB, which is significantly higher than the predicted noise level associated with the Project (up to 48 dB). The predicted change in noise level in this location will be difficult to perceive and is therefore not considered to be a significant impact on this residence.
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The average day time noise levels on Hawthorn Street are expected to be lower than Main Street and at times, noise levels may be more noticeable.

**Predicted noise levels (Quarter 2, Month 1)**

The predicted worst case noise contours that may occur during the first month of Quarter 2 are shown in Figure 8-43 below.

![Figure 8-42 Predicted worst case noise contours during the Project (Quarter 2, Month 1)](image)

The range of predicted noise levels relative to NIRV and the existing EMP limit are shown in Table 8-20 below.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Range of predicted noise levels, $L_{ef}$ dB</th>
<th>Predicted exceedance of NIRV target (46dB $L_{ef}$)</th>
<th>No. of locations predicted to exceed NIRV target</th>
<th>Predicted exceedance of EMP noise limit (50dB $L_{ef}$)</th>
<th>No. of locations predicted to exceed EMP noise limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>44-49</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zone 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North</td>
<td>42-47</td>
<td>Up to 1 dB</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>South</td>
<td>42-45</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>West</td>
<td>43-46</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
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In Zone 2, the average noise level is estimated to range between 42 and 47 dB. Although the Project will contribute to ambient noise levels, there is only one predicted exceedance of the NIRV target by 1 dB which is not considered to be significant and not an unacceptable impact.

Predicted noise levels (Quarter 5, Month 3)
The predicted worst case noise contours that may occur during the third month of Quarter 5 are shown in Figure 8-43 below.

![Figure 8-43 Predicted worst case noise contours during the Project (Quarter 5, Month 3)](image)

The range of predicted noise levels during this period relative to NIRV and the existing EMP limit are shown in Table 8-21 below.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Range of predicted noise levels, $L_{eq}$ dB</th>
<th>Predicted exceedance of NIRV target (46dB $L_{eq}$)</th>
<th>No. of locations predicted to exceed NIRV target</th>
<th>Predicted exceedance of EMP noise limit (50dB $L_{eq}$)</th>
<th>No. of locations predicted to exceed EMP noise limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>42-48</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zone 2</td>
<td>North 41-48</td>
<td>Up to 2 dB</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>South 43-50</td>
<td>Up to 4 dB</td>
<td>9</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>West 44-50</td>
<td>Up to 4 dB</td>
<td>26</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
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In the north, south and west, 35 locations (primarily along Fisher Street) are expected to experience noise levels up to 5 dB during this period as Project activity begins at the top of the South Pit with limited screening provided by the intervening topography. As activity progresses deeper into the South Pit, noise sources will be screened by multiple benches and pit walls and are expected to reduce for these residences.

The average ambient noise levels along Fisher Street currently range from 39-61 dB during the daytime. The predicted change in noise level will therefore vary with the fluctuating ambient noise levels present regardless of the Project noise. When ambient noise levels at residential locations are higher (e.g. 50-61 dB), noise from the mine will be less noticeable than at times when ambient noise levels are lower (e.g. 39-50 dB).

**Predicted noise levels (Quarter 8, Month 3)**

The predicted worst case noise contours that may occur during the third month of Quarter 8 are shown in Figure 8-44 below.

*Figure 8-44  Predicted worst case noise contours during the Project (Quarter 8, Month 3)*
The range of predicted noise levels relative to NIRV and the existing EMP limit are shown in Table 8-22 below.

Table 8-22  Predicted noise levels from the Project (Quarter 8, Month 3)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Range of predicted noise levels, $L_{eq}$ dB</th>
<th>Predicted exceedance of NIRV target (46dB $L_{eq}$)</th>
<th>No. of locations predicted to exceed NIRV target</th>
<th>Predicted exceedance of EMP noise limit (50dB $L_{eq}$)</th>
<th>No. of locations predicted to exceed EMP noise limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>42-49</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zone 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North</td>
<td>41-47</td>
<td>Up to 1 dB</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>South</td>
<td>42-46</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>West</td>
<td>46-58</td>
<td>Up to 12 dB</td>
<td>29</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

A total of 16 residential premises located in the west may experience noise levels up to 50 dB and an additional 14 residential premises may experience noise levels between 50 and 58 dB for a period of up to one month (only three locations are predicted to reach 58 dB). During this period, the North Pit backfill and final compaction will occur concurrently. Due to the topography of the site, rehabilitation of Big Hill would occur at height and noise levels (particularly from the compactor) will be unshielded and noticeable during this time.

The noise level will vary depending on the proximity of the compactor to houses and is not expected to be up to 58 dB in all locations and at all times throughout the month. This work is of short duration and is necessary to achieve a safe and stable landform. NIRV allows for variations to the noise target for ‘final site rehabilitation, short projects and necessary unshielded work’ as described in further detail in Section 8.5.3.8 below.

In this instance, temporary noise screening by shipping containers has been investigated and found to be infeasible. The shipping containers would need to be stacked three high and to be within 15 metres of the noise source to provide effective screening. This is not possible as the newly rehabilitated surface will not be flat or provide the required stability for the shipping containers. In addition, the compactor needs to have the flexibility to move forwards and backwards across the reinstated landform and would not be operating close enough to the barrier to be shielded.

8.5.3.8  Variations and exemptions to the NIRV recommended levels

The following table describes the various work activities that are considered to be exceptions to normal operations for which specific exemption or variation to the recommended noise limit applies.

In all activities described below, SGM has applied best practice to reduce noise levels as far as practical as detailed in Section 8.5.4.
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## Table 8-23 Proposed Variations and Exemptions to NIRV recommended noise levels

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration and time of activity</th>
<th>Applicable NIRV variation / exemption</th>
<th>NIRV Definition</th>
<th>Description of activity</th>
</tr>
</thead>
</table>
| Site clearing and preparation of North Pit | Prior to Quarter 1  
Site clearing and preparation will take place in two stages for approximately one week per stage prior to overburden removal in North Pit. | Site clearing and preparation (exemption) | Site clearing and preparation means vegetation removal, topsoil removal, subsoil removal, road construction and civil works such as site drainage. | Removal of vegetation with a dozer. Vegetation will be removed for mulching and will occur away from the North Pit area. |
| Construction of roads                 | Prior to beginning of Quarter 1  
Construction of haul roads will be undertaken by a dozer and take approximately two weeks | Site clearing and preparation (exemption) | Site clearing and preparation means vegetation removal, topsoil removal, subsoil removal, road construction and civil works such as site drainage. | Construction of haul roads will involve cutting in the road to three metres or more in places. |
| Construction of haul route barriers and bunds | Prior to beginning of Quarter 1  
Construction of haul route barriers and bunds would take approximately two weeks | Installation of constructed noise-control works (exemption) | Constructed noise control works are works specifically targeted to a noise control purpose. They can include walls or fences; or earth mounds or bunds, constructed in particular circumstances | Timber fencing or bunds to be constructed along the haul road. The timber fencing and bunds are intended solely for the purpose of noise control. |
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<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration and time of activity</th>
<th>Applicable NIRV variation / exemption</th>
<th>NIRV Definition</th>
<th>Description of activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction of multiple pit benches in the North Pit</strong></td>
<td>Construction of multiple benches within the pits is an on-going process as activity moves further into the pit. Construction of the initial pit benches would take one month and would be completed at the end of the first month of Quarter 1.</td>
<td>Necessary unshielded work (variation)</td>
<td>Necessary unshielded work includes waste dump extensions (at a mine or quarry), tailings dam construction or final landform construction. It includes work that is necessary but cannot practicably be shielded by barriers, landforms or natural topography</td>
<td>One pit bench is common practice for open-cut mining to conduct operations near the edge of the pit. North and South Pit require the construction of additional pit benches to provide screening for equipment located in the pit. The upper pit bench is to be extracted as a double bench to provide full screening during removal. The additional pit benches are solely for noise and dust control. The construction of the pit bench would be undertaken by a 190T Excavator/120T Excavator and/or a D9/D11 bulldozer.</td>
</tr>
<tr>
<td><strong>Construction of pit benches in the South Pit</strong></td>
<td>Construction of multiple benches within the pits is an on-going process. Construction of the initial benches is expected to take 2 weeks at the beginning of Quarter 5.</td>
<td>Necessary Unshielded Works (variation)</td>
<td>Necessary unshielded work includes waste dump extensions (at a mine or quarry), tailings dam construction or final landform construction. It includes work that is necessary but cannot practicably be shielded by barriers, landforms or natural topography</td>
<td>One pit bench is common practice for open-cut mining to conduct operations near the edge of the pit. North and South pit require the construction of additional pit benches to provide screening for equipment located in the pit. The upper pit bench is to be extracted as a double bench to provide full screening during removal. The additional pit benches are solely for noise and dust control. The construction of the pit bench would be undertaken by a 190T Excavator/120T Excavator and/or a D9/D11 bulldozer.</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration and time of activity</th>
<th>Applicable NIRV variation / exemption</th>
<th>NIRV Definition</th>
<th>Description of activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of TWRS perimeter bund (5 metres height)</td>
<td>The initial TWRS perimeter bund will be completed by the end of the first month of Quarter 2, with the total construction duration lasting four 4 months. The bund will be constructed as a matter of priority from material extracted from North Pit.</td>
<td>Installation of constructed noise-control works (exemption)</td>
<td>Constructed noise control works are works specifically targeted to a noise control purpose. They can include walls or fences; or earth mounds or bunds, constructed in particular circumstances</td>
<td>The primary purpose of the TWRS bund is to screen residents on Crowlands Rd and nearby areas from noise at the TWRS. The bund will be constructed with a priority to screen the nearest or worst-affected residents first.</td>
</tr>
<tr>
<td>Final site rehabilitation of the North Pit</td>
<td>Final site rehabilitation of the North Pit would be undertaken during Quarter 8 for a period of approximately four weeks, occurring concurrently with the final back-filling operations.</td>
<td>Final site rehabilitation, short projects and necessary unshielded work (variation)</td>
<td>Final site rehabilitation means any activity related to site closure occurring at the final surface level after normal operations have ceased. It does not include backfilling of a pit</td>
<td>Final site rehabilitation would be undertaken by a compactor and water trucks. Due to the natural topography of the site, rehabilitation of Big Hill will occur at height and without shielding.</td>
</tr>
<tr>
<td>Final site rehabilitation of the South Pit</td>
<td>Final site rehabilitation of the South Pit would be undertaken during Quarters 18-20 for a period of eight weeks.</td>
<td>Final site rehabilitation, short projects and necessary unshielded work (variation)</td>
<td>Final site rehabilitation means any activity related to site closure occurring at the final surface level after normal operations have ceased. It does not include backfilling of a pit</td>
<td>Final site rehabilitation would be undertaken by a compactor and water trucks. Due to the natural topography of the site, rehabilitation of Big Hill will occur at height and without shielding.</td>
</tr>
</tbody>
</table>
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8.5.4 Management and Mitigation Measures

The location of the Project is constrained by the location of the gold resource. Due to its proximity to local residents, best practice noise mitigation has been considered, and where practicable, incorporated into the Project design. Table 8-24 presents a detailed review of the best practice measures incorporated in the Project and the expected noise reduction that will be achieved.
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Table 8-24  Best practice noise control included in the Project design

<table>
<thead>
<tr>
<th>Noise control measure</th>
<th>Description</th>
<th>Anticipated noise reduction value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project activities restricted to daytime hours only</td>
<td>Construction activities, mining, stockpiling and haulage will occur only during daytime hours (7am – 6pm) from Monday to Friday (excluding environmental and maintenance activities).</td>
<td>Noise impacts from new operations will not occur during evening and night periods. Most complaints received to date related to noise from trucks or other equipment during the night or evening hours. Risk of sleep disturbance will be minimised as far as practical</td>
<td>The SGM mill will continue to operate 24 hours a day, seven days a week.</td>
</tr>
<tr>
<td>Optimising mine layout (e.g. through a push-back, multi bench mining arrangement to shield noise generating plant and haul roads)</td>
<td>The most efficient and cost-effective mining practice for North Pit and South Pit would involve flat bench level mining (i.e. no benches, and operations would initially occur on flat level). To enable landform screening, a push-back mining arrangement will be undertaken, involving removal of earth material from the farthest point of the pit from residences, and moving towards residences using multiple benches as landform screening to reduce noise levels at residences. The push-back mining arrangement places equipment farther from residences at the initial unscreened location than under a flat bench level mining operation. Noise from activity will be attenuated by the additional distance to extraction activities.</td>
<td>The anticipated noise reduction provided by the two, five metre pit benches is predicted to be at least five dB.</td>
<td></td>
</tr>
</tbody>
</table>
# 8 Environmental Impact Assessment

<table>
<thead>
<tr>
<th>Noise control measure</th>
<th>Description</th>
<th>Anticipated noise reduction value</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Low noise plant /   | Equipment based noise mitigation packages have been selected:  
| Additional silencing  |   - haul trucks: exhaust/intake attenuation  
| of mobile plant       |   - water trucks: exhaust/intake attenuation  
|                      |   - dozers: exhaust/intake attenuation  
|                      |   - excavator 190T: exhaust/intake attenuation  
|                      |   - excavator 120T: exhaust/intake attenuation  
|                      |   - drill Rig: use of Atlas Copco drill silencing kit  
|                      |   - compactor: 'CE' mitigation package (sound panels and additional exhaust attenuation)  | The anticipated reduction value of the equipment-based mitigation is as follows:  
|                      |                      |   - haul trucks: -5 dB  
|                      |                      |   - water trucks: -5 dB  
|                      |                      |   - dozers: -4 dB  
|                      |                      |   - excavator 190T: -4 dB  
|                      |                      |   - excavator 120T: -4 dB  
|                      |                      |   - drill Rig: -3 dB  
|                      |                      |   - compactor: -5 dB  | Mitigated sound power levels for each item of plant considered in the noise model are listed in the Technical Appendix 5. |

Strategically designed bund walls for acoustic screening

- Multiple 5 metre pit benches (North and South Pits)

  5 metre pit benches will be constructed in the pits to provide visual and acoustic screening between pit operations and residential locations.

  Typical open-cut mine practice involves the use of a single pit bench, but at least two, five metre pit benches will be used for the Project for noise control purposes.

  As material is extracted from the pit, the benches will be extended towards the pit perimeter, shielding activities within the pit from nearby residences. Mobile plant operating within the pit will be contained below a minimum of two, five metre benches, while a loading excavator would be located below a minimum of one, five metre bench.

  The two, five metre pit benches are predicted to reduce noise by at least five decibels, compared to operations with no benches.

  As equipment progresses lower into the pit, the pit edges will provide additional screening and noise levels are expected to reduce.

  A diagram of the five metre pit benches is shown in Chapter 6, Figure 6-5.
## 8 Environmental Impact Assessment

<table>
<thead>
<tr>
<th>Noise control measure</th>
<th>Description</th>
<th>Anticipated noise reduction value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 metre noise bund at TWRS Stockpile</td>
<td>A five metre bund will be created around the TWRS with the extracted waste rock. Stockpiling will occur behind the bund, shielding activity from nearby residents. As the stockpile progresses inward, the process will be repeated, whereby the outer edge of the stockpile will be created first, providing screening for subsequent stockpiling activities.</td>
<td>The TWRS bund is predicted to reduce noise levels by 5 dB when equipment is fully screened.</td>
<td>A diagram of the TWRS bund is shown in Chapter 6, Figure 6-6.</td>
</tr>
<tr>
<td>3 metre noise barriers along haul routes</td>
<td>On the east side of the haul route, a three metre earth bund will be constructed for the length of the road. Where this is not practical (e.g. along Reservoir 4), a three metre timber wall will be constructed. On the west side of the haul route, the natural topography of the site, will create a three metre bund where the road is cut in.</td>
<td>For the haul trucks, the height of the exhaust outlet is 2.5 metres above ground and the height of the engine is two metres above ground. The haul route bund is predicted to provide up to five dB noise mitigation.</td>
<td></td>
</tr>
<tr>
<td>Providing acoustic screening around the rock-breaker</td>
<td>A four metre high solid screen will shield the rock-breaker from nearby dwellings on O'Regan Street. The screen will be at least 1.5 metres higher than the top of the noise source.</td>
<td>The acoustic screen around the rock-breaker is predicted to provide up to eight dB of noise mitigation.</td>
<td></td>
</tr>
<tr>
<td>Use of ‘smart alarms’ to minimise annoyance related to traditional reversing alarms</td>
<td>All existing and new equipment operating on site must be fitted with broadband reversing signals. These devices do not produce the high pitched, tonal noise associated with traditional reversing signals but still meet safety requirements.</td>
<td>The tonal component of traditional reversing alarms will be eliminated with the use of ‘smart alarms’ or broadband reversing signals.</td>
<td></td>
</tr>
<tr>
<td>Regular maintenance of equipment to manufacturer standards</td>
<td>Regular inspection and maintenance of equipment must occur to ensure the equipment is in good working order and to reduce noise impacts resulting from excessive vibration.</td>
<td>Noise attenuation is not quantifiable.</td>
<td></td>
</tr>
</tbody>
</table>
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In addition, the following management and mitigation measures will be included to further reduce noise impacts.

**Siting of mobile activities**
Mobile activities such as chipping / mulching of vegetation removed during site clearance will be situated away from residential areas.

**Regular maintenance**
All haul routes will be kept level and free from debris to mitigate the potential for noise from loose loads on trucks.

Regular inspection and maintenance of equipment will occur to ensure that equipment is in good working order. If mobile equipment is replaced or upgraded, any reduction in noise level will be confirmed by attended noise measurements.

**Driver training**
As driver behaviour can impact noise levels, drivers will undertake training as part of the site induction process. This training will instruct drivers to:

- minimise the use of compression brakes where safe to do so
- avoid prolonged periods of idling.

**Community consultation**
Unacceptable noise impact within the community will be further addressed via comprehensive community consultation. This will include:

- Liaison with the community to identify what aspects of the noise cause the most disturbance so that noise control efforts may be better targeted
- Prompt response and reporting of community complaints
- For intensive activities such as site rehabilitation SGM will consult with nearby residents to determine if there is a preference for alternate operating hours for the duration of this activity e.g. shorter periods throughout the day over a longer duration or extended hours to reduce the duration of the work
- For periods in which noise is particularly high for specific receptors, one on one consultation will be undertaken to agree on a suitable alternative that considers the specific needs of the individuals e.g. temporary relocation or acoustic treatment. These options are discussed in further detail below.
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**Acoustic treatment for dwellings**
Specialised acoustic treatment incorporated into dwelling facades (such as laminated glazing or double glazing) may be considered as a potential mitigation measure for the Project. However, as compliance with NIRV is assessed externally to dwellings, any facade treatments will not assist with compliance with NIRV targets. Such treatments may, however, reduce noise levels inside nearby dwellings, and therefore some of the potential amenity impacts of the Project on these residents.

The potential noise reduction provided by facade upgrade treatments also relies on all windows and doors to be closed in order to achieve the desired effect, which may impact on fresh air flow and ventilation during the summer periods.

This type of treatment does not reduce noise levels in outdoor areas, but is considered a potentially effective means of noise mitigation for dwellings exposed to noise levels in excess of 50 dB L_{eq}. Implementation would be assessed on a case-by-case basis once operating noise levels are confirmed.

**Resident relocation**
Temporary relocation of residents to quieter areas may be considered if all other forms of mitigation are exhausted (or inappropriate) and following consultation with the affected resident and regulatory authorities. This would be assessed on a case-by-case basis once operating noise levels are confirmed.

**Construction works**
Construction works (noise bunds, double benches, site clearance) will be limited to 13 continuous weeks prior to the commencement of mining activities. One month prior to the commencement of construction, SGM will circulate the construction schedule to residential and business premises within close proximity to the Project area.

**Noise management plan**
A noise management plan will be prepared as part of the EMP that will detail the noise monitoring to be undertaken at critical times in the life of the Project and measures taken to address any non-compliance issues including:

- continuous noise monitoring
- identification of key times when the daytime noise levels may approach NIRV and existing noise limits
- requiring that daytime noise monitoring be periodically undertaken at key times during operation to determine compliance with the noise criteria
- requiring that equipment is checked for compliance with the values used in the predictive model before commencing permanent operation at the site
- inclusion of hand-held attended noise measurements in noise monitoring surveys
- use of temporary screening where appropriate
- actions to be taken if daytime noise exceeds the criteria.
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8.5.5 Conclusion

The noise environment surrounding the Project area is characterised by a number of ambient noise sources including; local and highway traffic, noise from local industries (including existing SGM activities) and commercial sites, noise from schools and community activity, and wildlife noise (insects and birds). Over the past 14 years there has been an average of one or two noise complaints per year associated with SGM activities. Most of these have been related to non-routine activity such as drilling or haul trucks operating during evening or night time hours when background noise levels are lower.

The average day time noise level ($L_{Aeq}$) in the streets surrounding the Project area (as measured at ten locations) ranged from 39 dB to 61 dB, with average noise levels exceeding 50 dB in all but one location, and 60 dB in three locations.

The relevant noise guidelines for the Project is NIRV, which recognises the existing SGM EMP limit of 50 dB ($L_{eq}$) for dwellings previously exposed to noise from SGM operations (Zone 1), and establishes a daytime noise target of 46 dB ($L_{eq}$) for all other areas (Zone 2).

In recognition of the Project’s proximity to the community, the Project design has incorporated best practice measures to reduce noise levels as far as practicable, including restricting Project activities to Monday to Friday, daytime hours only (7am – 6pm), optimising mine layout, low-noise plant, additional silencing of mobile plant, bund walls, screens and acoustic enclosures.

The noise assessment has considered four ‘worst case’ scenarios in which activities occur at elevation, with intensity and with minimal shielding. It has used a conservative model that includes changes in topography, locations of equipment and plant at the typical worst-case position for each key stage, the upper range of noise levels for each piece of equipment, and assumes that the receiver is always downwind of the noise source.

Noise levels and impacts will vary throughout the Project with the location of work, the topography of the pits and stockpile, and the equipment used. However:

- noise levels from mining will decrease as mining moves progressively deeper into the pits and increase again as the pits are backfilled and re-contoured
- noise impacts will progressively move from north to south as mining and rehabilitation activities move from the North Pit to the South Pit.

In Zone 1, the average daytime noise level is estimated to range between 42 and 49 dB ($L_{eq}$) and therefore impacts are within the existing EMP limit in this area.

In Zone 2, the average daytime noise level is estimated to be under than 46 dB ($L_{eq}$) at most locations and at most times throughout the Project. At a few locations it is estimated that receptors will experience noise levels of up to 50 dB ($L_{eq}$) for short durations. During site rehabilitation, noise levels may be up to 58 dB ($L_{eq}$) at three locations, due to equipment working at elevation and without shielding. NIRV allows for variations to the target during construction of noise control, site preparation and clearing and site rehabilitation, which are applicable in this case.

The predicted change in noise level will vary with the fluctuating ambient noise levels present regardless of the Project noise. When ambient noise levels at residential locations are higher (e.g. 50-61 dB), noise from the mine will be less noticeable than at times when ambient noise levels are lower (e.g. 39-50 dB).
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Noise limits and targets will be integrated to the EMP and managed as part of a noise management plan which includes the continuous monitoring of noise at a number of locations to determine the Project noise ($L_{eff}$) as opposed to the ambient noise level ($L_{Aeq}$).

It is considered that predicted noise levels presented in this EES represent the upper range of noise levels that could be produced by the Project. Daytime noise levels may be above 46 dB ($L_{eff}$) for short durations of the Project and may or may not be noticeable depending on ambient noise levels. Every effort has been made to reduce noise impacts as far as practical to acceptable levels and any exceedances of noise targets will only occur during daytime hours and are of short duration rather than over the entire Project life.
8.6 Blasting
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8.6 Blasting

8.6.1 Introduction
This section of the EES describes the potential impacts of blasting from the Project; measures to manage and mitigate potential adverse impacts; and the overall impacts of the Project following the proposed management and mitigation measures.

It is based primarily on information presented in:
- Terrock Consulting Engineers (January 2014) *Big Hill Enhanced Development Project, Blasting Assessment*, prepared for CGC.

This report is included in Technical Appendix 6 of this EES and should be referred to for more detail on the issues discussed in this section.

<table>
<thead>
<tr>
<th>Relevant sections of EES Scoping Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>This section of the EES addresses the following requirements of the EES Scoping Requirements insofar as they relate to blasting and vibration:</td>
</tr>
</tbody>
</table>

**‘4.5 Health and Social Impacts’**

**Evaluation Objective**
To protect the health, safety and wellbeing of residents and the social fabric of the community in the area in the context of project hazards.

**4.5.1 Public Health and Safety**

**Key issues**
- Public safety hazards during mine construction, operation, rehabilitation and post-closure, including in relation to the presence of deep pits in close proximity to existing residential areas and the geotechnical stability of the mine and rehabilitated landform.”

**Design and mitigation measures**
- Describe and evaluate potential and proposed design and mitigation measures that could:
- Ensure public safety during mine development, operation and rehabilitation, that is prior to the completion of the restoration and rehabilitation of Big Hill.

**Assessment of likely effects**
- Assess potential safety hazards to the public arising from the project.

**Approach to manage performance**
- Describe and evaluate any proposed measures to mitigate or manage public safety hazards.’

**‘4.6 Amenity’**

**Evaluation Objective**
To minimise adverse noise, vibration and other amenity effects on nearby residents and local communities, to the extent practicable.
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**Key issues**
- Nearby residents potentially exposed to excessive noise or vibration.

**Priorities for characterising the existing environment**
- Identify dwellings and any other potentially sensitive receptors that could be exposed to project-related noise or vibration.
- Characterise noise and vibration generation by proposed mine activities.

**Design and mitigation measures**
- Describe and evaluate both potential and proposed design responses and/or other mitigation measures (construction and mining equipment and methods, staging and scheduling of works), which could minimise noise and vibration and effects on sensitive receptors.

**Assessment of likely effects**
- Predictions of likely vibration levels at dwellings adjacent to project area, describing any sources of uncertainty associated with vibration modelling.

**Approach to manage performance**
- Outline and evaluate proposed additional measures to monitor and manage noise and vibration levels to minimise residual effects and ensure compliance with relevant standards.’

---

**Key issues emerging from EES studies and community consultation:**

The EES Scoping Requirements outlined above provide a detailed list of the issues requiring attention in the EES. A key group of issues emerged from the community in the course of the EES investigations and as a result of the ongoing community engagement and communications program. These are:

- Concerns about:
  - annoyance created by ground vibration
  - noise impacts of blasting
  - health and safety of the general public posed by flyrock
  - damage to residential properties and/or public infrastructure cause by ground vibration and/or flyrock.

- While the predicted levels of air blasts and vibration are unlikely to be directly associated with adverse health effects for the general population it may have impacts on shift workers who sleep during the day. In addition, people suffering from post-traumatic stress disorder could experience an increased level of anxiety during blasting.

**Summary of findings**
- SGM has over 30 years of experience in conducting and managing blasting in underground workings and aboveground pits. This includes previous experience in open cut mining (former Davis Pit and Wonga Pit) which has provided essential information for predicting blast impacts for North and South Pit.
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- Blasting is likely to be required to break waste rock and ore in the bottom 30 metres of both the North Pit and the South Pit (which is only about 8 per cent of the pit volume).
- Blasting can be managed in compliance with DSDBI guidelines for ‘Ground Vibration and Airblast Limits for Blasting in Mines and Quarries’.
- Residential premises, schools and public infrastructure will not be exposed to possible damage-causing vibration levels.
- Flyrock from blasting will be contained within the Project boundary.

8.6.2 Existing Conditions

Big Hill has been subject to gold mining since the mid-1850s and as a result the Project area includes many historic shafts and workings.

SGM has operated within its current location for over 30 years which has involved the progressive mining of gold in a series of aboveground pits and extensive underground workings. The mining licence extends under the township of Stawell through an underground network of approximately 180 kilometres of tunnels. Blasting has been used throughout the course of underground and open cut mining operations at SGM over many years.

Surface blasting has also been conducted and managed by SGM during mining of the Wonga Pit (1986-1988) and the former Davis Pit (1987-1998). The former Davis Pit being within the footprint of the South Pit.

Surface mining regularly involves controlled blasting when the rock becomes too hard or too tough to be broken economically by mechanical extraction methods. It is expected that some blasting will be required for the Project in the lower levels of both the North and South Pits as outlined later in this section.

8.6.3 Impact Assessment

The energy contained in explosives used in mine blast holes is designed to break and displace rock. The more energy utilised for breaking rock, the more efficient the blast. Energy that is not utilised for breaking rock creates vibration in the surrounding rock and air. The energy from explosives is in the form of gas at very high pressure that is created in a very short period of time and gradually dissipates producing the following potential effects:

- ground vibration
- air vibration (airblast)
- flyrock.

Each of these potential impacts associated with blasting in the North and South Pits is discussed below.
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8.6.3.1 Regulatory Blast Vibration Limits

The main regulatory requirements covering annoyance and nuisance from blasting are the DSDBI guidelines for ‘Ground Vibration and Airblast Limits for Blasting in Mines and Quarries’ which apply to sensitive sites such as residences and schools as shown below in Table 8-25.

<table>
<thead>
<tr>
<th>Environmental effects</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground vibration (The vibration that is transmitted through the ground from a blast)</td>
<td>≤ 5 mm/s for 95% of blasts in a 12 month period</td>
</tr>
<tr>
<td></td>
<td>≤ 10 mm/s for all blasts</td>
</tr>
<tr>
<td>Air vibration (Airblast) (The shockwave or pressure pulse generated by a blast.)</td>
<td>≤ 115 dBL for 95% of blasts in a 12 month period</td>
</tr>
<tr>
<td></td>
<td>≤ 120 dBL for all blasts</td>
</tr>
<tr>
<td>Flyrock (Rock fragments that are thrown from a blast)</td>
<td>must be contained within the mine property and not present a danger to people and property</td>
</tr>
</tbody>
</table>

The vibration limits for annoyance and nuisance as shown in Table 8-25 are well below levels at which damage to houses or infrastructure will be sustained, which is detailed in Australian Standards AS 2187.2-2006 and is summarised as:

- 19 millimetres per second (mm/s) in the frequency range four hertz to 15 hertz may result in cosmetic or hairline cracks in plasterboard. Above 15 hertz, the non-damaging limit rises to 50 mm/s at 40 hertz.
- 100 mm/s is the recommended limit for structures of concrete and steel construction.

8.6.3.2 Requirement for Blasting associated with the Project

Analysis of data collected during the geotechnical investigation conducted for the Project have been used to determine the excavatability of the waste rock and ore material in each pit. The excavatability is based on the hardness of the rock.

The type of material in the lower 30 metres of the pits (which is about eight per cent of the pit volume) is classed as hard ripping and is uneconomical for mechanical extraction. The only economical extraction method is to apply a light blasting practice as outlined in the section below. Figure 8-45 and Figure 8-46 show the areas in which blasting may be required relative to the pit outline and as a cross-section.
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Figure 8-45  Potential areas of blasting relative to the North and South Pits
Blasting may be required in the North Pit during Quarters 6 and 7 of the Project.

Limited blasting may commence in the South Pit in Quarter 11 of the mining operation due to the staged cutback design with a mixture of blasting and free dig through to Quarter 13 and blasting during Quarter 14.

When blasting occurs it will take place at a set time, no more than once per day. SGM has a short message service (SMS) notification service which will provide advance notification of blasts within the defined timeframe to residents who wish to be alerted.
8.6.3.3  Environmental Blast Design

During the mining of Davis Pit, data were collected from 70 production blasts. The location of the former Davis Pit in relation to residential properties and the blast monitoring points are shown in Figure 8-47.

In addition, seven single test holes were fired. For each blast, the blast impacts were measured at five locations ranging from distances of 15 metres to 500 metres to understand how impacts varied with distance from the blast.

Figure 8-47  Former Davis Open Cut relative to the South Pit

In addition, seven single test holes were fired. For each blast, the blast impacts were measured at five locations ranging from distances of 15 metres to 500 metres to understand how impacts varied with distance from the blast.
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Previous blast experience (from the Davis Pit mining) together with single hole investigations in the Big Hill area (Blastronics Systems and Services, 1999) have been used to develop empirical blasting models for this Project. These models are used to predict the level of ground vibration and airblast so that blasting can be managed within DSDBI guideline limits.

The empirical models, in combination with industry experience, have been used to design the critical parameters for a standard blast for the Project. The key blast parameters and a description are included in Table 8-26 below.

Table 8-26  Standard blasting specifications for the Project

<table>
<thead>
<tr>
<th>Blast parameter</th>
<th>Description of what each parameter means</th>
<th>Standard blasting specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hole diameter</td>
<td>The diameter of the drill hole in which the explosive charge will be inserted.</td>
<td>76 millimetres</td>
</tr>
<tr>
<td>Face height / Hole depth</td>
<td>The height of the rock wall adjacent to the drill hole.</td>
<td>4 metres</td>
</tr>
<tr>
<td>Stemming height</td>
<td>The distance between the collar of the hole and the top of the explosive column.</td>
<td>2 metres</td>
</tr>
<tr>
<td>Front row burden</td>
<td>The distance between the main charge in the drill hole and the nearest point on the free face.</td>
<td>2 metres</td>
</tr>
<tr>
<td>Explosive charge mass per metre</td>
<td>The mass of each explosive charge that will be used for each metre.</td>
<td>3.6 kilograms (ANFO)</td>
</tr>
<tr>
<td>Column length</td>
<td>The height of the explosive charge that is placed in a drill hole.</td>
<td>2 metres</td>
</tr>
<tr>
<td>Explosive charge per hole</td>
<td>The mass of each explosive charge per hole.</td>
<td>7.2 kilograms (ANFO)</td>
</tr>
</tbody>
</table>

The potential environmental effects for ground vibration, airblast and flyrock have been assessed below for a standard blast with the characteristics outlined in the table above. The assessment has shown that for some areas of the pits, the standard blast must be modified to ensure compliance with regulatory limits. Accordingly, special blast areas and special blast requirements have been defined as mitigation measures to ensure compliance with regulatory limits.

8.6.3.4  Potential Effects of Ground Vibration

Ground vibration is the vibration that is transmitted through the ground as an elastic wave. It radiates outwards from the blast site and gradually reduces in magnitude in the same manner as ripples behave when a stone is thrown into a pool of water. Ground vibration is measured with a blasting seismograph and commonly expressed in terms of peak particle velocity (PPV) and measured in terms of millimetres per second (mm/s).

In the community there is a wide response to vibration. Some people may be sensitive to vibration at levels slightly above perception levels while others become accustomed to and tolerate relatively high levels of vibration. For example, residents in houses 20 metres from a railway line could expect ground vibration up to 2.5 mm/s from joined rails in poor condition. Some of the adverse reactions to vibration include being startled by a sudden vibration event.
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The contributing factors to human perception of vibration are the duration of the blast event, the frequency spectrum of the vibration, the number of occurrences per day, the time they occur and the magnitude of the vibration.

A predictive model was developed for ground vibration using the former Davis Pit vibration records together with the Blastronics single hole investigations. The predictive model considers the geology of the rock, especially if the depth of weathering varies around the pit floor, as geology may give directionality to vibration transmission. The depth of free dig (weathering) before blasting is required may influence blast design, as solid rock transmits vibration more efficiently than weathered rock. (refer to Technical Appendix 6).

**Potential Impacts on Residential and Commercial Properties**

For the purposes of blast vibration control, sensitive sites as defined by DSDBI\(^6\) are residential properties adjacent to the pits and nearby schools (St Patrick’s School and the Stawell Secondary College) where compliance is defined as 5 mm/s (95 per cent) (as shown in Figure 8-48). As a commercial premises, the human comfort limit for the Middendorp electrical supplies building (Middy’s) from AS 2187.2 – 2006 is 25 mm/s.

The ground vibration contour assessment shown in Figure 8-48 shows the maximum ground vibration that will result in the surrounding area from blasts located at the edge of the blasting area. The vibration from blasts further away from the edge of the blasting area will result in lower vibration levels.

\(^6\) Sensitive sites are defined by DSDBI in guidelines for ‘Ground Vibration and Airblast Limits for Blasting in Mines and Quarries’ and include residential premises and schools
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Figure 8-48  Predicted ground vibration contours resulting from blasting
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Figure 8-48 shows that for most locations, standard blast design (as defined in Table 8-26) will achieve compliance with vibration guideline limits.

There are a total of three residential properties (located along the west side of North Pit and South Pit) where a special blast area may be required to comply with the five mm/s (95 per cent) DSDBI guidelines limit. The vibration limit can be complied with at these premises if the charge mass is reduced by half (to 3.6 kilograms) by splitting the explosive column into two.

The minimum inclined distances from the potentially affected properties together with the maximum predicted vibration at the property boundary and premises are listed in Table 8-27.

Table 8-27 Ground vibration assessment of closest sensitive receptors (residential premises)

<table>
<thead>
<tr>
<th>Address</th>
<th>Inclined distance to house at closest blast(s) (metres)</th>
<th>Standard blasting</th>
<th>Special blasting*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PPV at house</td>
<td>PPV at boundary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(mm/s)</td>
<td>(mm/s)</td>
</tr>
<tr>
<td>47 Fisher St</td>
<td>131</td>
<td>Charge mass reduction req.</td>
<td>2.9</td>
</tr>
<tr>
<td>51 Fisher St</td>
<td>130</td>
<td>Charge mass reduction req.</td>
<td>2.9</td>
</tr>
<tr>
<td>61 Fisher St</td>
<td>149</td>
<td>4.0</td>
<td>5.2</td>
</tr>
<tr>
<td>1 Fisher St</td>
<td>139</td>
<td>4.5</td>
<td>5.6</td>
</tr>
<tr>
<td>215 Main St</td>
<td>117</td>
<td>Charge mass reduction req.</td>
<td>3.4</td>
</tr>
<tr>
<td>222 Main St</td>
<td>140</td>
<td>4.5</td>
<td>5.7</td>
</tr>
<tr>
<td>Middy’s</td>
<td>93</td>
<td>Charge mass reduction req. for 215 Main St.</td>
<td>4.9</td>
</tr>
</tbody>
</table>

*A charge mass reduction of 3.6kg is required to limit the ground vibration to the DSDBI limit of 5 mm/s (95 per cent).

While the five mm/s (95 per cent) guideline limit for vibration is exceeded at the property boundaries of three residential properties, data in Table 8-27 demonstrate that compliance is attained at the residential and commercial premises located within the property boundary by using a standard blast or a reduced blast where required.

Once blasting commences, monitoring at the nearest property boundary to verify that the ground vibration complies with the five mm/s (95 per cent) guideline will enable SGM to further modify the blast program outlined above if required.
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Potential impacts on public use and educational facilities
With respect to other public use and educational facilities in Stawell, most are more distant from the Project area than the potentially affected residential and commercial properties discussed above. The table below shows that ground vibration (PPV) at all of these facilities is well below the five mm/s (95 per cent) requirement and as such, impacts are within acceptable limits.

For these facilities, the ground vibration will be just above perception level (which is 0.5 mm/s) at most sites meaning the ground vibration from some blasts may be felt, but levels are well below the DSDBI guideline limits for minimisation of human annoyance.

Table 8-28  Ground vibration assessment of closest sensitive receptors (non-residential)

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from blasting (metres)</th>
<th>PPV (mm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>St Patrick's Primary/Church</td>
<td>425</td>
<td>0.8</td>
</tr>
<tr>
<td>Stawell Secondary College</td>
<td>500</td>
<td>0.6</td>
</tr>
<tr>
<td>Stawell Library</td>
<td>350</td>
<td>1.0</td>
</tr>
<tr>
<td>Stawell Campus - Ballarat University</td>
<td>425</td>
<td>0.8</td>
</tr>
<tr>
<td>Skene St School</td>
<td>450</td>
<td>0.7</td>
</tr>
<tr>
<td>Eventide Homes</td>
<td>600</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Potential impacts on infrastructure
As discussed above, the vibration limits for annoyance and nuisance are well below levels at which damage to houses or infrastructure will be sustained. Australian Standard AS 2187.2-2006 details limits for plasterboard (houses) and for structures of concrete and steel construction.

For infrastructure within the vicinity of the North and South Pits, the non-damaging vibration limit specified by AS 2187.3-2006 or as agreed with relevant asset owners (GWMWater and SP Ausnet) is shown in Table 8-29.

The table also shows the maximum predicted PPV that will occur at buildings and infrastructure potentially affected by ground vibration associated with blasting.
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Table 8-29  Ground vibration assessment of adjacent infrastructure

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Non-damaging vibration limit (mm/s)</th>
<th>Source of limit</th>
<th>Maximum predicted PPV (mm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>19</td>
<td>AS 2187.2-2006</td>
<td>4.9</td>
</tr>
<tr>
<td>GWM Water tanks and reservoirs, mains valves etc.</td>
<td>100</td>
<td>AS 2187.2-2006</td>
<td>&lt;10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recommended limit for structures of concrete and steel</td>
<td></td>
</tr>
<tr>
<td>375 mm AC Pressure pipeline (GWM Water)</td>
<td>50</td>
<td>DIN 4150-3&lt;sup&gt;7&lt;/sup&gt;</td>
<td>&lt;10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adopted by the South Australian Department of Planning Transport and Infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Underground gas mains (Main Street)</td>
<td>20</td>
<td>SP Ausnet</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>

This assessment of infrastructure shows that the vibration levels caused by the blasting proposed in the North and South Pits are well below the limit at which damage may be sustained for all categories of infrastructure including adjacent residential properties, schools and utility services. As such, vibration damage to infrastructure is not expected to occur as a result of the Project and mitigation measures are not required. However, in the unlikely event that damage was caused to any infrastructure in the vicinity of the mining operation, SGM is legally obligated to address the damage.

**Historical underground blasts at SGM**

Vibration from underground blasting has been experienced at residential premises around Stawell over the past 30 years.

There have been historical complaints associated with underground blasting, particularly when blasting has been in shallow areas, even when vibrations have been within regulatory limits. The annual average surface vibration for which complaints have been received by SGM has ranged from 1.6 mm/s to 5.3 mm/s. On two occasions between 2002 and 2013 (14 January 2009 and 27 May 2010), regulatory limits were exceeded resulting in a total of 67 complaints. Historical complaints received by SGM are further detailed in Section 8.18.

It is expected that vibration from open cut blasts will feel differently to underground blasts currently experienced in the SGM vicinity and are expected to be less noticeable, even at the same ground vibration, because of the shorter blasting duration.

8.3.6.2 Potential Effects of Air Vibration (Airblast)

Air vibration, or airblast, is the airborne shock wave or pressure pulse generated by a blast. Airblast radiates outwards from the blast site and gradually reduces with distance. It is measured in terms of decibels linear peak (dBL). This is the maximum level of air pressure fluctuation measured in decibels and occurs mostly at inaudible frequencies. Although airblast is sub-audible it may result in secondary noise (e.g. windows rattling) that is audible and measurable as dBA, although no standards exist for its control.

<sup>7</sup> German Standard DIN4150-2, “Structural Vibration Part 3 – Effects of Vibration on Structures”
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**Potential impacts on residential and commercial properties**

For sensitive land uses such as residential, there is a 115 dBL (95 per cent) DSDBI guideline limit for airblast emissions and 120 dBL (for all blasts). For a commercial premises, the recommended human comfort limit from AS 2187.2 – 2006 is 125 dBL.

A predictive model was developed from analysis of the former Davis Pit measurements that shows airblast emission reduces logarithmically with distance. Airblast emission is also reduced by the effects of shielding provided by the pit rim as shown in Figure 8-49.

Figure 8-49 shows the worst case airblast at the nearest premises (Middy’s) for the closest blasting on the western side of the pit and the predicted airblast from the far blasts on the eastern side of the pit.

![Figure 8-49 Middendorp electrical supplies building - cross section showing effective barrier heights (provided by the pit rim)](image)

The airblast contour assessment is shown in Figure 8-50.
Figure 8-50  Predicted airblast contours relative resulting from blasting
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Figure 8-50 shows the highest airblast that will result from standard blasts on the west side of the blasting area, with an allowance for topographical shielding. All other blasts within the blasting area will result in lower airblast levels than this worst case scenario.

The predicted airblast levels at the closest addresses to the blasting (Table 8-30) show that compliance with the 115 dBL (95 per cent) guideline can be achieved for all residential properties and the 125 dBL requirement for commercial premises is readily met at the Middy’s property. As with ground vibration, this will be validated as part of a blast monitoring program and adjustments will be made to the blasting program as required.

Table 8-30 Airblast assessment of closest sensitive receptors (residential premises)

<table>
<thead>
<tr>
<th>Address</th>
<th>Nearest distance from blast to house (metres)</th>
<th>Airblast from west side (shielded) (dBL)</th>
<th>Airblast from east side (less shielded) (dBL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>47 Fisher St</td>
<td>131</td>
<td>111</td>
<td>107</td>
</tr>
<tr>
<td>51 Fisher St</td>
<td>130</td>
<td>109</td>
<td>108</td>
</tr>
<tr>
<td>61 Fisher St</td>
<td>149</td>
<td>106</td>
<td>106</td>
</tr>
<tr>
<td>1 Fisher St</td>
<td>139</td>
<td>111</td>
<td>110</td>
</tr>
<tr>
<td>215 Main St</td>
<td>117</td>
<td>109</td>
<td>109</td>
</tr>
<tr>
<td>Middy’s</td>
<td>93</td>
<td>118</td>
<td>115</td>
</tr>
<tr>
<td>222 Main St</td>
<td>140</td>
<td>109</td>
<td>110</td>
</tr>
</tbody>
</table>

If the blast monitoring program shows that additional confinement is required to reduce the airblast, it may be achieved by increasing the stemming height (which is the distance between the top of the hole and the top of the explosive column or effectively placing the explosive deeper in the hole). This means that the blast has more shielding which reduces its effectiveness at breaking rock and produces a lower airblast. An increased stemming height of 2.4 metres will provide three dBL of shielding.

Potential impacts on public use and educational facilities

The predicted worst case airblast levels at public use and educational sites within close proximity to Big Hill are listed in Table 8-31.

Table 8-31 Airblast assessment of closest sensitive receptors (non-residential)

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from blasting (metres)</th>
<th>Airblast (dBL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>St Patrick’s Primary/Church</td>
<td>425</td>
<td>96</td>
</tr>
<tr>
<td>Stawell Secondary College</td>
<td>500</td>
<td>95</td>
</tr>
<tr>
<td>Stawell Library</td>
<td>350</td>
<td>99</td>
</tr>
<tr>
<td>Stawell Campus - Ballarat University</td>
<td>425</td>
<td>96</td>
</tr>
<tr>
<td>Skene St School</td>
<td>450</td>
<td>95</td>
</tr>
<tr>
<td>Eventide Homes</td>
<td>600</td>
<td>93</td>
</tr>
</tbody>
</table>
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This table shows that for the public use and educational sites listed, all airblasts will be below human threshold perception levels (which is 100 dBL). As such, airblast impacts at these facilities are within acceptable limits and mitigation measures are not required.

8.3.6.3 Potential Effects of Flyrock

Flyrock includes any rock fragments thrown unpredictably from a blast from mining operations. Blasting may be towards a ‘free face’ or to a pile of rubble from previous blasts known as ‘choke blasting’. With choke blasts there is no free face and the first row of drill holes is drilled behind the ground broken by the previous blast. The flyrock distance behind a blast is considered to be the most appropriate assessment as any blasts that are not choke blasts will face away from the nearest sensitive uses such as houses.

The worst case flyrock trajectory path for the residential premises at 47 Fisher Street (which is the closest residential premise to the South Pit) is shown Figure 8-51. A safety factor (SF) of 2.0 has been applied to plant and equipment. A safety factor of 4.0 has been applied to property boundaries and personnel. The trajectory path is influenced by the pit depth at which blasting is conducted and the pit walls will shorten the predicted throw.

Figure 8-51  Flyrock trajectory path placed on section through 47 Fisher Street
Assessment of the flyrock trajectory has concluded that for all free face blasts, the minimum front row burden should be three metres and must face away from houses. This means that the maximum throw is predicted to be 22.6 metres and the recommended exclusion zone is 90 metres in front of the free face (inclined distance) to achieve a SF of 4.0 as shown below in Figure 8-52.

This representation is conservative because a 90 metre horizontal distance has been used. Because of the high trajectory and depth within the pit of the closest blasting, any flyrock will fall short of the 90 metres as shown in Figure 8-51. The 90 metre horizontal distance is contained predominantly within the mine property and beyond the back fences of all houses, with the possible exception of Middy’s (a commercial premise). The zone of special blasting will be introduced at 90 metres from Middy’s back fence to comply with the exclusion zone requirements. Enforcement of the exclusion zone may require stopping of traffic in Main Street for some blasts in the North Pit.
Figure 8-52  90 metre flyrock exclusion zone
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On this basis, there is no expected impact of flyrock on adjacent properties provided that appropriate blasting controls are applied consistent with the requirements specified in the Blast Management Plan proposed for the operation (see below).

The use of blasting mats to control flyrock and airblast near houses may be used in small scale construction blasts while in larger construction blasts, it is fairly common practice to either drill through in situ soft material and utilise this for limiting flyrock, or to physically place clay or fine aggregate over the loaded blast holes prior to firing. These methods are not considered to be appropriate for the Project as they introduce other unnecessary complications particularly the identification and treatment of misfires. Flyrock (and airblast) is more effectively controlled by ensuring that the explosion is effectively confined by detailed monitoring during loading practice which will be specified in the proposed Blast Management Plan.

8.6.4 Management and Mitigation Measures

Blasting is a controlled process. Measures to further manage and mitigate potential impacts from blasting are described below.

Blast Management Plan

A Blast Management Plan is required which describes responsibilities, blast design process, monitoring and performance evaluation. The key steps are shown in Figure 8-53.

A key element of the plan will be monitoring of ground vibration, airblast and flyrock during mining so that if required modifications can be made to the blast design to ensure compliance with the regulatory requirements outlined in this section.
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**BLAST SPECIFICATIONS FOR EACH BLAST**
- Hole diameter
- Face height
- Hole angle
- Sub-grade
- Hole depth
- Stemming height
- Column height
- Explosive density
- Maximum explosive charge
- Powder factor
- Burden
- Spacing
- Initiation sequence
- Deck location
- Internal Stemming
- Air decks

**ASSESSMENT OF RESULTS**

**ENVIRONMENTAL COMPLIANCE**
- Airblast
- Ground vibration
- Flyrock contained

**REPORTING PROTOCOL**
- In house
- EPA
- Mine Inspector

**BLASTING EFFICIENCY**
- Visual Assessment
- Fragmentation
- Reave
- Muckpile shape

**BLASTING PERFORMANCE**
- Digability
- Fragmentation
- Production rates
- Oversize
- Impactor hours

**COMMUNITY COMPLAINTS RECORD**
- Time / Date
- Complainant
- Contact Details
- Nature of Complaint
- Follow up Action

**RECORDING OF PERFORMANCE EVALUATION**

**OWNED LOCATION**
- Distance to lease boundary
- Distance & direction to sensitive sites (houses)
- Environmental design or performance design
- Public access areas

**ROCK TYPE**
- Hardness classification
- Structure - eg. massive, laminated, joint spacing
- Muckpile loading - shovel/ loader

**INITIATION SEQUENCE**
- Face blast
- Ramp blast
- Sump blast
- Choke blast

**ENVIRONMENTAL DESIGN LIMIT COMPLIANCE**
- Ground vibration (Max. charge from Site Law)
- Airblast (Min. front burden and stemming height)
- Flyrock (Min. front burden and stemming height)

**EXPLOSIVE DISTRIBUTION**
- Under-burdened sections
- Face height
- Location of inconsistencies
- Need to deck
- Deck design to optimise explosive distribution

**OTHER CONSIDERATIONS**
- Exclusion Zone
- Mine Infrastructure
- Firing point
- Mine Plant

**ANALYSIS AND REVIEW DESIGN PARAMETERS**
- Modify parameters

---

Figure 8-53   Environmental blast design procedure
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Mitigation of blast impacts

The Blast Management Plan will detail measures to minimise annoyance associated with blasting, including:

- Consideration of potential environmental or meteorological conditions (e.g. wind, temperature inversions) that could influence blasting.
- Limiting blast duration to a maximum of 2 to 3 seconds per blast to minimise public perception of vibration (people are more aware of blasting that has a longer duration, regardless of the PPV level).
- Conducting blast firing at defined times that will cause minimum annoyance such as during school lunch times, school dismissal time or in the early afternoon.
- Commencing blasting at the closest point to the sensitive site (residence) and progressing the firing sequence away from the residence. This has been used to reduce ground vibration levels at other mines.
- Using a non-reinforcing initiation sequence and evaluating whether electronic initiation is effective in reducing vibration levels.
- Using an initiation sequence that creates forcing frequencies outside the range of natural frequencies of houses.
- Minimising airblast by using a minimum front row burden of 3 metre in free face blasts. When blasting towards a free face, the free face will face away from the houses, i.e. towards the west and south, as airblast may be six to eight dBL higher in front of a free face.
- Quality assurance to measure and record the distance from the hole collar to the top of the explosives column. If this is less than 150 millimetres below the design specification, excessive explosive must be removed or dissolved with water.
- Measuring and recording the quantity of stemming material poured into the hole collar to determine if bridging has occurred.
- Quality assurance program to record the charge loading, and sign-off that the loading has been conducted according to the design.
- An appropriately qualified person to approve and sign off all blast designs.
- Monitoring the vibration from all blasts at the nearest premises and recording the wave traces for further analysis.
- Video recording all blasts from at least one location.

Old workings and blast vibration control

Dealing with historic voids is not a situation unique to Big Hill and examples of where old underground mines have been reopened as open cuts include the Super Pit at Kalgoorlie, the Martha Mine at Waihi in New Zealand and recent open cut pits at Broken Hill.

The predictions of the impact of ground vibration, airblast and flyrock are based on the assumption of competent rock between the blast hole and any face or void. A potential problem for vibration control is that a drill hole(s), with no indication of workings or broken ground, may result in poor confinement of the explosion close to a void which vents to the atmosphere with an increased potential for high airblast and uncontrolled flyrock.
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A procedure for identifying and controlling blast effects from unknown voids will be developed as part of the Blast Management Plan.

The procedure will incorporate the information and detail gathered on mining voids through probe drilling under the Ground Control Management Plan and update for any of the following conditions encountered during production drilling:

- loss of air or cuttings return
- jammed rods and ‘grabbing’ rods
- sudden dropping of rods
- ground subsidence while drilling.

Where voids are identified the shape of the void will be fully ascertained and an appropriate blast design developed for the particular circumstances, including the shape and extent of the void, and depth below bench level. Blasting may also result in ground collapses just beyond the extent of the blast, and these incidences will be managed under the relevant section of the Ground Control Management Plan.

Large voids may be backfilled and other voids may be incorporated into the drilling pattern and blast design providing the minimum confinement conditions for burden, spacing and stemming height can be complied with.

8.6.5 Conclusion

Blasting is a controlled process with which SGM has extensive experience. Data collected during the former Davis Pit mining have been used to develop predictive models that can be used to design blasts for any target airblast and ground vibration level. The models will be validated with actual data once blasting commences, and if required modifications will be made to the blasting program to ensure compliance.

The assessment of blasting has shown that compliance with guideline levels for ground vibration are readily achievable with a standard blast (defined earlier in this section) at all but three residential properties and one commercial property. For these properties, compliance with guideline levels is readily achievable if the blast mass is reduced. The study has also shown that the proposed blasting associated with mining activity will generate vibration well below the levels known to cause damage to property and infrastructure.

With respect to airblast, the assessment showed that compliance with regulatory requirements was achieved at all properties.

Modelling has shown that flyrock will be contained within the mine boundary with safety factors built in to ensure that there is no risk to people or property.

It is expected that vibration from open cut blasts will feel different from underground blasts currently experienced in the SGM vicinity and are expected to be less noticeable, even at the same PPVs, because of the shorter duration.

Blasting can be conducted in accordance with guidelines for sensitive sites and Australian Standards and therefore potential impacts are considered to be within acceptable limits.
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8.7 Air Quality

8.7.1 Introduction
This section of the EES describes and assesses the potential air quality impacts of the Project; identifies measures to manage and mitigate potential adverse impacts and assesses overall impacts following implementation of the proposed management and mitigation measures.

This assessment is based primarily on information provided in:

- URS Australia Pty Ltd (2014), Big Hill Enhanced Development Project: Air Quality Impact Assessment (AQIA) report, prepared for CGC.

This report is included in Technical Appendix 7 to this EES.

Relevant sections of EES Scoping Requirements
This section of the EES covers the following components of the EES Scoping Requirements relating to air quality:

**4.5 Health and Social Impacts**

**Draft Evaluation Objective**
To protect the health, safety and wellbeing of residents and the social fabric of the community in the area in the context of project hazards.

**4.5.1 Public Health and Safety**

**Key issues**
- Potential for nearby residents and other sensitive receptors to be exposed to hazardous dust levels during open-cut mining construction, operation and rehabilitation.

**Priorities for characterising the existing environment**
- Describe the physical and chemical characteristics of overburden, ore and waste rock to be removed during mine development and operations, following mechanical extraction, including specific aspects relevant to human health.
- Assess background levels of airborne particulates (dust) in the vicinity of Big Hill during potential weather conditions at different times of the year, with due regard to data requirements under the PEM for background air quality monitoring, or alternative data sets to the satisfaction of the Environment Protection Authority (EPA).

**Design and mitigation measures**
- Describe and evaluate potential and proposed design and mitigation measures that could:
  - avoid or minimise the exposure of people to hazardous levels of airborne particulate matter; and
  - ensure public safety during mine development, operation and rehabilitation, that is prior to the completion of the restoration and rehabilitation of Big Hill.
Assessment of likely effects

- Predict likely atmospheric concentrations of particulate matter and other relevant Class 1, 2 or 3 indicators in surrounding areas during mine construction, operation and rehabilitation. Modelling of the dispersal of relevant emissions is to be provided for varying weather conditions, including evaluation of predicted levels relative to criteria specified in the PEM or design criteria in Schedule A of SEPP (Air Quality Management). Satisfactory evidence of quality assurance of predictive studies is to be provided.

Approach to manage performance

Outline proposed measures to ensure that the public is not exposed to levels of airborne particulate matter exceeding PEM or SEPP criteria, including measures to monitor and control exposure to such hazards.

Key issues emerging from EES studies and community consultation:

Community concerns arising from the ongoing community engagement and communications program that relate to potential air impacts of the Project are:

- Concerns about the negative amenity and potential health impacts resulting from reduced air quality. Concern is greater for residents living within close proximity to the Project.

8.7.2 Summary of findings

- An Independent Technical Reviewer (ITR) was engaged for the Project to report on the adequacy of the Air Quality Impact Assessment (AQIA). The ITR reviewed and endorsed the following components of the AQIA as appropriate for the Project:
  - The scope of the air quality impact assessment
  - The background air quality data adopted for the assessment (PM$_{10}$, NO$_x$ and CO at Bendigo)
  - The approach to the meteorological and dispersion modelling
  - The ambient air quality monitoring program
  - Emission inventory

- Air quality data from the EPAV ambient air quality monitoring station at Bendigo (1 July 2004 to 30 June 2005) were adopted as background data (PM$_{10}$, CO and NO$_x$, and PM$_{2.5}$ extrapolated from the PM$_{10}$ data) for the air quality impact assessment. The background data were combined with the predicted concentrations generated by the Project to estimate the likely air quality impacts of the Project.
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- Eight months of local background data were collected from two ambient air quality monitoring stations which commenced operation on 24 May 2013, and are progressively being compared with the Bendigo data. Comparison of data collected to date show that the Bendigo background data are representative of the conditions at Stawell and fit for the purposes of the air quality impact assessment.

- There were no exceedances of the PEM criterion for the monitoring period analysed at any of the ambient air quality monitoring stations, however the maximum PM$_{10}$ concentration recorded at Bendigo over the same period is approximately 15 per cent higher than the maximum recorded at either of the SGM monitoring stations.

- The maximum PM$_{10}$ concentration recorded at Bendigo on 28 April 2005 (55.7 µg/m$^3$) was unusually high and is close to the PEM criterion (60 µg/m$^3$). The source of this elevated concentration is not known.

- Air dispersion modelling was used to predict the maximum ground level concentrations for a range of air quality indicators during Year 2 and Year 5. These years were selected as they have the highest material movements and represent the highest potential impacts that may occur in the North Pit (Year 2) and in the South Pit (Year 5).

- Limited modelling was undertaken for particulates (PM$_{10}$) in Year 1 and confirmed that the highest potential PM$_{10}$ impacts occurred at sensitive receptors such as houses in proximity to the North Pit.

- The air dispersion modelling predicted that a few receptors would exceed criteria$^8$ for particulates on a few days per year when existing background levels were elevated. These exceedances can be managed by active intervention to reduce or cease mining activities on days when these conditions may be experienced. A summary of the predicted impacts includes the following:
  
  — During Year 1, the predicted maximum 24 hour average PM$_{10}$ ground level concentrations indicate no exceedances of the PEM 2007 at any of the receptor locations assessed.
  
  — During Year 2, PM$_{10}$ is predicted to exceed the criterion$^1$ (of 60 µg/m$^3$) at six locations on two days of the year. Five of the exceedances occurred on a day in which the background concentration was 55.7 µg/m$^3$.

  — During Year 5, PM$_{10}$ is predicted to exceed the criterion at seven receptors. At one receptor, a maximum of two exceedances were predicted.

  — During Year 2 and Year 5, the annual average PM$_{2.5}$ predicted concentrations, did not exceed the NEPM advisory standard at any of the modelled receptors (based on the use of site specific data to estimate the ratio between PM$_{2.5}$ to PM$_{10}$).

  — The dust deposition results indicate predicted exceedances of the monthly cumulative criterion at two receptors during Year 2 and two other receptors reach the criterion. There were no predicted exceedances at any modelled receptor during Year 5.

$^8$ Protocol for Environmental Management: Mining and Extractive Industries 2007 (PEM 2007)
— For Year 2, the cumulative annual arsenic (as PM$_{10}$) ground level concentrations were predicted to exceed the PEM 2007 criterion at one of the modelled receptors and reach the criterion at one other location. Two receptors were predicted to exceed the criterion for Year 5.

— Two exceedances of the annual average polyaromatic hydrocarbons (as Benzo(a)Pyrene) (PAH (BaP) were predicted for Year 2 and one exceedance in Year 5.

— There were no exceedances predicted for 24 hour PM$_{2.5}$, respirable crystalline silica, NO$_2$, CO, SO$_2$ or heavy metals (with the exception of arsenic as described above).

- Inputs to the dispersion model have incorporated a range of best practice mitigation measures (primarily around the mine plan/pit design) to minimise pollutant emissions at the source.

- The range of management and mitigation measures to address air emissions, in particular particulate matter, for the Project can be considered best practice measures and some are ‘beyond’ best practice and facilitate MEA.

- To gain an understanding of the extent of proposed mitigation measures proposed for this Project, a comparative assessment against current practice in Australia and internationally was undertaken. These results clearly demonstrate that the Project has incorporated almost all of the management measures including best practice measures as defined in the Katestone report (refer to Section 8.7.5.3).

- When compared to existing mines in NSW, in all cases, the Project either equals, or in most cases, exceeds the numbers of mitigation measures currently being implemented. This is a clear demonstration that the proposed mitigation measures, when taken together, are not only best practice in Australia and internationally (given that all mines in NSW should be operating at best practice level), but are ‘beyond’ best practice.

- Management and mitigation measures provide a mechanism for ensuring that particulate matter and other air quality comply with relevant regulatory criteria and are minimised to acceptable levels in the receiving environment.

8.7.3 Existing Conditions

8.7.3.1 Topography

The Project site is situated in the northern foothills of the Great Dividing Range and approximately 20 kilometres northeast of the Grampians Range. The Wimmera Plains extend to the north, northeast and northwest of the Project site. The topography of the receiving environment is described in further detail in Chapter 4.

The effect of terrain on the meteorology of the region has been included in the CALPUFF air dispersion model as described in the AQIA report (Technical Appendix 7).
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8.7.3.2 Sensitive receptor locations

Potential air quality impacts have been modelled at 125 sensitive receptor locations which include residences, schools, kindergartens, aged care facilities, hospitals, childcare centres and recreational areas. This includes 16 locations on the GWMWater reservoirs.

A map showing the location of the nearest sensitive receptors relative to the Project site is presented in Figure 8-54. A series of maps showing all modelled receptors is available in Technical Appendix 7 (AQIA, Appendix C).

Receptor locations R99 and R42 represent the Ambient Air Quality Monitoring Stations (AAQMSs) at Stawell (Location 1, 7 Fisher Street and Location 2, 1 Park Road) and are illustrated in Figure 8-54.
Figure 8-54 Nearest sensitive receptor locations to the Project site
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8.7.3.3 Existing air quality and meteorology at the SGM Project site

SGM has conducted air quality monitoring at the Project site historically. However, the extent of monitoring and the air quality parameters measured were not sufficiently comprehensive to enable a fully informed air quality impact assessment. On this basis, an air quality monitoring program was undertaken to collect specific data for the Project in response to the requirements of the PEM 2007. As the monitoring is ongoing, data will continue to be collected during the EES preparation and exhibition phases and updated information provided to the independent panel established to assess the Project. At present eight months of local background data at Stawell has been recorded and validated. Four months of background data (February to May 2014) remain outstanding. At the time of the Panel Hearing, 11 months of local background data at Stawell will be available. As discussed in the impact assessment section, air quality data from an EPAV monitoring station at Bendigo (1 July 2004 to 30 June 2005) were adopted as background and are progressively being compared with data being collected at Stawell to ensure the Bendigo data are representative and fit for the purposes of the AQIA.

Existing air quality at the current SGM ambient air quality monitoring stations (AAQMS)

The ambient air quality monitoring program outlined above commenced operation on 24 May 2013 at two AAQMSs; 7 Fisher Street (Location 1 – receptor location R99) and 1 Park Road (Location 2 – receptor location R42) as shown in Figure 8-54. Data collection is ongoing and a summary of the results to date is provided below, refer to Technical Appendix 7 for further details. As outstanding continuous PM$_{2.5}$ and PM$_{10}$ data is collected and validated, they will be made available on the SGM website (www.crocgold.com/bighill) for the purposes of demonstrating compliance with the PEM 2007 requirement for 12 months of local background data for the Air Quality Impact Assessment.

PM$_{10}$

Continuous PM$_{10}$ (particulate matter with an aerodynamic diameter of less than or equal to 10 microns) monitoring using a Tapered Element Oscillating Microbalance (TEOM) is currently being undertaken at both SGM AAQMSs. Table 8-32 presents the maximum, minimum, mean and median results for the monitoring period between 24 May 2013 and 31 January 2014.

Table 8-32 24 hour average particulate matter (PM$_{10}$) concentrations at the two SGM ambient air quality monitoring stations

<table>
<thead>
<tr>
<th>Time averaging period</th>
<th>Location 1 (7 Fisher Street)</th>
<th>Location 2 (1 Park Road)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 hour maximum</td>
<td>38.9</td>
<td>39.6</td>
</tr>
<tr>
<td>24 hour minimum</td>
<td>2.9</td>
<td>3.0</td>
</tr>
<tr>
<td>24 hour mean</td>
<td>12.7</td>
<td>12.6</td>
</tr>
<tr>
<td>24 hour median</td>
<td>11.4</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Note 1: Corrected and referenced to 0°C and 101.3kPa as required by NEPM

The table above shows that the maximum 24 hour PM$_{10}$ concentrations recorded to date, at the two AAQMSs are below the PEM 2007 criterion by approximately 30%.
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**PM$_{2.5}$**

Continuous PM$_{2.5}$ (particulate matter with an aerodynamic diameter equal to or less than 2.5 microns) monitoring using a Beta Attenuation Monitor (BAM) was also commenced at both SGM AAQMSs from 24 May 2013. Table 8-33 presents the maximum, minimum, mean and median 24 hour average PM$_{2.5}$ concentrations for this monitoring period between 24 May 2013 and 31 January 2014.

**Table 8-33 24 hour average particulate matter (PM$_{2.5}$) concentrations at the two SGM ambient air quality monitoring stations**

<table>
<thead>
<tr>
<th>Time averaging period</th>
<th>Concentration (µg/m$^3$)$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Location 1 (7 Fisher Street)</td>
</tr>
<tr>
<td>24 hour maximum</td>
<td>11.6</td>
</tr>
<tr>
<td>24 hour minimum</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>24 hour mean</td>
<td>4.2</td>
</tr>
<tr>
<td>24 hour median</td>
<td>3.9</td>
</tr>
<tr>
<td><strong>24 hour average PEM criterion</strong></td>
<td>36</td>
</tr>
</tbody>
</table>

Note 1: Referenced to 0°C and 101.3kPa

The maximum 24 hour PM$_{2.5}$ data collected from the two AAQMSs to date is below the 24 hour average PEM 2007 criterion with PM$_{2.5}$ concentrations less than 40 percent of this limit.

**Respirable crystalline silica (as PM$_{2.5}$)**

Monitoring of respirable crystalline silica (RCS) (as PM$_{2.5}$) has been undertaken at both SGM AAQMS for a one week period each month from July 2013 to January 2014 in accordance with the PEM 2007 requirements. The results are presented in Table 8-34. $\alpha$-quartz and cristobalite are two forms of crystalline silica, the former being the most common. Both forms may become respirable size particles when disturbed or processed.

**Table 8-34 Respirable Crystalline Silica (as PM$_{2.5}$) concentrations at the two SGM ambient air quality monitoring stations**

<table>
<thead>
<tr>
<th>Monitoring period</th>
<th>RCS (as PM$_{2.5}$) Concentration (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Location 1 (7 Fisher Street)</td>
</tr>
<tr>
<td></td>
<td>$\alpha$-Quartz</td>
</tr>
<tr>
<td>2 – 9 July 2013$^1$</td>
<td>&lt;0.79</td>
</tr>
<tr>
<td>31 July – 7 August 2013$^1$</td>
<td>&lt;0.60</td>
</tr>
<tr>
<td>22 – 29 August 2013$^1$</td>
<td>&lt;0.60</td>
</tr>
<tr>
<td>17 – 24 September 2013$^2$</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>17 – 24 October 2013$^2$</td>
<td>&lt;0.4</td>
</tr>
<tr>
<td>14 – 21 November 2013$^2$</td>
<td>NA</td>
</tr>
<tr>
<td>18 – 25 November 2013$^2$</td>
<td>&lt;0.4</td>
</tr>
<tr>
<td>4 – 11 December 2013$^2$</td>
<td>&lt;0.4</td>
</tr>
<tr>
<td>16 – 23 January 2014$^2$</td>
<td><strong>0.75</strong></td>
</tr>
</tbody>
</table>

Annual average PEM criterion 3

8-128
With the exception of January 2014 at 7 Fisher Street, RCS (as PM$_{2.5}$) was not detected above its analytical detection limit at both locations during this period. During the January 2014 monitoring period, the AAQMS at 7 Fisher Street recorded a concentration for RCS (as PM$_{2.5}$) of 0.75 µg/m$^3$.

**Arsenic (total inorganic as PM$_{10}$)**

Arsenic and other heavy metals commonly occurs in gold bearing rock. Monitoring of arsenic (as PM$_{10}$) has been undertaken at both SGM AAQMS for a one week period each month from June 2013 to January 2014. The results are presented in Table 8-35.

**Table 8-35  Arsenic (as PM$_{10}$) concentrations at the two SGM ambient air quality monitoring stations**

<table>
<thead>
<tr>
<th>Monitoring period</th>
<th>Arsenic (as PM$_{10}$) concentration (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Location 1 (7 Fisher Street)</td>
</tr>
<tr>
<td>20 – 27 June 2013$^1$</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>24 – 31 July 2013$^1$</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>14 – 21 August 2013$^1$</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>1 – 8 October 2013$^1$</td>
<td>&lt;0.03</td>
</tr>
<tr>
<td>10 – 17 October 2013$^1$</td>
<td>&lt;0.03</td>
</tr>
<tr>
<td>4 – 11 November 2013$^1$</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>4 – 11 December 2013$^1$</td>
<td>&lt;0.03</td>
</tr>
<tr>
<td>9 – 16 January 2014$^1$</td>
<td>&lt;0.003</td>
</tr>
<tr>
<td><strong>Annual average PEM 2007 criterion</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Analysed by SGS
Note 2: Data rejected as the MiniVol flow rate was outside the acceptable tolerance of ± 10%.
Note 3: Analysed by ALS Environmental

The recorded results for arsenic (as PM$_{10}$) are low and below the analytical limit of detection for all sampling periods and at both AAQMSs. However, it was noted that this detection limit is higher than the annual average PEM criterion of 0.003 µg/m$^3$.

For January 2014, samples for arsenic (and heavy metals) were analysed at an alternative laboratory (ALS Environmental) with a lower detection limit (0.003 µg/m$^3$) than previous monitoring periods. The January 2014 results for arsenic were below the limit of detection which is the same as the PEM criterion.

**Heavy metals**

Monitoring of the following heavy metals (as PM$_{10}$) was undertaken at both SGM AAQMS for a one week period each month from June 2013 to January 2014: antimony, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc.
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The results for all heavy metals at both AAQMSs are below their derived criteria for all monitoring periods.

**Dust and metal deposition**

Dust and metal deposition monitoring has been undertaken at both SGM AAQMS since June 2013. The dust deposition results at both SGM AAQMS are below the 4 g/m²/month criterion.

With the exception of dust deposition, there are no assessment criteria for heavy metal deposition. The following metals; beryllium, cobalt, and vanadium, are below analytical detection limits. With the exception of copper (October 2013 – November 2013), relatively low deposition levels were recorded for arsenic, antimony and all other metals analysed.

*Existing meteorology at the current SGM AAQMSs*

Both SGM AAQMSs are continuously recording the following meteorological parameters:

- wind speed and wind direction
- barometric pressure
- ambient temperature
- relative humidity
- solar radiation
- rainfall.

The results for the monitoring period 24 May 2013 to 31 January 2014 are presented in Technical Appendix 7.

**8.7.3.4 Background dataset used for dispersion modelling**

To assess potential air quality impacts of the Project, dispersion modelling is required to predict the likely impact of airborne contaminants at receptors locations in the vicinity of the Project area. Adopted air quality criteria for the Project (Section 8.7.4.4) provide the basis for assessing whether the airborne emissions associated with the Project demonstrate compliance with regulatory requirements and, as a result, whether air quality impacts in surrounding areas are acceptable. This section of the EES describes the air quality data that have been used as background concentrations.

**PM$_{10}$ (EPAV Bendigo AAQMS)**

For the purposes of this assessment, URS has used background PM$_{10}$ data recorded at Bendigo for the period 1 July 2004 to 30 June 2005. This approach was accepted by the ITR.

The EPAV deployed a continuous AAQMS at Garden Gully Reserve in Ashlet Street in June 2004; a residential area located approximately 1.6 kilometres northwest of Bendigo Central Business District (CBD). Monitoring was undertaken over a 12 month period from 1 July 2004 to 30 June 2005 and measured PM$_{10}$, visibility, CO, NO$_2$ and ozone (O$_3$).

Table 8-36 presents a summary of the recorded 24 hour PM$_{10}$ concentrations at the Bendigo AAQMS for the 12 month monitoring period.
Table 8-36  24 hour PM$_{10}$ concentrations at the EPAV Bendigo AAQMS (1 July 2004 – 30 June 2005)

<table>
<thead>
<tr>
<th>Statistical parameter</th>
<th>24 hour PM$_{10}$ concentration (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum$^1$</td>
<td>55.7</td>
</tr>
<tr>
<td>Mean</td>
<td>15.6</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Note 1: Occurred on 28 April 2005

24 hour PM$_{10}$ dataset comparison (EPAV Bendigo and the two SGM AAQMSs)

The PM$_{10}$ results at Bendigo for the period 1 July 2004 to 30 June 2005 together with the data collected at the two SGM AAQMSs at Stawell from 24 May 2013 to 31 January 2014 are shown in Figure 8-55 below. This figure shows that the Bendigo and Stawell data are similar in magnitude, with 24 hour PM$_{2.5}$ and PM$_{10}$ concentrations at Stawell marginally lower than Bendigo.

The Bendigo data were used as background PM$_{10}$ data and combined with the predicted PM$_{10}$ concentrations generated by the Project (Year 1, Year 2 and Year 5) to estimate the likely air quality impacts of the Project.

![Comparison of 24 hour particulate matter (PM$_{10}$) concentrations at the two SGM ambient air quality monitoring stations and EPAV Bendigo for the period 24 May 2013 – 31 January 2014](image)

Table 8-37 presents a summary of the recorded 24 hour PM$_{10}$ concentrations at the two SGM AAQMS and EPAV Bendigo AAQMS for the period 24 May to 31 January.
Table 8-37  Comparison of 24 hour PM$_{10}$ concentrations for the period 24 May to 31 January at the two SGM and EPAV Bendigo AAQMSs

<table>
<thead>
<tr>
<th>Statistical parameter</th>
<th>EPAV Bendigo AAQMS Location 1 (7 Fisher Street)</th>
<th>SGM AAQMS Location 2 (1 Park Road)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>46.2</td>
<td>38.9</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.6</td>
<td>2.9</td>
</tr>
<tr>
<td>Mean</td>
<td>13.2</td>
<td>12.7</td>
</tr>
<tr>
<td>Median</td>
<td>11.8</td>
<td>11.4</td>
</tr>
<tr>
<td>PEM Criterion</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Number of PEM exceedances</td>
<td></td>
<td>0 0</td>
</tr>
</tbody>
</table>

The 24 hour PM$_{10}$ concentrations at both SGM AAQMSs are of similar magnitude for all parameters. Analysis of the results indicates that the maximum, median and average 24 hour PM$_{10}$ concentrations are slightly lower at the two SGM AAQMS than at Bendigo for the eight month monitoring period to date. The minimum recorded PM$_{10}$ concentrations at Stawell are marginally higher than at Bendigo. The maximum concentration recorded at the Bendigo AAQMS (8 June 2005) is approximately 15 per cent higher than the maximum recorded at either SGM AAQMSs (17 January 2014). There were no exceedances of the PEM criterion for the monitoring period analysed at any of the AAQMSs.

**PM$_{2.5}$ (extrapolated from EPAV Bendigo PM$_{10}$ data)**

The EPAV Bendigo monitoring station did not monitor PM$_{2.5}$ for the period assessed in this study. Although a 12 month data set for background PM$_{10}$ and PM$_{2.5}$ was not available at the two SGM AAQMSs during the preparation of this AQIA, the data available from these stations (24 May 2013 – 31 January 2014) were used to derive a PM$_{2.5}$/PM$_{10}$ ratio. A ratio of 0.34 (7 Fisher Street AAQMS) and 0.28 (1 Park Road AAQMS) was determined from 24 hour mean PM$_{2.5}$ and PM$_{10}$ concentrations for the monitoring period 24 May 2013 to 31 January 2014.

To account for potential variance at Stawell, a number of PM$_{2.5}$ to PM$_{10}$ ratios were applied to the 24 hour PM$_{10}$ Bendigo background data. This resulted in varying background PM$_{2.5}$ data sets being applied to the results of the dispersion modelling assessment. As such, the sensitivity of applying varying background concentrations, to the results of the dispersion modelling for PM$_{2.5}$, was assessed.

This sensitivity analysis is presented in detail in the AQIA report (Technical Appendix 7).

**Dust deposition**

A dust deposition level of 1.4 g/m$^2$/month (October 2013 at 7 Fisher Street) was adopted as background for the Project. It is the highest monthly dust deposition level recorded at the two SGM AAQMSs to date (June to January 2014). It is below the 2 g/m$^2$/month incremental criterion.

**Respirable crystalline silica (as PM$_{2.5}$)**

With the exception of one positive result at 7 Fisher Street in January 2014, all recorded results of RCS (as PM$_{2.5}$) at the two AAQMS at Stawell were below the analytical limit of detection. The RCS (as PM$_{2.5}$) concentration of 0.75 µg/m$^3$ recorded at 7 Fisher Street, was adopted as background for the Project.
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**Arsenic (total inorganic as PM$_{10}$)**
There are currently no monitoring data for arsenic (as PM$_{10}$) in the local area that could be used to establish background levels for the Project. In this absence, it was proposed to use the results of monitoring that is currently being undertaken (one week per month) at the two AAQMSs at Stawell as background.

The recorded results at both SGM AAQMSs were below the limit of detection of 0.003 µg/m$^3$ for the January 2014 monitoring period. One half of this detection limit (0.0015 µg/m$^3$) was adopted as background for this Project. In the absence of recorded data, this approach to treating background concentrations is standard practice.

**Oxides of nitrogen (as NO$_2$) and carbon monoxide (CO)**
The adopted Project site background concentrations of CO have been derived based on time varying hourly concentrations recorded at the Bendigo EPAV AAQMS between 1 July 2004 and 30 June 2005. Hourly varying concentrations of NO$_x$ recorded at the EPAV Bendigo AAQMS were used as background levels for the period 1 July 2004 to 30 June 2005. There has been no regulatory requirement to continuously monitor NO$_x$ and CO at Stawell and the EPAV has agreed that the Bendigo data can be used for the purposes of this assessment. The ITR also supports the use of this data as background NO$_x$ and CO.

**PAHs**
The Project site is located adjacent to the Stawell township. Low levels of PAHs are likely to be generated from combustion sources such as vehicular traffic in the town, operation of agricultural machinery in the surrounding land, diesel trains and wood smoke.

From 31 May 2012 to 29 May 2013, the EPAV measured benzo(a)pyrene concentrations at Francis Street in Yarraville, Melbourne. An average concentration of 0.06 ng/m$^3$ was recorded during this period. Francis Street is a busy urban area with an estimated 20,000 cars and trucks travelling each weekday between Williamstown Road and Whitehall Street. The results reflect an area that is heavily influenced by emissions from traffic and is a conservative estimate of background PAHs (as BaP) at Stawell. A background concentration of 0.06 ng/m$^3$ was adopted for this AQIA.

**Sulphur dioxide**
Sulphur dioxide (SO$_2$) is not required to be monitored at the SGM site and was not measured at the EPAV air monitoring station in Bendigo (2004-2005). In this absence, hourly monitoring undertaken at the EPAV air monitoring station at Geelong South in 2004 and 2005 has been adopted. This data is considered conservative given the urban and industrial nature of Geelong city in comparison to the rural setting of the Stawell township.

**Heavy metals**
Table 8-38 presents the adopted background concentrations for each heavy metal species based on the SGM AAQMSs monitoring results from June 2013 to January 2014.

For those metals that recorded positive results, the maximum concentration was used. For those heavy metals that recorded concentrations below the analytical limit of detection, one half the mean detection limit was adopted.
Table 8-38  Developed background heavy metal concentrations (as PM$_{10}$)

<table>
<thead>
<tr>
<th>Heavy metal indicator</th>
<th>Developed background concentrations (as PM$_{10}$) in mg/m$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>$4.0 \times 10^{-5}$</td>
</tr>
<tr>
<td>Barium</td>
<td>$2.2 \times 10^{-6}$</td>
</tr>
<tr>
<td>Beryllium</td>
<td>$1.0 \times 10^{-6}$</td>
</tr>
<tr>
<td>Cadmium</td>
<td>$1.0 \times 10^{-6}$</td>
</tr>
<tr>
<td>Chromium</td>
<td>$2.2 \times 10^{-6}$</td>
</tr>
<tr>
<td>Cobalt</td>
<td>$2.0 \times 10^{-6}$</td>
</tr>
<tr>
<td>Copper</td>
<td>$3.8 \times 10^{-6}$</td>
</tr>
<tr>
<td>Lead</td>
<td>$5.0 \times 10^{-6}$</td>
</tr>
<tr>
<td>Manganese</td>
<td>$3.6 \times 10^{-5}$</td>
</tr>
<tr>
<td>Mercury</td>
<td>$4.7 \times 10^{-7}$</td>
</tr>
<tr>
<td>Nickel</td>
<td>$5.0 \times 10^{-6}$</td>
</tr>
<tr>
<td>Vanadium</td>
<td>$5.0 \times 10^{-6}$</td>
</tr>
<tr>
<td>Zinc</td>
<td>$4.6 \times 10^{-5}$</td>
</tr>
</tbody>
</table>

Summary of adopted background ambient air quality for assessment purposes

In summary, the background air quality concentrations adopted for the purposes of this AQIA are presented in Table 8-39.

Table 8-39  Adopted background concentrations for assessment purposes

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Assumed background level</th>
<th>Units of concentration</th>
<th>Averaging period</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{10}$</td>
<td>Daily varying</td>
<td>µg/m$^3$</td>
<td>24 hour average</td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>Daily varying</td>
<td>µg/m$^3$</td>
<td>24 hour average</td>
</tr>
<tr>
<td>Dust deposition</td>
<td>1.4</td>
<td>g/m$^2$/month</td>
<td>Monthly average</td>
</tr>
<tr>
<td>RCS (as PM$_{2.5}$)</td>
<td>0.8</td>
<td>µg/m$^3$</td>
<td>Annual average</td>
</tr>
<tr>
<td>Arsenic (as PM$_{10}$)</td>
<td>0.0015</td>
<td>µg/m$^3$</td>
<td>Annual average</td>
</tr>
<tr>
<td>NO$_2$</td>
<td>Maximum 1-hour</td>
<td>ppb / µg/m$^3$</td>
<td>1 hour average</td>
</tr>
<tr>
<td>CO$_2$</td>
<td>Hourly varying</td>
<td>ppm / mg/m$^3$</td>
<td>1 hour average</td>
</tr>
<tr>
<td>PAHs</td>
<td>0.06</td>
<td>ng/m$^3$</td>
<td>Annual average</td>
</tr>
<tr>
<td>Heavy metals (as PM$_{10}$)</td>
<td>Varying$^4$</td>
<td>µg/m$^3$</td>
<td>Annual average</td>
</tr>
<tr>
<td>SO$_2$</td>
<td>0.008 / 0.02</td>
<td>ppm / mg/m$^3$</td>
<td>1 hour average</td>
</tr>
</tbody>
</table>

Note 1: Daily 24 hour varying concentrations adopted from the Bendigo EPA air monitoring station for the period 1 July 2004 to 30 June 2005.
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Note 2: Constant hourly background concentration adopted for the 70th percentile at the Bendigo EPAV air monitoring station for the period 1 July 2004 to 30 June 2005.

Note 3: Maximum background concentration adopted from Bendigo EPAV air monitoring station for the period 1 July 2004 to 30 June 2005.

Note 4: Maximum background concentration recorded or one half the detection limit depending on recorded concentrations for each metal. See Table 3-11.

Note 5: Constant hourly background concentration adopted for the 75th percentile at the Geelong South EPAV air monitoring station for 2004 and 2005 (average).

8.7.3.5 Characterisation of the Ore, Overburden and Waste Rock

To provide data on the characteristics of the material to be excavated, 260 samples taken from the ore, overburden and waste rock were collected and analysed for a range of chemical and physical parameters. These were a combination of core samples taken from drilling at selected locations within the Project area and samples from stockpiles. Between 56 and 100 samples were taken from the cores for selected analyses. Table 8-40 presents a summary of the sampling program.

Table 8-40 Summary of characterisation sampling

<table>
<thead>
<tr>
<th>Sample locations</th>
<th>Heavy metal</th>
<th>Particle size distribution (PSD)</th>
<th>Silica</th>
<th>Radionuclides</th>
<th>Asbestos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of samples</td>
<td>260</td>
<td>3</td>
<td>17</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Source cores</td>
<td>cores</td>
<td>cores and stockpile</td>
<td>cores and stockpile</td>
<td>cores</td>
<td>cores</td>
</tr>
</tbody>
</table>

Four samples of the soil, overburden and ore body from the Project area were collected and analysed for radionuclides or Naturally Occurring Radioactive Material (NORM). The results showed that no individual radionuclide concentration exceeded the adopted reference activity level of 1,000 Becquerel's per kilogram (Bq/Kg).

Four samples of the soil, overburden and ore body from the Project area were collected and analysed for asbestos containing material (ACM). The results indicated asbestos levels below the laboratory analytical detection limits.

8.7.4 Impact Assessment

8.7.4.1 Regulatory engagement

The following regulatory bodies and groups proved an important and informative part of the process during the various stages of the AQIA:

- EPAV
- Technical Reference Group (TRG)
- Independent Technical Reviewer (ITR)

The appointment an ITR for the AQIA was undertaken in consultation with EPAV, the Department of Health and DPPLI. The purpose of the role was to assess the adequacy and technical accuracy of the AQIA.
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8.7.4.2 Regulatory framework
The following Victorian legislation, policies and guidance documents were referenced during preparation of the AQIA report:

- Environment Effects Statement (EES) Scoping Requirements for the Project
- Environment Protection Act 1970 (EP Act)
- State Environment Protection Policy (Ambient Air Quality) February 1999 (SEPP AAQ)
- Protocol for Environmental Management: Mining and Extractive Industries 2007
- National Environment Protection (Ambient Air Quality) Measure, July 2003
- Recommended separation distances for industrial residual air emissions, March 2013

For the assessment of air quality impacts for the Project, the most relevant regulatory documents are the SEPP AQM 2001 and the PEM 2007 which prescribe the air quality criteria against which the Project will be assessed.

8.7.4.3 Air quality indicators assessed
Assessment of the potential air quality impacts of the Project was undertaken using a dispersion modelling approach agreed by the EPAV as the relevant regulatory authority and using background air quality data described in the previous section of this EES. The following air quality indicators were quantitatively assessed through predictive air dispersion modelling for this Project:

- 24 hour PM$_{10}$
- 24 hour and annual PM$_{2.5}$
- annual respirable crystalline silica (as PM$_{2.5}$)
- annual arsenic (total inorganic as PM$_{10}$)
- monthly dust deposition
- hourly oxides of nitrogen (as nitrogen dioxide)
- hourly carbon monoxide
- annual polyaromatic hydrocarbons (as Benzo(a)Pyrene)
- hourly sulphur dioxide (SO$_2$)
- 3 minute averages (99.9th percentile) for a range of heavy metals including barium, beryllium, cadmium, chromium, cobalt, copper, manganese, nickel, lead, vanadium, zinc, antimony and mercury for the PM$_{10}$ fraction.

The following air quality indicators have been assessed qualitatively (through comparison with adopted criteria only) for this Project:

- naturally occurring radioactive material (NORM),
- naturally occurring asbestos (NOA),
- hydrogen cyanide (HCN)
- odour.
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No individual radionuclide concentrations exceeded the relevant reference activity level (1,000 Bq/Kg) and asbestos levels were not detected above the analytical laboratory detection level.

There are no additional sources or expected increases in HCN or odour emissions arising from operations at the Project site and it was agreed with the EPAV that a quantitative assessment (predictive air dispersion modelling) of these indicators was not required.

8.7.4.4 Assessment criteria

Protocol for Environmental Management: Mining and Extractive Industries 2007 (PEM 2007)

The PEM 2007 prescribes the assessment criteria applicable to relevant indicators for mining and extractive industries and provides the basis for regulatory authorities to assess whether a project has acceptable air quality impacts. The criteria are established for the protection of human health and reflect the intervention levels (these levels are relevant to all sources of a specific pollutant within a defined area rather than an individual source) set out in the SEPP (AQM) 2001. The PEM 2007 assessment criteria for the air quality indicators relevant to the Project are presented in Table 8-41.

Table 8-41 PEM 2007 assessment criteria

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Criteria</th>
<th>Unit</th>
<th>Averaging period</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM₁₀</td>
<td>60</td>
<td>µg/m³</td>
<td>24-hour average</td>
<td>SEPP (AQM) 2001³</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>36</td>
<td>µg/m³</td>
<td>24-hour average</td>
<td>SEPP (AQM) 2001³</td>
</tr>
<tr>
<td>Respirable crystalline silica (RCS)¹</td>
<td>3</td>
<td>µg/m³</td>
<td>Annual average</td>
<td>CEPA Office⁴</td>
</tr>
<tr>
<td>Arsenic (total inorganic)²</td>
<td>0.003</td>
<td>µg/m³</td>
<td>Annual average</td>
<td>CEPA Office⁷</td>
</tr>
<tr>
<td>Hydrogen cyanide</td>
<td>340</td>
<td>µg/m³</td>
<td>1-hour average</td>
<td>CEPA Office⁴</td>
</tr>
<tr>
<td>Dust deposition</td>
<td>²⁵³⁶</td>
<td>g/m²/month</td>
<td>Monthly average</td>
<td>PEM 2007</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>0.14 / 263.4¹⁰</td>
<td>ppm / µg/m³</td>
<td>1-hour average</td>
<td>SEPP (AQM) 2001³</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>29 / 33.2³⁸</td>
<td>ppm / mg/m³</td>
<td>1-hour average</td>
<td>SEPP (AQM) 2001³</td>
</tr>
<tr>
<td>PAHs (as B(a)P)</td>
<td>0.3</td>
<td>ng/m³</td>
<td>Annual average</td>
<td>NEPC⁸, NEPM⁹</td>
</tr>
<tr>
<td>Asbestos</td>
<td>0.2</td>
<td>µg/m³</td>
<td>Annual average</td>
<td>CEPA Office⁷</td>
</tr>
<tr>
<td>Radionuclides</td>
<td>ALARA¹¹</td>
<td>-</td>
<td>Annual average</td>
<td>DHS¹²</td>
</tr>
</tbody>
</table>

Note 1: RCS as PM₂.₅ fraction
Note 2: Total inorganic arsenic as PM₁₀ fraction
Note 3: Intervention Levels prescribed in the State Environment Protection Policy (Air Quality Management) 2001
Note 4: CEPA Office, California Environment Protection Agency Office for Environmental Health Hazard Assessment Reference Exposure Levels
Note 5: Incremental impacts
Note 6: Cumulative impacts
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Note 7: CEPA Office, Cancer Potency Factors from the California Environment Protection Agency Office for Environmental Health Hazard Assessment
Note 10: Conversion of ppm to µg/m$^3$ or mg/m$^3$ based on 25$^\circ$C and 1 atmosphere.
Note 11: ALARA – As Low As Reasonably Achievable
Note 12: ALARA determined by the Department of Human Services (DHS), Public Health Branch under the Radiation Act 2005 and Radiation Regulations 2007

SO$_2$

For sulphur dioxide (SO$_2$), an hourly design criteria listed in the *SEPP AQM 2001* was adopted as presented in Table 8-42.

**Table 8-42 SEPP (AQM) 2001 design criteria**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Design Criteria</th>
<th>Units</th>
<th>Averaging period</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO$_2$$^1$</td>
<td>0.17 / 0.45</td>
<td>ppm / mg/m$^3$</td>
<td>1-hour</td>
<td>SEPP (AQM) 2001</td>
</tr>
</tbody>
</table>

Note 1: Intervention level prescribed in the *SEPP (AQM) 2001*

**Heavy metals**

There is no assessment criteria prescribed in the *PEM 2007* for heavy metals. A review of the *SEPP (AQM) 2001* was conducted to determine appropriate criteria against which to assess the estimated concentrations for the 13 heavy metals. Schedule A of the *SEPP (AQM) 2001* prescribes 3-minute (for the 99.9$^{th}$ percentile) design criteria for a range of heavy metals. However, although not explicitly stated, these criteria appear to refer to the total suspended particulate (TSP) component of the heavy metal.

The *PEM 2007* prescribes an assessment criterion for arsenic in the PM$_{10}$ fraction only. The *PEM 2007* also requires that heavy metal monitoring is undertaken for the PM$_{10}$ fraction. In cases where design criteria are not prescribed for a pollutant indicator, Section 3.3 of the *PEM 2007* states the following:

*‘For indicators that do not have assessment criteria listed in Table 2 (of the PEM) but may be present at some sites, e.g. heavy metals, the proponent should contact EPA for advice on appropriate assessment criteria to be used’*

In the absence of clear guidance on this matter, Haber’s Law has been used to adjust the criteria for each heavy metal based on averaging periods in accordance with National Health and Medical Research Council (NHMRC). Details on the derivation of the criteria for each heavy metal are provided in Technical Appendix 7.

The design criterion for each heavy metal assessed for this Project is presented in Table 8-43.
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### Table 8-43 Proposed 3 minute design criteria (99.9\textsuperscript{th} percentile) for heavy metals (as PM\textsubscript{10})

| Indicator   | 3 minute design criteria (TSP) | 3 minute design criteria (PM\textsubscript{10})
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.7 x 10\textsuperscript{-2}</td>
<td>1.1 x 10\textsuperscript{-2} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Antimony</td>
<td>1.7 x 10\textsuperscript{-2}</td>
<td>1.1 x 10\textsuperscript{-2} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Barium</td>
<td>7.0 x 10\textsuperscript{-6}</td>
<td>5.0 x 10\textsuperscript{-6} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Beryllium</td>
<td>3.3 x 10\textsuperscript{-5}</td>
<td>2.2 x 10\textsuperscript{-5} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Chromium</td>
<td>1.7 x 10\textsuperscript{-2}</td>
<td>1.1 x 10\textsuperscript{-2} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Cobalt</td>
<td>1.7 x 10\textsuperscript{-3}</td>
<td>1.1 x 10\textsuperscript{-3} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Copper</td>
<td>3.3 x 10\textsuperscript{-2}</td>
<td>2.2 x 10\textsuperscript{-2} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Lead</td>
<td>3 x 10\textsuperscript{-3} (1 hour)</td>
<td>2.0 x 10\textsuperscript{-3} (1 hour) mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Manganese</td>
<td>3.3 x 10\textsuperscript{-2}</td>
<td>2.2 x 10\textsuperscript{-2} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Mercury</td>
<td>3.3 x 10\textsuperscript{-3}</td>
<td>2.2 x 10\textsuperscript{-3} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Nickel</td>
<td>3.3 x 10\textsuperscript{-4}</td>
<td>2.2 x 10\textsuperscript{-4} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Vanadium</td>
<td>1.7 x 10\textsuperscript{-3}</td>
<td>1.1 x10\textsuperscript{-3} mg/m\textsuperscript{3}</td>
</tr>
<tr>
<td>Zinc</td>
<td>1.7 x 10\textsuperscript{-1}</td>
<td>1.1 x 10\textsuperscript{-1} mg/m\textsuperscript{3}</td>
</tr>
</tbody>
</table>

Note 1: 3 minute averages for the 99.9\textsuperscript{th} percentile

The 3 minute average design criterion (as PM\textsubscript{10}) was adopted for each of the heavy metals. For consistency, the 0.66 PM\textsubscript{10}/TSP factor for deriving a 1 hour design criterion for lead (1 hour) was also used.

### 8.7.4.5 Assessment methodology

As previously outlined, PM\textsubscript{10} data collected for the period 1 July 2004 to 30 June 2005, at the EPAV managed AAQMS in Bendigo has been used as background PM\textsubscript{10} data for this Project.

To ensure consistency in the approach to the AQIA, the same time period was used to develop meteorological files for input into the dispersion model (1 July 2004 to 30 June 2005).

The predicted pollutant concentrations were modelled during the equivalent time period for which background PM\textsubscript{10} monitoring data is available. Cumulative impacts were determined using predicted concentrations from site activities only (incremental) and combined with measured background concentrations for the same period.

The modelling methodology involves the following main steps:

16. identification of emissions sources associated with Project site activities for each year of the mine plan

17. selection of two modelling scenarios to represent the two operational years of the Project operation (Year 2 and Year 5) that would potentially generate the greatest emissions

18. modelling of Year 1 to determine the potential impacts from activities at sensitive receptors located adjacent to the North Pit
19. development of a Project emissions inventory and source-specific pollutant emission rates (particulate matter fractions and combustion gases) for each scenario, including varying levels of mitigation

20. meteorological modelling to generate an hourly input file for use in the dispersion model

21. identification of sensitive receptor locations and receptor grid for assessment within the dispersion model

22. atmospheric dispersion modelling for each scenario and identified air quality indicators for the Project

23. post-processing of dispersion modelling results to enable analysis against the assessment criteria and inform the requirement for further management and mitigation measures.

**Project emissions inventory**

**Modelling scenarios assessed**

Two scenarios were initially considered in the AQIA to reflect the varying stages of the Project and were selected on the basis of the:

- volume of mined material extracted and transported
- location and nature of mining and rehabilitation activities (e.g. blasting operations)
- proximity of these activities to the location of sensitive receptors (e.g. residences and schools).

Following a recommendation by the ITR and TRG, Year 1 was assessed and predicted results for PM$_{10}$ only were presented in the AQIA report.

A description of the activities proposed to occur for each of the years assessed is provided below:

- **Year 1**: represents the excavation in the North Pit and movement of overburden to the TWRS and ore to the ROM pad. Haulage will occur between the North Pit and the TWRS and ROM pad. The haul truck movements transferring material between the North Pit and the TWRS or ROM pad, combined with the loading and unloading activities, has the potential to impact receptors in proximity to the north, west and south of the North Pit and around the TWRS. The haul road between the North Pit exit to the TWRS entrance and 50% of the North Pit ramp will be sealed by application of sealing agents. The material moved is 40% less than the in Year 2.

- **Year 2**: the extraction of overburden and ore is expected to peak at 1.0 Mt in Quarters 6 to 8, with excavation occurring in both the North and South Pits. A total of 3.9 Mt of material will be moved in Year 2. Overburden excavated from the South Pit will be used to commence backfilling of the North Pit during this period. All material hauling activities, including loading and unloading of material, will take place between the North and South Pits, ROM pad, and the TWRS. Hauling of material (waste rock and ore) will occur on mainly sealed roads by application of sealing agents i.e. North and South Pit exits to the TWRS, section between the TWRS and the ROM Pad, the TWRS haul road and 50% of the North and South Pit ramps. Blasting is planned in Quarters 5 and 6, with dozer and grader activity at or near peak activity during this period.
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- **Year 5**: the highest total movement of material (4.2 Mt) will occur within the site as part of backfilling and reinstatement works. All haulage will be concentrated between the South Pit and the TWRS and also Mt Micke, and will occur on mainly sealed roads by application of sealing agents i.e. South Pit exit to the TWRS, section between the TWRS and Mt Micke, section between the TWRS and the ROM Pad, the TWRS haul road and 50% of the South Pit ramp. Unloading of material will only occur within the South Pit, with loading activities predominantly at the TWRS during this period. The higher number of haul truck movements required to transfer material between the TWRS and South Pit, combined with the loading and unloading activities, has the potential to impact receptors in proximity to the west of the South Pit and around the TWRS.

**Inventory development**

As detailed in previous sections, an inventory of the following pollutants was developed for Year 2 and Year 5 based on the mine and ore processing activities that will be undertaken, including:

- particulate matter fractions (PM$_{10}$, PM$_{2.5}$, total suspended particulates (TSP) deposition)
- combustion emissions (PM$_{10}$ / PM$_{2.5}$, NO$_x$, CO, SO$_2$, PAHs).

For Year 1, an emission inventory for PM$_{10}$ only was prepared.

Inventories for heavy metals (as PM$_{10}$) and RCS (as PM$_{2.5}$) were not required as concentrations were based on percentages of each metal analysed in the ore/overburden samples and predicted PM$_{10}$/PM$_{2.5}$ levels i.e. the percentage of each heavy metal was determined from the ore/overburden samples analysed and multiplied by the predicted PM$_{10}$ (heavy metals) or PM$_{2.5}$ (RCS) concentration to determine the level of each heavy metal for the PM$_{10}$ fraction and RCS as PM$_{2.5}$.

The emission factors were used in conjunction with the activity rate (i.e. the number of times a specific operational activity occurs) and source-specific variables (e.g. operational hours, volume of material moved, number of truck movements, truck capacity) to produce an annual emission total for each activity. The annual total was subsequently converted to an emission rate per activity for input to the dispersion model.

Details of the inventory development for each scenario and pollutant, including the treatment of source-specific variables, and the calculation of emission rates, are provided in Technical Appendix 7. The emission inventories for particulate matter and combustion gases were reviewed by the ITR. Based on the ITR’s comments and recommendations, the inventories were updated and further modelling undertaken based on the outcomes of the review.

**Meteorological modelling**

The following two meteorological models were used for the purposes of generating an hourly meteorological input file for use in the atmospheric dispersion modelling study:

- The Commonwealth Scientific and Industrial Research Organisation’s (CSIRO), The Air Pollution Model (TAPM), Version 4.05
- The Research Corporation’s (TRC) CALMET model version 6.334.
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**TAPM meteorological data processing**

TAPM was used to predict meteorological data for the Project site for the period 1 July 2004 to 30 June 2005. This period was selected to be consistent with the monitoring period for the adopted 24 hour PM$_{10}$ background concentration recorded at the EPAV managed AAQMS at Bendigo.

**CALMET meteorological data processing**

The CALMET model was used to generate three-dimensional meteorological data for two grids centred on the Project site:

- An outer 100 kilometre x 100 kilometre grid with a two kilometre resolution (1 June 2004 – 31 July 2005)
- An inner 10 kilometre x 10 kilometre grid with a 50 metre resolution (1 June 2004 – 31 July 2005).

To generate the outer grid, CALMET was run using the TAPM three-dimensional hourly meteorological data file (120 kilometre x 120 kilometre), in addition to incorporating hourly observational data for a number of meteorological variables from four regional BoM weather stations (Stawell Aerodrome, Horsham Aerodrome, Kanagulk and Longerenong).

The CALMET data output file from the coarse outer grid was used to initialise the inner 10 kilometre x 10 kilometre grid with a finer resolution of 50 metre, with the inclusion of hourly observational data from the BoM stations located within the inner grid area. The modelled three-dimensional data file output from the CALMET inner grid was used as the hourly meteorology input for the CALPUFF atmospheric dispersion modelling assessment.

A summary of the modelled CALMET grids is provided in Table 8-44.

<table>
<thead>
<tr>
<th>Grid centre UTM (metres)</th>
<th>Grid domain (kilometres)</th>
<th>Grid resolution (kilometres)</th>
<th>No. of grid points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Grid</td>
<td>100 x 100</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>(659303, 5897155)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inner Grid</td>
<td>10 x 10</td>
<td>0.05</td>
<td>200</td>
</tr>
<tr>
<td>(659303, 5897155)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis and validation of the CALMET inner grid meteorological data, extracted at the Project site and at Stawell Aerodrome, was carried out to ensure that the modelled meteorological conditions did not exhibit anomalies that may affect the dispersion model outputs.

**Meteorological Modelling Analysis and Validation**

Both modelled (CALMET) and observed (BoM) hourly meteorological data were compiled for the assessed period to facilitate analysis and validation of meteorological variables at the following locations within the model domain:

- the Project site (CALMET extracted data)
- Stawell Aerodrome BoM AWS (CALMET extracted data)
- Stawell Aerodrome BoM AWS (observed data).
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The following meteorological variables were compared:

- wind speed frequency
- wind direction frequency
- ambient temperature (hourly time series and monthly 24 hour average).
- Pasquill-Gifford (P-G) stability class frequency
- mixing height frequency
- time series mixing heights (1 hour and 24 hour).

For the purposes of validating the modelled meteorological data, the following variables common to both the modelled (CALMET extracted) and observed datasets at Stawell Aerodrome BoM AWS were compared:

- wind speed frequency
- wind direction frequency
- annual and seasonal wind roses
- ambient temperature (hourly time series and monthly 24 hour average).

The analysis and validation exercise was undertaken for the period 1 July 2004 – 30 June 2005 to ensure the meteorology was site representative and to assess potential anomalies in the modelled data.

In summary, the analysis and validation exercise demonstrated good correlation between the modelled and observed meteorological datasets. Further details on these outcomes are provided in Technical Appendix 7.

**Atmospheric dispersion modelling**

The CALPUFF model (version 6.4) was selected as an appropriate dispersion model for the prediction of potential air quality impacts from activities at the Project. This model has been accepted by the EPAV as ‘suitable for the project assessment’.

The model was used to simulate the operational activities as detailed in the emissions inventory for Year 1, Year 2 and Year 5. Each scenario was modelled independently in CALPUFF. The time period modelled (1 July 2004 to 30 June 2005) was consistent with that of the adopted 24 hour PM$_{10}$ background data collected at the EPAV Bendigo AAQMS.

The hourly meteorological data generated by the inner CALMET grid (10 kilometre x 10 kilometre) were input to the CALPUFF model for this period.

**Modelled sources**

The activities included in the emissions inventories for Year 1, Year 2 and Year 5 were represented in CALPUFF by a combination of area, point, and volume line sources, dependent on the nature of the activity.

A summary of the emission inventory activities and the corresponding modelled source types represented in CALPUFF for Year 1, Year 2 and Year 5 is provided in Table 8-45.
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Table 8-45  Summary of modelled source types for Year 1, Year 2 and Year 5

<table>
<thead>
<tr>
<th>Inventory activity</th>
<th>Applicable Year$^1$</th>
<th>Modelled source type (CALPUFF)</th>
<th>Pollutants assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-combustion activities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loading / unloading</td>
<td>Year 1, 2, 5</td>
<td>Area (time-varying)</td>
<td>TSP, PM$<em>{10}$, PM$</em>{2.5}$</td>
</tr>
<tr>
<td>Drilling</td>
<td>Year 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dozers</td>
<td>Year 1, 2, 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blasting</td>
<td>Year 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haul truck / grader / light vehicle movements</td>
<td>Year 1, 2, 5</td>
<td>Volume line (time-varying)</td>
<td></td>
</tr>
<tr>
<td>Wind erosion</td>
<td>Year 1, 2, 5</td>
<td>Area (continuous)</td>
<td></td>
</tr>
<tr>
<td>Crushing ore</td>
<td>Year 1, 2</td>
<td>Volume (time-varying)</td>
<td></td>
</tr>
<tr>
<td><strong>Combustion activities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loading</td>
<td>Year 1, 2, 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drilling</td>
<td>Year 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ancillary equipment</td>
<td>Year 1, 2, 5</td>
<td>Point (time-varying)</td>
<td>PM$<em>{10}$, PM$</em>{2.5}$, NO$_x$, CO, SO$_2$, PAHs</td>
</tr>
<tr>
<td>Hauling</td>
<td>Year 1, 2, 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon regeneration</td>
<td>Year 1, 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Year 1 has been assessed for PM$_{10}$ impacts only.

**Time-varying emissions**

A total of 250 work days per year are scheduled for mine production, with each day comprising a 12 hour shift. The time-varying emission rates were calculated based on Project activities occurring between Monday and Friday.

**Post-processing for each air quality indicator**

Post-processing allows for predicted ground level concentration outputs from the CALPUFF model, to be calculated for a range of time averaging periods and percentiles. Model outputs can also be refined for pollutant specific requirements e.g. applying the Ozone Limited Method (OLM) calculation to the predicted 1 hour NO$_x$ concentrations. Table 8-46 presents a summary of the post-processing of the modelling outputs that were undertaken for each air quality indicator assessed.
Table 8-46  Summary of post-processing undertaken for each air quality indicator

<table>
<thead>
<tr>
<th>Air quality indicator</th>
<th>Averaging period</th>
<th>Units</th>
<th>Notes on post-processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{10}$</td>
<td>24-hour / Annual</td>
<td>µg/m$^3$</td>
<td>Processed directly from CALPUFF output</td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>24-hour / Annual</td>
<td>µg/m$^3$</td>
<td>Processed directly from CALPUFF output</td>
</tr>
<tr>
<td>TSP (dust deposition)</td>
<td>Monthly</td>
<td>g/m$^2$/month</td>
<td>CALPUFF output as monthly average dust deposition (g/m$^2$/month)</td>
</tr>
<tr>
<td>NO$_2$</td>
<td>1-hour</td>
<td>µg/m$^3$</td>
<td>CALPUFF output as 1-hour NO$_x$ was converted to NO$_2$ by applying the US EPA Ozone Limiting Method</td>
</tr>
<tr>
<td>CO</td>
<td>1-hour</td>
<td>µg/m$^3$</td>
<td>Processed directly from CALPUFF output</td>
</tr>
<tr>
<td>PAHs</td>
<td>Annual</td>
<td>ng/m$^3$</td>
<td>Processed directly from CALPUFF output</td>
</tr>
<tr>
<td>SO$_2$</td>
<td>1-hour</td>
<td>mg/m$^3$</td>
<td>Processed directly from CALPUFF output</td>
</tr>
<tr>
<td>Arsenic (PM$_{10}$)</td>
<td>Annual</td>
<td>µg/m$^3$</td>
<td>Annual mean PM$<em>{10}$ CALPUFF output factored, based on the mean arsenic content (0.05%) for 260 site samples, to derive an annual mean arsenic (as PM$</em>{10}$) concentration</td>
</tr>
<tr>
<td>RCS (as PM$_{2.5}$)</td>
<td>Annual</td>
<td>µg/m$^3$</td>
<td>Annual mean PM$<em>{2.5}$ CALPUFF output factored, based on the mean silica oxide content (69.2%) of 18 site samples, to derive an annual mean RCS (as PM$</em>{2.5}$) concentration</td>
</tr>
<tr>
<td>Heavy metals (as PM$_{10}$)</td>
<td>3-minute / 1-hour</td>
<td>mg/m$^3$</td>
<td>99.9$^{th}$ percentile of 1-hour PM$_{10}$ CALPUFF output factored, based on the median heavy metal content (%) of 16-264 site sediment samples, to derive 3-minute and 1-hour (Pb only) heavy metal concentrations. Units converted from µg/m$^3$ to mg/m$^3$</td>
</tr>
</tbody>
</table>

**Treatment of terrain and land use**

To represent the influence of terrain elevations in the dispersion of particulates, a digital elevation file was used in CALPUFF. The elevation file was centred on the Project site and covered an area of 120 kilometres x 120 kilometres to encompass the CALMET and CALPUFF modelled grids, with a resolution of 50 metres.

**Limitations and assumptions**

During preparation of the Air Quality Impact Assessment report, the following limitations and assumptions were discussed in detail in Technical Appendix 7.

- background air quality data
- observed meteorological data
- project emissions inventory and modelled emission rates
- CALPUFF atmospheric dispersion modelling
- treatment of terrain and land use data.
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8.7.4.6 Results and discussion of the air quality modelling

The predicted results for each air quality indicator assessed based on the dispersion modelling are presented below.

24 hour PM$_{10}$ concentrations (using EPAV Bendigo data as background)

The results in Table 8-47 and Table 8-48 present the predicted maximum 24 hour average PM$_{10}$ ground level results for both Year 2 and Year 5 from the Project using Bendigo background PM$_{10}$ data and a summary of predicted exceedances for both operational years. The reason that the potential concentrations (impacts) of the mining operation are modelled without the addition of background levels is to establish the contribution that the mining itself will have prior assessing the cumulative impact of mining and existing ambient levels.

Year 2

The results in Table 8-47 for Year 2 demonstrate that modelling predicted no more than one exceedance of the 24 hour PM$_{10}$ PEM 2007 criterion at six of the modelled receptors. Two of the receptors (R92 and R95, residences on Fisher Street) are predicted to reach the PEM criterion. Seven of the eight locations were predicted to reach or exceed the criterion on the same day of the modelled period (28 April), when the recorded PM$_{10}$ background concentration at the Bendigo AAQMS was 55.7 µg/m$^3$, which, when compared with the overall Bendigo data set, is elevated. To date, none of the data recorded at the SGM AAQMSs have approached background levels as high as 55.7 µg/m$^3$. However, it should be noted that data has not yet been collected for a full 12 month period at the SGM data monitoring points.

These receptors where exceedances are predicted are located adjacent to the west and southwest of the South Pit, with the exception of R15 (Residence at Crowlands Road), which is located to the northeast of the North Pit. This reflects the focus of the Project activities within the South and North Pits during Year 2.

Table 8-47 Year 2 predicted maximum 24 hour average PM$_{10}$ ground level concentrations including background

<table>
<thead>
<tr>
<th>Sensitive receptor ID</th>
<th>Predicted maximum 24 hour PM$_{10}$ (µg/m$^3$)</th>
<th>Predicted number of PEM exceedances$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>R96 (residence at Fisher Street)</td>
<td>61.3</td>
<td>1</td>
</tr>
<tr>
<td>R97 (residence at Fisher Street)</td>
<td>61.0</td>
<td>1</td>
</tr>
<tr>
<td>R15 (residence at Crowlands Road)</td>
<td>60.7</td>
<td>1</td>
</tr>
<tr>
<td>R24 (residence at Fisher Street)</td>
<td>60.5</td>
<td>1</td>
</tr>
<tr>
<td>R28 (residence at Fisher Street)</td>
<td>60.5</td>
<td>1</td>
</tr>
<tr>
<td>R94 (residence at Fisher Street)</td>
<td>60.3</td>
<td>1</td>
</tr>
<tr>
<td>R95 (residence at Fisher Street)</td>
<td>60.0 at criterion</td>
<td></td>
</tr>
<tr>
<td>R92 (residence at Fisher Street)</td>
<td>60.0 at criterion</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Number of exceedances of the PEM 2007 24 hour PM$_{10}$ criterion of 60 µg/m$^3$
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Analysis of the predicted 24 hour PM$_{10}$ concentrations was undertaken to assess compliance against the NEPM standard for the general population. The NEPM standard was applied on a regional basis, accounting for the wider Stawell township, rather than receptors adjacent to the Project area for which the PEM 2007 criterion was applied.

A range of discrete receptor locations were modelled within the wider township, many of which predicted an exceedance of the NEPM standard for up to two days in the modelled period. The majority of these exceedances were predicted to occur on 28 April of Year 2 of the modelled period, when the high background level (55.7 µg/m$^3$) as previously discussed was also above the NEPM standard. As the NEPM standard allows for up to five exceedances, compliance with the NEPM standard is predicted to be achieved within the Stawell township.

A concentration contour plot, depicting Year 2 maximum 24 hour average PM$_{10}$ concentrations for Project site operations only (not including background levels), are presented in Figure 8-56. The higher PM$_{10}$ concentration contours are observed in the main work areas of the North and South Pits and the TWRS. The compliance contour of 60 µg/m$^3$ is well within the Project area boundary. The highest 24 hour concentration from the site only was predicted to be 44.8 µg/m$^3$ at R15 (residence at Crowlands Road).

![Figure 8-56 Predicted maximum 24 hour average PM$_{10}$ concentration contours – Year 2 site contribution only](image-url)
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Year 5

The results in Table 8-48 for Year 5 demonstrate that modelling predicted an exceedance of the 24 hour PM$_{10}$ PEM 2007 criterion at seven of the modelled receptors. Receptor location R12 (residence at Crowlands Road) exceeds the criterion twice.

Analysis of the predicted 24 hour PM$_{10}$ concentrations was undertaken to assess compliance against the NEPM standard for the wider Stawell township. A range of discrete receptor locations were modelled within the wider township, many of which predicted an exceedance of the NEPM standard for up to two days in the modelled period. As the NEPM standard allows for up to five exceedances, compliance with the NEPM standard is predicted to be achieved within the Stawell Township.

Table 8-48 Year 5 predicted maximum 24 hour average PM$_{10}$ ground level concentrations including background

<table>
<thead>
<tr>
<th>Sensitive receptor ID</th>
<th>Predicted Maximum 24 hour PM$_{10}$ levels (µg/m$^3$)</th>
<th>Predicted number of PEM exceedances$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>R12 (Residence at Crowlands Road)</td>
<td>89.9</td>
<td>2</td>
</tr>
<tr>
<td>R11 (Residence at Crowlands Road)</td>
<td>81.4</td>
<td>1</td>
</tr>
<tr>
<td>R14 (Residence at Vine Street)</td>
<td>67.6</td>
<td>1</td>
</tr>
<tr>
<td>R7 (Residence off Crowlands Road)</td>
<td>65.9</td>
<td>1</td>
</tr>
<tr>
<td>R97 (Residence at Fisher Street)</td>
<td>62.9</td>
<td>1</td>
</tr>
<tr>
<td>R96 (Residence at Fisher Street)</td>
<td>60.5</td>
<td>1</td>
</tr>
<tr>
<td>R8 (Residence at Crowlands Road)</td>
<td>60.5</td>
<td>1</td>
</tr>
<tr>
<td>R10 (Residence at Crowlands Road)</td>
<td>59.6</td>
<td>0</td>
</tr>
</tbody>
</table>

24 hour PEM 2007 PM$_{10}$ criterion 60

24 hour NEPM PM$_{10}$ standard 50

Note 1: Number of exceedances of the PEM 2007 24 hour PM$_{10}$ criterion of 60 µg/m$^3$

Figure 8-57 presents a concentration contour plot depicting Year 5 maximum 24 hour average PM$_{10}$ concentrations for Project site operations only (not including background levels). The higher PM$_{10}$ concentration contours are observed in the main work areas of the South Pit and the TWRS. The compliance contour of 60 µg/m$^3$ does extend beyond the Project site boundary; however it does not encompass any of the assessed sensitive receptors before the addition of ambient background. The highest 24 hour concentration from site operations only was predicted to be 58.8 µg/m$^3$ at R7 (residence off Crowlands Road), located to the northwest of the TWRS.
Summary of 24 hour PM\textsubscript{10} concentrations

A summary of the predicted 24 hour PM\textsubscript{10} impacts for both Year 2 and Year 5 is presented in Table 8-49.

Table 8-49 Summary of predicted maximum 24 hour average PM\textsubscript{10} results

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Year 2</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cumulative impacts</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of receptors that exceeded (or reached) PEM</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Number of dates on which exceedances occurred</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Location and number of days of exceedances occur</td>
<td>R15, R24, R28, R92, R94, R95, R96, R97: 1 day</td>
<td>R7, R8, R11, R14, R96, R97: 1 day R12: 2 days</td>
</tr>
<tr>
<td>Maximum cumulative concentration</td>
<td>R96: 61.3 µg/m\textsuperscript{3}</td>
<td>R12: 89.9 µg/m\textsuperscript{3}</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Criterion</th>
<th>Year 2</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental impacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum incremental concentration</td>
<td>R15: 44.8 µg/m³</td>
<td>R7: 58.8 µg/m³</td>
</tr>
<tr>
<td>Date on which this maximum incremental occurred</td>
<td>21 July 2004</td>
<td>26 June 2005</td>
</tr>
<tr>
<td>Number of receptors that exceeded PEM on this date</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

24 hour PM$_{2.5}$ concentrations (using extrapolated PM$_{10}$ data from Bendigo EPAV AAQMS as background)

The predicted maximum 24 hour average and annual average PM$_{2.5}$ ground level concentrations at all receptor locations assessed for both scenarios is presented in the AQIA report (Technical Appendix 7).

As discussed earlier in this section, the EPAV Bendigo monitoring station did not monitor PM$_{2.5}$ for the period assessed in this study. Although a 12 month data set for background PM$_{10}$ and PM$_{2.5}$ was not available at the two SGM AAQMSs during the preparation of this AQIA, the data available from these stations (24 May 2013 – 31 January 2014) were used to derive a PM$_{2.5}$/PM$_{10}$ ratio. A ratio of 0.34 (7 Fisher Street AAQMS) and 0.28 (1 Park Road AAQMS) was determined from 24 hour mean PM$_{2.5}$ and PM$_{10}$ concentrations for the monitoring period 24 May to 31 January 2014. For the purposes of the EES, the higher of these values was adopted for the air quality modelling.

To account for potential PM$_{2.5}$ variances at Stawell given that a full 12 month data set was not available, PM$_{2.5}$ to PM$_{10}$ ratios of 0.5 and 0.6 were also applied to the background PM$_{10}$ concentrations (recorded at the EPAV AAQMS at Bendigo, in addition to the actual recorded ratio of 0.34. However, based on actual data collected at Stawell between May 2013 and January 2014, the 0.34 value is considered most representative, the other values being more conservative and representing high background values.

Results presented with varying PM$_{2.5}$/PM$_{10}$ ratios (0.34, 0.5 and 0.6) adopted as background values and the derivation of the background values are provided in the AQIA report.

Year 2

Table 8-50 presents the 24 hour and annual PM$_{2.5}$ concentrations for all three PM$_{2.5}$/PM$_{10}$ ratios (0.34, 0.5 and 0.6).
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Table 8-50 Year 2 predicted maximum 24 hour average and annual average PM$_{2.5}$ ground level concentrations including varying background concentrations

<table>
<thead>
<tr>
<th>Sensitive receptor ID</th>
<th>Predicted PM$_{2.5}$ concentration (µg/m$^3$)</th>
<th>Maximum 24-hour average</th>
<th>24 hour PEM 2007 PM$_{2.5}$ criterion</th>
<th>24 hour NEPM PM$_{2.5}$ standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitive receptor ID</td>
<td>Ratio PM$<em>{2.5}$/PM$</em>{10}$</td>
<td>0.34$^1$</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>R24 (Residence at Fisher Street)</td>
<td>0.34</td>
<td>21.0</td>
<td>29.9</td>
<td>35.5</td>
</tr>
<tr>
<td>R92 (Residence at Fisher Street)</td>
<td>0.5</td>
<td>20.8</td>
<td>29.7</td>
<td>35.3</td>
</tr>
<tr>
<td>R93 (Residence at Fisher Street)</td>
<td>0.6</td>
<td>20.7</td>
<td>29.6</td>
<td>35.2</td>
</tr>
<tr>
<td>R94 (Residence at Fisher Street)</td>
<td>0.6</td>
<td>20.7</td>
<td>29.6</td>
<td>35.2</td>
</tr>
<tr>
<td>R96 (Residence at Fisher Street)</td>
<td>0.6</td>
<td>20.7</td>
<td>29.6</td>
<td>35.2</td>
</tr>
<tr>
<td>24 hour PEM 2007 PM$_{2.5}$ criterion</td>
<td>24 hour NEPM PM$_{2.5}$ standard</td>
<td>36</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Sensitive receptor ID</td>
<td>Annual average (µg/m$^3$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R17 (Residence at Main Street)</td>
<td>0.34</td>
<td>7.4</td>
<td>10.2</td>
<td>12.0</td>
</tr>
<tr>
<td>R105 (Residence at Main Street)</td>
<td>0.5</td>
<td>7.2</td>
<td>10.0</td>
<td>11.8</td>
</tr>
<tr>
<td>R92 (Residence at Fisher Street)</td>
<td>0.6</td>
<td>7.1</td>
<td>9.9</td>
<td>11.7</td>
</tr>
<tr>
<td>R24 (Residence at Fisher Street)</td>
<td>0.6</td>
<td>7.1</td>
<td>9.9</td>
<td>11.7</td>
</tr>
<tr>
<td>R15 (Residence at Crowlands Road)</td>
<td>0.6</td>
<td>7.0</td>
<td>9.8</td>
<td>11.6</td>
</tr>
<tr>
<td>Annual average background concentrations</td>
<td>6.1</td>
<td>8.9</td>
<td>10.7</td>
<td>8</td>
</tr>
</tbody>
</table>

Note 1: This is the factor applied to PM$_{10}$ background time series at Bendigo based on SGM AAQMS monitoring of PM$_{10}$ and PM$_{2.5}$.

For the 24 hour average PM$_{2.5}$ concentrations, the five receptors at which the highest predictions occur, demonstrate no exceedances of the PEM 2007 criterion, regardless of the background PM$_{2.5}$/PM$_{10}$ ratio applied. The most impacted receptors are located adjacent to the west and southwest of the South Pit.

The 24 hour NEPM standard was not exceeded at any modelled receptor using a ratio of 0.34 to derive background data. At least one exceedance was predicted at each receptor with a ratio of 0.5, all of which occurred on 28 April Year 2 of the modelled period. As discussed in the previous section, an unusually high background level of 55.7 µg/m$^3$ for the Bendigo data was recorded on 28 April 2005. As would be expected, multiple exceedances of the NEPM standard were predicted at most receptors across the modelled domain when the high factor of 0.6 were applied and when compared with the actual recorded levels of 0.34 where zero predicted exceedances are predicted.
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In terms of the annual average, the NEPM standard was not exceeded at any of the modelled receptors when background concentrations were derived using a ratio of 0.34. Again, as would be expected when the ratios of 0.5 and 0.6 are used to derive background concentrations, the annual standard was exceeded at all receptor locations compared with the zero exceedances when the local recorded ratio (0.34) is applied. The five receptors predicting the highest annual average concentrations are located to the north of the North Pit (R105, R15, residences at Main Street and Crowlands Road) and adjacent to the west of the South Pit (R17, R92, R24, residences at Main Street and Fisher Street).

A concentration contour plot, illustrating maximum 24 hour average PM$_{2.5}$ concentrations from Project site operations only, is presented as Figure 8-58. It is evident from the plot that the higher PM$_{2.5}$ concentration contours occur at the main work areas within the North and South Pits and the ROM pad. The compliance contour of 36 µg/m$^3$ is within the Project site boundary. The highest 24 hour concentration from site operations only was predicted to be 11.1 µg/m$^3$ at receptor R15 (residence at Crowlands Road).

![Figure 8-58 Predicted maximum 24 hour average PM$_{2.5}$ concentration contours – Year 2 site contribution only](image)

Figure 8-59 presents the contour plot which illustrates the predicted annual average PM$_{2.5}$ levels for Year 2 using a PM$_{2.5}$/PM$_{10}$ ratio of 0.6. This figure shows exceedances of the annual NEPM advisory standard primarily due to the background concentration adopted of 0.6 when compared to the actual recorded ratio of 0.34.
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Figure 8-59  Predicted annual average PM$_{2.5}$ concentration contours – Year 2 for the mine contribution plus background (0.6 ratio)

Year 5

Table 8-51 presents the 24 hour and annual PM$_{2.5}$ concentrations for all three PM$_{2.5}$/PM$_{10}$ ratios (0.34, 0.5 and 0.6).

Table 8-51  Year 5 predicted maximum 24 hour average and annual average PM$_{2.5}$ ground level concentrations including varying background

<table>
<thead>
<tr>
<th>Sensitive receptor ID</th>
<th>Predicted PM$_{2.5}$ concentration (µg/m$^3$)</th>
<th>Maximum 24-hour average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ratio PM$<em>{2.5}$/PM$</em>{10}$</td>
<td>0.34$^1$</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>R12 (residence at Crowlands Road)</td>
<td>25.2</td>
<td>31.1</td>
</tr>
<tr>
<td>R11 (residence at Crowlands Road)</td>
<td>22.8</td>
<td>27.9</td>
</tr>
<tr>
<td>R6 (residence off Crowlands Road)</td>
<td>22.1</td>
<td>28.7</td>
</tr>
<tr>
<td>R97 (residence at Fisher Street)</td>
<td>21.2</td>
<td>29.2</td>
</tr>
<tr>
<td>R96 (residence at Fisher Street)</td>
<td>20.9</td>
<td>29.0</td>
</tr>
<tr>
<td>24 hour PEM 2007 PM$_{2.5}$ criterion</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>24 hour NEPM PM$_{2.5}$ advisory standard</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Sensitive receptor ID</th>
<th>Predicted PM$_{2.5}$ concentration (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual average</td>
</tr>
<tr>
<td>R6 (residence off Crowlands Road)</td>
<td>7.8</td>
</tr>
<tr>
<td>R4 (residence off Crowlands Road)</td>
<td>7.6</td>
</tr>
<tr>
<td>R11 (residence at Crowlands Road)</td>
<td>7.1</td>
</tr>
<tr>
<td>R7 (residence off Crowlands Road)</td>
<td>7.0</td>
</tr>
<tr>
<td>R10 (residence at Crowlands Road)</td>
<td>7.0</td>
</tr>
<tr>
<td>Annual average background concentrations</td>
<td>6.1</td>
</tr>
</tbody>
</table>

**Annual NEPM PM$_{2.5}$ advisory standard** 8

Note 1: This is the factor applied to PM$_{10}$ background time series at Bendigo based on SGM AAQMS monitoring of PM$_{10}$ and PM$_{2.5}$.

For the 24 hour average PM$_{2.5}$ concentrations, no exceedances of the PEM 2007 criterion were predicted at any modelled receptor, regardless of the background ratio applied. With a ratio of 0.6 applied to derive background, the predicted maximum at R12 is 34.9 µg/m$^3$ which corresponds to 97% of the criterion. These receptors are located adjacent to the southwest of the South Pit (R96, R97, residences off Fisher Street) and north and northeast of the TWRS (R6, R11, R12, all residences off Crowlands Road).

The 24 hour NEPM standard was exceeded at one modelled receptor (R12, residence at Crowlands Road) with a ratio of 0.34 applied to derive background data. At least one exceedance was predicted at each receptor with a ratio of 0.5 applied, the majority of which occurred on 28 April Year 5 of the modelled period (which was the highest background concentration of 55.7 µg/m$^3$ recorded at the Bendigo EPAV AAQMS). As would be expected, multiple exceedances of the NEPM standard were predicted at most receptors across the modelled domain with a ratio of 0.6 applied when compared with the locally recorded ratio of 0.34.

For the annual average, the NEPM standard was not exceeded at any of the modelled receptors when background concentrations were derived using a ratio of 0.34. Again, as expected, with a ratio 0.5 and 0.6 used to derive background concentrations, the annual advisory standard was exceeded at all receptor locations across the modelled domain.

A concentration contour plot, depicting maximum 24 hour average PM$_{2.5}$ concentrations from Project site operations only, is presented as Figure 8-60. It is evident from the plot that the higher PM$_{2.5}$ concentration contours occur at the TWRS. The compliance contour of 36 µg/m$^3$ does extend beyond the Project site boundary. However it does not encompass any of the assessed sensitive receptors before the addition of ambient background. The highest 24 hour concentration from site operations only was predicted to be 14.6 µg/m$^3$ at receptor R11 (residence at Crowlands Road).
Figure 8-61 presents the contour plot which illustrates the predicted annual average PM$_{2.5}$ levels for Year 2 using a PM$_{2.5}$/PM$_{10}$ ratio of 0.6. This figure shows exceedances of the annual NEPM advisory standard primarily due to the background concentration adopted when compared with the locally recorded ratio of 0.34.
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Source Apportionment (mining operations only)

Source apportionment identifies the contribution that each particulate generating source makes at receptor locations and assists in developing dust control measures to minimise potential impacts.

Source apportionment was carried out to identify the main particulate matter generating sources and develop appropriate mitigation measures in the event that intervention by site personnel (such as reduction in operational activity and cessation of operations) is required.

The predominant particulate matter sources identified through dispersion modelling of the proposed mining activities in Year 2 are presented in Table 8-52. Source apportionment for Year 5 is presented in Technical Appendix 7.

The results in Table 8-52 demonstrate that the major particulate sources are the North and South Pit haul ramps, loading of ore and waste rock within each pit, dozer activity in each pit, and dumping of waste rock within the North Pit. Additional mitigation measures for these sources are discussed in Technical Appendix 7.
Table 8-52  Year 2 PM$_{10}$ source apportionment (by %) of the top ten highest impacted receptors

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Peak without background (site sources only)</th>
<th>Day of peak without background (site sources only)</th>
<th>24 hr mean background on peak day</th>
<th>HAUL ROAD: North Pit base - North Pit exit</th>
<th>HAUL ROAD: South Pit base - South Pit exit</th>
<th>SOUTH PIT - Loading waste rock and ore active area</th>
<th>NORTH PIT - Dumping of waste rock active area</th>
<th>NORTH Pit - Loading waste rock and ore / dozer active area</th>
<th>SOUTH Pit - Dozers active area</th>
<th>SOUTH PIT Loading/Drilling combustion</th>
<th>SOUTH PIT base - South Pit exit combustion</th>
<th>Sum of others</th>
</tr>
</thead>
<tbody>
<tr>
<td>R15</td>
<td>44.8</td>
<td>21-Jul-04</td>
<td>15.8</td>
<td>10.0</td>
<td>8.7</td>
<td>26.7</td>
<td>7.2</td>
<td>16.1</td>
<td>10.6</td>
<td>2.3</td>
<td>0.5</td>
<td>17.9</td>
</tr>
<tr>
<td>R16</td>
<td>40.5</td>
<td>21-Jul-04</td>
<td>15.8</td>
<td>10.9</td>
<td>8.2</td>
<td>25.3</td>
<td>8.2</td>
<td>18.2</td>
<td>10.1</td>
<td>2.3</td>
<td>0.5</td>
<td>16.2</td>
</tr>
<tr>
<td>R73</td>
<td>39.2</td>
<td>21-Jul-04</td>
<td>15.8</td>
<td>11.7</td>
<td>7.4</td>
<td>23.5</td>
<td>9.6</td>
<td>21.5</td>
<td>9.3</td>
<td>2.0</td>
<td>0.4</td>
<td>14.6</td>
</tr>
<tr>
<td>R72</td>
<td>36.7</td>
<td>21-Jul-04</td>
<td>15.8</td>
<td>11.5</td>
<td>7.9</td>
<td>23.8</td>
<td>9.1</td>
<td>20.2</td>
<td>9.5</td>
<td>2.2</td>
<td>0.5</td>
<td>15.4</td>
</tr>
<tr>
<td>R105</td>
<td>36.4</td>
<td>21-Jul-04</td>
<td>15.8</td>
<td>12.1</td>
<td>7.1</td>
<td>21.6</td>
<td>10.2</td>
<td>22.8</td>
<td>8.6</td>
<td>2.0</td>
<td>0.4</td>
<td>14.9</td>
</tr>
<tr>
<td>R74</td>
<td>35.2</td>
<td>21-Jul-04</td>
<td>15.8</td>
<td>12.0</td>
<td>7.3</td>
<td>21.7</td>
<td>10.2</td>
<td>22.5</td>
<td>8.6</td>
<td>2.1</td>
<td>0.4</td>
<td>15.1</td>
</tr>
<tr>
<td>R17</td>
<td>33.5</td>
<td>21-Jul-04</td>
<td>15.8</td>
<td>12.7</td>
<td>7.2</td>
<td>20.0</td>
<td>10.6</td>
<td>23.0</td>
<td>8.1</td>
<td>2.2</td>
<td>0.5</td>
<td>15.8</td>
</tr>
<tr>
<td>R24</td>
<td>27.1</td>
<td>21-Jul-04</td>
<td>15.8</td>
<td>4.3</td>
<td>40.6</td>
<td>12.3</td>
<td>0.7</td>
<td>1.6</td>
<td>5.1</td>
<td>9.2</td>
<td>6.8</td>
<td>19.5</td>
</tr>
<tr>
<td>R92</td>
<td>25.5</td>
<td>21-Jul-04</td>
<td>15.8</td>
<td>4.9</td>
<td>37.3</td>
<td>13.1</td>
<td>0.8</td>
<td>1.9</td>
<td>5.5</td>
<td>9.7</td>
<td>6.5</td>
<td>20.3</td>
</tr>
<tr>
<td>R93</td>
<td>24.7</td>
<td>21-Jul-04</td>
<td>15.8</td>
<td>4.1</td>
<td>41.8</td>
<td>11.9</td>
<td>0.6</td>
<td>1.5</td>
<td>4.9</td>
<td>8.8</td>
<td>6.9</td>
<td>19.6</td>
</tr>
</tbody>
</table>

Respirable crystalline silica (RCS as PM$_{2.5}$)

The predicted cumulative annual RCS (as PM$_{2.5}$) ground level concentration shows that there are no predicted exceedances of the PEM criterion at any of the receptors locations. The receptors at which the highest RCS concentrations are expected during Year 2 are located to the north of North Pit and to the west of South Pit. In Year 5, the most impacted receptors are located to the north and west of the TWRS.

Arsenic (total inorganic as PM$_{10}$)

The results for total inorganic arsenic are based on the calculated mean annual 24 hour PM$_{10}$ concentration at each receptor and the estimated mean arsenic concentration in the dust based on the analysis of 260 core samples. The mean was approximately twice the median in the samples (486.8 parts per million (ppm) compared to 194.5 ppm) and used in this assessment for conservatism. It was also assumed that the concentration in the PM$_{10}$ fraction was the same as the bulk sample.

The five highest predicted (incremental and cumulative) annual average arsenic (as PM$_{10}$) ground level concentrations for both Year 2 and Year 5 are presented in Table 8-53.
Table 8-53  Predicted annual average arsenic (as PM$_{10}$) ground level concentrations for Year 2 and Year 5

<table>
<thead>
<tr>
<th>Sensitive receptor ID</th>
<th>Annual average arsenic (as PM$_{10}$) concentrations (µg/m³)</th>
<th>Incremental</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R24 (residence at Fisher Street)</td>
<td>0.0016</td>
<td>0.0031</td>
<td></td>
</tr>
<tr>
<td>R17 (residence on Main Street)</td>
<td>0.0015</td>
<td>0.0030</td>
<td></td>
</tr>
<tr>
<td>R105 (residence at Main Street)</td>
<td>0.0014</td>
<td>0.0029</td>
<td></td>
</tr>
<tr>
<td>R92 (residence at Fisher Street)</td>
<td>0.0014</td>
<td>0.0029</td>
<td></td>
</tr>
<tr>
<td>R93 (residence at Fisher Street)</td>
<td>0.0014</td>
<td>0.0029</td>
<td></td>
</tr>
<tr>
<td><strong>Year 5</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R6 (residence off Crowlands Road)</td>
<td>0.0018</td>
<td>0.0033</td>
<td></td>
</tr>
<tr>
<td>R4 (residence off Crowlands Road)</td>
<td>0.0018</td>
<td>0.0033</td>
<td></td>
</tr>
<tr>
<td>R11 (residence at Crowlands Road)</td>
<td>0.0012</td>
<td>0.0027</td>
<td></td>
</tr>
<tr>
<td>R10 (residence at Crowlands Road)</td>
<td>0.0012</td>
<td>0.0027</td>
<td></td>
</tr>
<tr>
<td>R7 (residence off Crowlands Road)</td>
<td>0.0011</td>
<td>0.0026</td>
<td></td>
</tr>
<tr>
<td><strong>Background</strong></td>
<td></td>
<td><strong>0.0015 µg/m³</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Annual average criterion</strong></td>
<td><strong>0.003 µg/m³</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The predicted cumulative annual arsenic (as PM$_{10}$) ground level concentrations were predicted to exceed the PEM 2007 criterion for Year 2 at one of the modelled receptors (R24, residence at Fisher Street), with the criterion value predicted to be reached at one other location (R17, residence on Main Street). The top five receptors presented in the above table are located adjacent to the north of the North Pit (R17, R105, residences on Main Street) and the south and west of the South Pit (R24, R92, R93). Two receptors (R6, R4, residences off Crowland Street) were predicted to exceed the criterion for Year 5. All top five receptors in Year 5 are located in proximity to the north of the TWRS. These reflect the locations of the main operational activities in each modelled year.

A range of management and control measures detailed in Section 8.7.5 and the AQIA report (Technical Appendix 7) to ensure that emissions of As (as PM$_{10}$) are minimised and comply with its assessment criterion.

**Heavy metals**

The predicted cumulative 3 minute (for the 99.9th percentile) of average heavy metal (as PM$_{10}$) ground level concentrations for both modelled years (Year 2 and Year 5) indicate that there are no non-compliances predicted against the proposed adopted criteria at any receptor locations. For Year 2, the most impacted receptor is R105, located to the north of North Pit. For Year 5, the most affected receptor is predicted to occur at R6, located to the north of the TWRS.
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Dust deposition
The air dispersion modelling results indicate predicted exceedances of the monthly cumulative criterion for dust deposition at two receptors (R24, R96) in Year 2 and two receptors (R17 and R94) at the criterion. However, the proposed real time monitoring of ambient conditions and the comprehensive management responses proposed by SGM outlined later in the Section to achieve compliance with regulations on the high days of dust generation, mitigate these exceedances predicted by the modelling. All other receptors are predicted to comply with the cumulative criterion. There were no predicted exceedances at any modelled receptor in Year 5.

Combustion Products

CO and NO₂
The predicted results indicate that for all receptor locations assessed, the predicted one hour ground level CO and NO₂ ground level concentrations are below their respective PEM 2007 criteria for both scenarios (Year 2 and Year 5).

PAHs
The predicted results show that for Year 2, annual average ground level PAH concentrations will exceed the PEM 2007 criterion at two receptor locations and two receptors will reach it. For Year 5, one exceedance occurs at receptor location R6, located to the north of the TWRS. As outlined above, the proposed air quality monitoring and management response regime will mitigate against these exceedances.

SO₂
The 99.9% highest predicted hourly average SO₂ ground level concentrations for both scenarios (Year 2 and Year 5) are all below the one hour SEPP (AQM) criterion at all receptor locations assessed. Higher levels predicted for Year 2 are due to the operation of the carbon regeneration unit which will not be operational in Year 5.

Year 1 – PM₁₀
The ITR and EPAV, DoH and DPPLI requested that air quality modelling was also conducted for Year 1 operations (PM₁₀ only). The results in Table 8-54 for Year 1 demonstrate that no exceedances of the 24 hour PM₁₀ PEM 2007 are predicted to occur.

Of the five most impacted receptors, three are located within 130 metres of the North Pit (R82, R83, R84, residences on Fisher Street) to the south-southwest and are predominantly influenced by the activities within the North Pit. The remaining two receptors are located approximately 300 metres to the south of the ROM Pad. The highest cumulative concentrations at the five most impacted receptors were predicted to occur on 28 April Year 1 of the modelled period, which, as previously discussed in this Section, a day where a high background concentration of 55.7 µg/m³ was recorded in the Bendigo data set used for the air dispersion modelling.
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Table 8-54 Predicted maximum 24 hour average PM$_{10}$ ground level concentrations and exceedances for Year 1

<table>
<thead>
<tr>
<th>Sensitive receptor ID</th>
<th>Predicted Maximum 24 hour PM$_{10}$ levels (µg/m$^3$)</th>
<th>Predicted number of PEM exceedances$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>R82 (Residence on Fisher Street)</td>
<td>58.3</td>
<td>0</td>
</tr>
<tr>
<td>R34 (Residence on O’ Regan Street)</td>
<td>58.1</td>
<td>0</td>
</tr>
<tr>
<td>R83 (Residence on Fisher Street)</td>
<td>58.0</td>
<td>0</td>
</tr>
<tr>
<td>R109, R81 (Residences on Fisher Street)</td>
<td>57.9</td>
<td>0</td>
</tr>
<tr>
<td>R84 (Residence on Fisher Street)</td>
<td>57.8</td>
<td>0</td>
</tr>
</tbody>
</table>

24 hour PM$_{10}$ PEM criterion 60

Note 1: Number of exceedances of the 24 hour PM$_{10}$ criterion of 60 µg/m$^3$

The maximum predicted 24 hour PM$_{10}$ concentrations at receptor locations in Year 1 are lower than for Years 2 and 5 and supports the selection of Years 2 and 5 as those considered to represent the ‘worst case’ for potential air quality impacts based on the highest levels of material handling during these years. Irrespective, the proposed ambient air quality monitoring and active management intervention up to, and including cessation of activities on extreme days, means exceedances in any year during the Project can be avoided and compliance achieved.

Summary
As a result of the comprehensive air quality dispersion modelling undertaken, the predicted results of potential impacts on sensitive receptors (e.g. residences, aged care centres and schools) arising from on-site mining activities plus a background contribution can be summarised as follows:

- Six receptors in Year 2 and seven receptors in Year 5 exceed the 24 hour PM$_{10}$ criterion. Two receptors in Year 2 are at the criterion. During Year 2, all but one of these exceedances occurs on a day for which an elevated background concentration of 55.7 µg/m$^3$ was recorded in the Bendigo data set used for the dispersion modelling.
- No receptors in Year 2 or Year 5 are predicted to exceed the 24 hour PM$_{2.5}$ advisory standard using a PM$_{2.5}$/PM$_{10}$ ratio of 0.34, 0.5 or 0.6.
- For both Year 2 and Year 5, there were no exceedances of the annual average PM$_{2.5}$ advisory standard using a PM$_{2.5}$/PM$_{10}$ ratio of 0.34 which is the measured ratio at the two SGM AAQMSs. As expected, applying a higher ratio of 0.5 or 0.6 to the annual PM$_{10}$ background concentration rather than the recorded ratio at Stawell, exceedances of the NEPM standard were predicted to occur at all receptor locations across the modelled domain. Exceedances of the annual NEPM advisory standard for ratios of 0.5 and 0.6 are primarily due to the background concentration adopted. It is contended that the recorded data at Stawell (0.34) is the most representative for adoption as the PM$_{2.5}$/PM$_{10}$ ratio.
- There are no predicted exceedances of the annual RCS (as PM$_{2.5}$) criterion for both Year 2 and Year 5 operations.
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- One receptor (R24) is predicted to exceed the annual arsenic (as PM$_{10}$) criterion for Year 2 and one (R17) is predicted to reach the criterion. For Year 5, two exceedances (R4 and R6) are predicted.
- The predicted cumulative 99.9 per cent of three minute (one hour for lead) average heavy metal (as PM$_{10}$) ground level concentrations for Year 2 and Year 5 indicate that there are no exceedances of the derived criteria.
- For Year 2, two locations (R24 and R96) exceed the incremental monthly dust deposition criteria and two receptor locations R17 and R94) meet this criterion. For Year 5, one receptor location exceeds the incremental criterion and no receptors locations exceed the cumulative criterion.
- For both Year 2 and Year 5, the combustion emissions including NO$_2$, CO, and SO$_2$ demonstrate compliance with their respective air quality criteria.
- For PAHs, exceedances are predicted to occur at two locations (R24 and R92) in Year 2 and two receptors reach the criterion. In Year 5, there is one exceedance (R6) of the annual average criterion.
- For Year 1, no exceedances of the 24 hour PM$_{10}$ criterion is predicted to occur at any receptor location assessed.

While the results of the dispersion modelling indicate a number of exceedances against air quality criteria at some adjacent receptors (residences) as outlined above (particularly on days of high background concentrations), more than 80 per cent of Project dust emissions are associated with the mining operations rather than static sources such as stockpiles. Accordingly, and as outlined in more detail below, the proposed management and mitigation measures allow for actions on a daily basis which means such exceedances in reality can be avoided. Proposed real time monitoring and attendant management intervention, or in worst case conditions, cessation of onsite activities means that air quality impacts of the Project can be managed within acceptable limits and achieve regulatory compliance.

Section 8.7.5 details the proposed management and mitigation measures to minimise adverse air quality impacts arising from on-site operations.

8.7.4.7 Dust impacts on drinking water

Rainwater tanks
It is not expected that dust deposition on the roofs of houses near to the Project site will greatly impact on the water supply of rainwater tanks. Notwithstanding, a limited rainwater tank monitoring (and analysis) program to be implemented prior to the commencement of the Project is proposed. This will focus on those residences that use tank water for drinking and domestic uses. The number and location of houses chosen will depend on several of factors including location, proximity to the Project site and rainwater uses. The details of this program will be included in the AQMP.
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Grampians Wimmera Mallee Water (GWMWater) Reservoir

An assessment of the potential impact of dust deposition (and metals) on the GWMWater reservoirs (4, 6 and 7) from Project activities was undertaken and is detailed in Section 8.10.

In summary, it was found that the background levels of iron and aluminium currently exceed the Australian Drinking Water Guidelines (prior to treatment in the GWMWater water treatment plant). However, the contribution of the Project to iron and aluminium concentrations would be minimal and the expected concentrations are well within the capacity of the treatment plant, ensuring a safe reticulated water supply.

The additive effects of the other heavy metals assessed were minimal and do not create any potential risk.

8.7.5 Management and Mitigation Measures

The following sections outline the proposed management and control measures that will be implemented during operation of the proposed Project.

8.7.5.1 Best Management Practice for the Project

The SEPP (AQM) 2001 defines ‘best practice’ as

‘the best combination of eco-efficient techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of a generator of emissions in that industry sector or activity’.

The EPAV has produced a guidance document\(^6\) which outlines an approach to addressing best practice requirements where they are required through the SEPPs. In demonstrating ‘best practice’ and ‘MEA’ for this Project, the following sources have been consulted:

- benchmarking reports for the mining industry
- consultation with specialists in the field of air quality
- consultation with specialists in the mining industry
- published journal papers and articles (Australian and overseas) relating to current dust management practices
- information published by mining companies (management and control of particulate emissions)
- consultation with Government bodies e.g. EPAV, TRG, Department of Health
- legislation and guidance (State and interstate)
- Mineral Council of Australia.

SGM propose to employ a range of best practice measures during the day to day site operations to minimise the generation of particulate matter and reduce off-site impacts to acceptable levels.

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\(^6\)EPAV, February 2013, Publication no 1517, Demonstrating Best Practice.
Chapter 1, Section 1.4 summarises the leading operational and management practices adopted by SGM that are over and above what are typically referred to as ‘best practice’ at other mine sites. Where possible, the leading practices have been benchmarked against whether they are utilised at other known mining operations (refer to Section 8.7.5.3 below).

In addition SGM will continually seek to identify measures to further reduce particulate emissions through its continual improvement program detailed in the AQMP. Best practice measures are summarised in Table 8-55. They form the basis of the particulate management strategy for the Project.

**Table 8-55  Proposed best practice measures for the Project**

<table>
<thead>
<tr>
<th>Mining activity</th>
<th>Best practice measures</th>
</tr>
</thead>
</table>
| Sealing of selected haul roads and in pit ramps | • sealing selected haul roads by application of sealing agents from Year 1 and provide road maintenance to minimise particulate matter generation on all sealed haul roads  
  • in-pit ramps and the TWRS road will be engineered with structural and surface dust controls |
| Hauling on unsealed ramps / road section | • use of larger trucks and consequent reduction of vehicle movements  
  • use of low silt content materials in construction                                                     |
| Vehicle emissions                      | • emissions from trucks to be regulated in accordance with the requirements prescribed in the NEPM (Diesel Vehicle Emissions 2001)  
  • emissions from vehicles to comply with the Environment Protection (Vehicle Emissions) Regulation 2013  
  • all diesel trucks to be fitted with particulate filters and catalytic convertors.                    |
| Blasting                              | • blasting to take place during favourable meteorological conditions (e.g. favourable wind speed and direction, location of blast not resulting in adverse offsite impacts and following a pre-blast environmental assessment  
  • all blasting will be stemmed to maximise efficiency and reduce overpressure effects  
  • minimise the blasting area                                                                 |
| Drilling                              | • watering to be applied to the drill area                                                                   |
| Active work areas                     | • watering up to a rate up to a rate of 2L/m²/hr and above as necessary to achieve modelled dust suppression targets.  
  • watering to be supplemented with chemical suppressant e.g. dustex  
  • work areas to be kept to a minimum                                                                          |
| Wind erosion of stockpiles (ROM pad / TWRS) | • application of watering and chemical suppressants, external walls of the TWRS  
  • TWRS will be mulched, seeded and watered  
  • material stockpile areas to be kept to a minimum                                                             |
| Wind erosion of overburden / active areas | • application of chemical suppressants e.g. Dustex, sprinklers, pit rim mist system, and mulching the sides of the TWRS |
| Truck loading/unloading               | • wetting of loads to minimise dust, when required                                                            |
| Processing plant                      | • adherence to the International Code for Cyanide Management.                                                 |
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The best practice mitigation measures that have been incorporated into the model that will be employed throughout the Project lifetime are summarised in Table 8-56. This table also states the relevant document(s) through which each measure will be prescribed during the Project.

**Table 8-56 Summary of best practice mitigation measures included in the dispersion modelling that will be employed during the Project operation**

<table>
<thead>
<tr>
<th>Best practice measure included in model</th>
<th>Project document(s) that prescribes measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watering up to a rate of 2 L/m²/hr and above as necessary to achieve modelled dust suppression targets.</td>
<td>Incorporated in AQMP and operational procedures</td>
</tr>
<tr>
<td>Sealing of selected roads and ramps by application of sealing agents</td>
<td>Incorporated in AQMP and operational procedures</td>
</tr>
<tr>
<td>Use of dust suppression chemicals as necessary to achieve modelled dust suppression targets</td>
<td>Incorporated in AQMP and operational procedures</td>
</tr>
<tr>
<td>Drill rigs to include dust curtains and fabric filters</td>
<td>Incorporated in AQMP and operational procedures</td>
</tr>
<tr>
<td>Fixed water sprays and area watering, as required</td>
<td>Incorporated in AQMP, mine road and stockpile design, operational procedures</td>
</tr>
<tr>
<td>Minimum drop heights (&lt;1.5m)</td>
<td>Incorporated in AQMP and operational procedures</td>
</tr>
<tr>
<td>Minimise work area</td>
<td>Incorporated in AQMP, mine planning, operational procedures</td>
</tr>
</tbody>
</table>

Other best practice measures included for the Project, are described in more detail in Technical Appendix 7.

8.7.5.2 Maximum Extent Achievable

In addition to the application of best practice, emissions of Class 3 indicators (arsenic, RCS, PAHs) are required to be controlled to the maximum extent achievable (MEA).

MEA is defined in the SEPP (AQM) 2001 as:

> ‘a degree of reduction in the emissions of wastes from a particular source that uses the most effective, practicable means to minimise the risk to human health from those emissions and is at least equivalent to or greater than that which can be achieved through application of best practice’.

The objective of the management and mitigation measures is to minimise the environmental impact from particulate matter and other airborne emissions.

In addition to the management measures included in the modelling, a number of additional controls are proposed as well as a proactive and reactive management process. This will involve on line continuous monitoring and the use of a meteorological forecasting tool which, if necessary, will lead to intervention (by site personnel) and modification of activities, further controls and ultimately, if required, cessation of work (reactive). These management systems combined with best practice controls would be implemented to achieve a MEA outcome.
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8.7.5.3 Benchmarking

SGM propose to implement a range of management and mitigation measures to address air emissions, in particular particulate matter, for the Project. Many of these can be considered best practice measures and some are ‘beyond’ best practice or leading practices.

To gain an understanding of the extent of proposed mitigation measures proposed for this Project, a comparative assessment against current practice in Australia and internationally was undertaken.

Katestone Environmental, on behalf of the New South Wales (NSW) Office of the Environment (OEH), undertook a benchmarking study on current international best practice measures for reducing particulate matter emissions from the coal mining industry in New South Wales (NSW). This report is the most recent and comprehensive study of management and control measures currently utilised in the coal mining industry in NSW, Australia and internationally.

While the report focusses on the management of particulate emissions from coal mining operations in NSW and internationally, the majority of the measures currently being implemented at these mines are relevant to this Project. Additionally, the study surveyed numerous open cut and underground mines co-located with the community which bear a similarity to this Project e.g., open cut mine, adjacent to residences.

Current management practices were assessed for four coal fields in NSW Greater Metropolitan Region (GMR), including; the Hunter Valley, Newcastle, Southern and Western coal fields which produce 92 per cent of NSW’s coal.

The report identifies the major sources of particulate emissions, nominates current practice for up to 25 mines and proposes best practice measures for minimising potential impacts.

The practices and the number of mines (as a percentage) that have adopted these practices are presented in Table 8-57 through to Table 8-63, for the major particulate generating sources.

Table 8-57 Comparison of the Project mitigation measures against those adopted in the GMR mines – Haul Roads

<table>
<thead>
<tr>
<th>Covered product trucks</th>
<th>Proportion of total (%)</th>
<th>Big Hill Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haul road watering</td>
<td>96</td>
<td>✓</td>
</tr>
<tr>
<td>Road sweeping</td>
<td>4</td>
<td>✓</td>
</tr>
<tr>
<td>Road grading</td>
<td>52</td>
<td>✓</td>
</tr>
<tr>
<td>Permanent sealing site roads</td>
<td>28</td>
<td>✓</td>
</tr>
<tr>
<td>Dust shaker grids</td>
<td>4</td>
<td>NP</td>
</tr>
<tr>
<td>Maintain all sealed roads</td>
<td>8</td>
<td>✓</td>
</tr>
<tr>
<td>Minimise haul distances</td>
<td>28</td>
<td>✓</td>
</tr>
<tr>
<td>Chemical dust suppressant on unsealed roads</td>
<td>12</td>
<td>✓</td>
</tr>
<tr>
<td>Well defined haul routes</td>
<td>40</td>
<td>✓</td>
</tr>
</tbody>
</table>
Table 101: Management of particulate matter from haul roads in the GMR - open-cut mines and combined open-cut and underground mines

<table>
<thead>
<tr>
<th>Speed limits on haul roads</th>
<th>64</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watering during peak activity periods (shift changes)</td>
<td>16</td>
<td>✓</td>
</tr>
<tr>
<td>Vegetating obsolete haul roads</td>
<td>24</td>
<td>✓</td>
</tr>
<tr>
<td>Fewer larger trucks</td>
<td>4</td>
<td>✓</td>
</tr>
<tr>
<td>Low silt aggregate</td>
<td>NS</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note 1: Table number from Katestone report.
Note 2: Elements in bold have been defined as best practice in the Katestone report.
GMR: Greater Metropolitan Region
NP: Not Proposed
NS: Not Surveyed

The Project proposes to use 13 of the 15 management measures currently used in NSW. It has not proposing to use dust shaker grids. These were only used in 4 per cent of the mines surveyed in the Hunter Valley. It has not proposed use of covered product trucks which is only applicable on public highways.

Table 8-58 Comparison of the Project mitigation measures against those adopted in the GMR mines – Wind Erosion

<table>
<thead>
<tr>
<th>Water exposed areas/active areas</th>
<th>92</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topsoil stripping when moisture is elevated but not sodden</td>
<td>36</td>
<td>✓</td>
</tr>
<tr>
<td>Minimise area of disturbance</td>
<td>84</td>
<td>✓</td>
</tr>
<tr>
<td>Chemical dust suppressants</td>
<td>16</td>
<td>✓</td>
</tr>
<tr>
<td>Stockpile moisture content measured and controlled</td>
<td>NS</td>
<td>✓</td>
</tr>
<tr>
<td>Wind barriers</td>
<td>16</td>
<td>✓</td>
</tr>
<tr>
<td>Water application by fixed sprays or water cart on ROM pad</td>
<td>64</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note 1: Table number from Katestone report.
Note 2: Elements in bold have been defined as best practice in the Katestone report.
NP: Not Proposed
NS: Not Surveyed

The Project proposes to use seven of the eight measures currently used in NSW. Use of suppressant on ROM stockpiles was not used at any of the mines surveyed. It is important to note that all ore extracted from mining operations at the Project site will be sufficiently moist due to watering and chemical suppressant added during extraction.
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Table 8-59  Comparison of the Project mitigation measures against those adopted in the GMR mines – Bulldozers

<table>
<thead>
<tr>
<th>Table 109(^1): Current control factor for bulldozing coal and overburden in the Coal Mines Emission Database for GMR coal mines and particulate matter emission control metrics(^2)</th>
<th>Proportion of total (%)</th>
<th>Big Hill Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>No controls</td>
<td>48</td>
<td>NP</td>
</tr>
<tr>
<td>No emissions</td>
<td>52</td>
<td>NP</td>
</tr>
<tr>
<td><strong>Minimise speed and distance</strong></td>
<td>NS</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Keep travel routes and materials moist</strong></td>
<td>NS</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note 1: table number form Katestone report.
Note 2: Elements in bold have been defined as best practice in the Katestone report
NP: Not Proposed
NS: Not Surveyed

No mines were identified as having controls on bulldozer activity in NSW. The Project includes two proposed controls.

Table 8-60  Comparison of the Project mitigation measures against those adopted in the GMR mines – Blasting

<table>
<thead>
<tr>
<th>Table 110(^1): Management of particulate matter from blasting in the GMR - open-cut mines and combined open-cut and underground mines(^2)</th>
<th>Proportion of total (%)</th>
<th>Big Hill Project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No blasting during adverse weather conditions</strong></td>
<td>91</td>
<td>✓</td>
</tr>
<tr>
<td>Blast during day only</td>
<td>96</td>
<td>✓</td>
</tr>
<tr>
<td>Advise local residents of blasting times</td>
<td>57</td>
<td>✓</td>
</tr>
<tr>
<td>Gravel stemming blast holes</td>
<td>43</td>
<td>✓</td>
</tr>
<tr>
<td>Blast protocol</td>
<td>35</td>
<td>✓</td>
</tr>
<tr>
<td>Coordination with surrounding mines</td>
<td>4</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Minimise blast area</strong></td>
<td>NS</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note 1: table number form Katestone report.
Note 2: Elements in bold have been defined as best practice in the Katestone report
NA: Not Applicable
NS: Not Surveyed

The Project will use six of the seven current mitigation measures used in NSW. The remaining management measure is not relevant as there are no other mines in the area.
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Table 8-61  Comparison of the Project mitigation measures against those adopted in the GMR mines – Drilling

<table>
<thead>
<tr>
<th>Management of particulate matter from drilling in the GMR - open-cut mines and combined open-cut and underground mines</th>
<th>Proportion of total (%)</th>
<th>Big Hill Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill rigs have dust curtains</td>
<td>63</td>
<td>✓</td>
</tr>
<tr>
<td>Water sprays on the drill</td>
<td>58</td>
<td>NP</td>
</tr>
<tr>
<td><strong>Fabric filters on the drill</strong></td>
<td>4</td>
<td>✓</td>
</tr>
<tr>
<td>No drilling in adverse weather</td>
<td>17</td>
<td>✓</td>
</tr>
<tr>
<td>Drill area moistened</td>
<td>21</td>
<td>✓</td>
</tr>
<tr>
<td>Water Injection</td>
<td>NS</td>
<td>NP</td>
</tr>
</tbody>
</table>

Note 1: Table number form Katestone report.
Note 2: Elements in bold have been defined as best practice in the Katestone report
NP - Not Proposed
NS: Not Surveyed

The Project will use four of the six current management measures used in NSW. The remaining mitigation measure was not surveyed and it is not clear if it is currently used.

Table 8-62 Comparison of the Project mitigation measures with those used in the GMR mines – loading and dumping overburden

<table>
<thead>
<tr>
<th>Management of particulate matter from loading and dumping overburden in the GMR - open-cut mines and combined open-cut and underground mines</th>
<th>Proportion of total (%)</th>
<th>Big Hill Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water sprays or boom spray on water cart</td>
<td>92</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Automatic water sprays</strong></td>
<td>32</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Minimise drop height</strong></td>
<td>36</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Suspension or modification of operations during adverse weather</strong></td>
<td>56</td>
<td>✓</td>
</tr>
<tr>
<td><strong>No dumping on high emplacements in strong winds</strong></td>
<td>12</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note 1: Table number form Katestone report.
Note 2: Elements in bold have been defined as best practice in the Katestone Report
NP: Not Proposed

The Project will use all five of the identified mitigating measures that are considered best practice.
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Table 8-63  Comparison of Project management measures against those adopted in the GMR mines – Air quality management tools

<table>
<thead>
<tr>
<th>Table 1271 Air quality management tools in the GMR - open-cut mines and combined open-cut and underground mines2</th>
<th>Proportion of total (%)</th>
<th>Big Hill Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meteorological monitoring</td>
<td>84</td>
<td>✓</td>
</tr>
<tr>
<td>Dust deposition gauges</td>
<td>88</td>
<td>✓</td>
</tr>
<tr>
<td>TEOMs (Tapered Element Oscillating Microbalances)</td>
<td>40</td>
<td>✓</td>
</tr>
<tr>
<td>HVAS (High Volume Air Samplers)</td>
<td>80</td>
<td>✓</td>
</tr>
<tr>
<td>Directional gauge</td>
<td>16</td>
<td>NP</td>
</tr>
<tr>
<td>Continuous, non-standard particulate measurement method</td>
<td>12</td>
<td>✓</td>
</tr>
<tr>
<td>GPS in trucks aid dust controls</td>
<td>4</td>
<td>NP</td>
</tr>
<tr>
<td>SMS alarm system during high winds</td>
<td>16</td>
<td>✓</td>
</tr>
<tr>
<td>Ceasing or modifying activities on dry windy days considering monitoring information</td>
<td>48</td>
<td>✓</td>
</tr>
<tr>
<td>Training tool box talks, incorporation of dust minimisation into procedures</td>
<td>NS</td>
<td>✓</td>
</tr>
<tr>
<td>Use of forecasting tools</td>
<td>NS</td>
<td>✓</td>
</tr>
<tr>
<td>Scheduling activates based on real time forecasting</td>
<td>NS</td>
<td>✓</td>
</tr>
<tr>
<td>Observation based feedback</td>
<td>NS</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note 1: Table number form Katestone report.
Note 2: Elements in bold have been defined as best practice in the Katestone report.
NP: Not Proposed
NS: Not Surveyed

The Project will incorporate 11 of the 13 current management measures included in Table 8-63. The Project does propose not to include directional dust deposition gauges as part of its ambient air monitoring program. This type of sampling technique is not considered best practice. Standard deposition monitoring is currently being undertaken at the mine and will continue for the duration of the proposed Project. Directional dust monitoring would not be expected to provide significant additional value.

Given the haul roads will be sealed by application of sealing agents, the GPS tracking of movements is less important for the Project and is also not considered best practice.

The survey indicates that not all best practices measures were incorporated into every mine in the GMR region. This may be due to underground mines being included, the nature of the activities in each mine and proximity to receptors. Open cut mines were not reported separately, but and accounted for 63 per cent of the extracted coal.
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Summary
Table 8-57 though to Table 8-63 show that that the Project incorporates almost all standard practice and best practice measures. In a number of cases, the Project incorporates leading practices that were not included in the survey, implying that these measures are not undertaken or were not considered necessary for inclusion in the survey e.g. for an underground mine.

These results clearly demonstrate that the Project has incorporated almost all of the management measures including best practice measures as defined in the Katestone report. When compared to existing mines in NSW, in all cases, the Project either equals, or in most cases, exceeds the numbers of mitigation measures currently being implemented. This is a clear demonstration that the proposed mitigation measures, when taken together, are not only best practice in Australia and internationally (given that all mines in NSW should be operating at best practice level), but are ‘beyond’ best practice.

None of the existing mines surveyed as part of the NSW benchmarking study, have the range of mitigation measures proposed for this Project primarily due to the proximity of the community. This clearly demonstrates the commitment by SGM to minimising impacts and health risks consistent with ‘beyond’ best practice and MEA principles.

8.7.5.4 Draft Air Quality Management Plan
The key components of the draft AQMP for the Project are presented in this section.

Objectives and targets
The proposed objectives of the AQMP will be outlined together with proposed targets that should be achieved over the reporting period. These include:

- preventing and minimising off-site air quality impacts at all sensitive receptor locations
- implementing a proactive real-time particulate matter monitoring program to ensure TRLs and the PEM 2007 criteria are not being exceeded for specific air quality indicators (PM$_{2.5}$ and PM$_{10}$)
- establishing site specific 1 hour and 24 hour TRLs for the monitoring program and corresponding management measures
- establishing weather forecasting for three days in advance, designed to predict weather conditions including precipitation, wind speed and direction enabling
  - advanced evaluation of potential adverse particulate matter impacts
  - advanced evaluation of potential adverse particulate matter impacts
  - advanced planning of non-routine control measures in the event of predicted unfavourable weather conditions
- annual review of the AQMP with the intent of achieving continual improvement in managing particulate matter emissions
- ensuring best practice and where practicable MEA is implemented for on-site activities
- increasing awareness of all on-site personnel (including sub-contractors) in respect of their contribution to minimising activities that have the potential to generate high levels of particulate matter
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- developing of clear roles and responsibilities for:
  - the collection, review, storage and reporting of monitoring data
  - responding to periods where TRLs are being breached
  - reporting of complaints to the relevant authority.

Proposed ambient air monitoring program

A real-time continuous ambient air monitoring program is proposed for the operational phase of the Project. The monitoring program will be linked to the proposed TRLs and associated control measures which are detailed in Technical Appendix 7. The purpose of the monitoring program is to facilitate the implementation of real-time reactive management measures in the event of TRLs being reached in order to maintain compliance with air quality criteria.

The monitoring program is designed to prevent an exceedance of air quality criteria at off-site receptor locations. An ambient air quality monitoring program will be prepared as part of the AQMP and will comprise the following components:

- 24 hour real-time continuous monitoring of PM$_{2.5}$ and PM$_{10}$ at three AAQMS:
  - two of these stations will be located at most impacted receptors based on the modelling assessment depending on the phase of operation
  - the third station will be used as on-going background monitoring
  - all AAQMSs will be relocated during the lifetime of the Project depending on the location of the most affected receptors

- sampling locations to be agreed with the regulatory authorities and will take cognisance of all relevant Australian Standards

- real-time continuous meteorological monitoring at the same three locations that record, wind speed, wind direction and rainfall as a minimum

- for the first 12 months of operation, RCS (as PM$_{2.5}$) and arsenic (as PM$_{10}$) monitoring (one in six day sampling program) will be undertaken at the above three locations enabling validation of the dispersion modelling results

- dust deposition monitoring at the two continuous monitoring locations, to monitor nuisance dust levels on a monthly basis

- the results from the monitoring stations will be presented at the quarterly Environmental Review Committee (ERC) meetings.

Trigger action response plan

The proposed trigger action response plan (TARP) is designed to ensure that potential particulate matter impacts from on-site activities are minimised through the following two approaches:

1. a particulate matter and meteorological forecasting system installed at the Project site to proactively manage the potential for particulate matter impacts, enabling:
   - advanced evaluation of potential adverse particulate matter impacts
   - advanced planning of non-routine control measures and/or site activity modifications in the event of predicted unfavourable weather conditions.
2. reactive application of further control measures, should the installed AAQMS record a breach of the assigned 1 hour or 24 hour particulate matter TRLs:

- control measures that would be implemented by SGM are presented in the AQIA report (Technical Appendix 7).

**Trigger response levels**

The forecasting system will incorporate the following one hour and rolling 24 hour TRLs for PM$_{2.5}$ and PM$_{10}$. In the event of a predicted or actual exceedance of a TRL, associated non-routine control measures would be applied. The proposed TRLs have been developed with reference to predicted modelled results for this Project and relevant legislative criteria.

There are three one hour and rolling 24 hour PM$_{2.5}$ and PM$_{10}$ TRLs proposed for this Project. These are referred to as TRL1, TRL2 and MaxTRL respectively. They represent PM$_{2.5}$ and PM$_{10}$ concentrations that, if reached, require hierarchical control measures to be applied with the aim of preventing a potential exceedance of the respective 24 hour PEM 2007 criteria.

The proposed TRLs are defined as follows and presented in Table 8-64.

**Trigger response level 1 (TRL1)**

This is the lowest response level for the one hour and rolling 24 hour measured PM$_{2.5}$ and PM$_{10}$ concentrations. The one hour TRL1 is based on predicted concentrations plus background (cumulative) levels. The 24 hour rolling average TRL1 for both particulate fractions is 67% of the legislative PEM 2007 criteria. When PM$_{10}$ and PM$_{2.5}$ concentrations are below this level, no further control measures would be required other than proposed best practice measures as presented in Section 5 of the AQIA report (Technical Appendix 7).

In the event that predicted or real-time monitored concentrations are above this level but below TRL2, an exceedance notification would be sent via mobile phone SMS and/or email to the appropriate site personnel. The source of particulates would be identified and additional controls implemented (e.g. additional watering, use of chemicals suppressants), which target the relevant source activity where appropriate. The continuous PM$_{10}$ and PM$_{2.5}$ monitoring instruments will be checked regularly to review the effectiveness of the corrective action(s) implemented.

**Trigger response level 2 (TRL2)**

This is the second TRL for the one hour and rolling 24 hour measured PM$_{2.5}$ and PM$_{10}$ concentrations. The one hour TRL2 for PM$_{2.5}$ and PM$_{10}$ is based on predicted concentrations plus background (cumulative) levels. The 24 hour rolling average TRL2 for both particulate fractions is 83% of the legislation PEM 2007 criteria.

Should particulate levels be predicted or measured above TRL2 but below the MaxTRL, an exceedance notification would be sent via mobile phone SMS and/or email to the appropriate site personnel. The source of the elevated dust level would be investigated and identified. Dust controls, targeted to the source activity where relevant would be implemented to adequately manage the emissions. Work activities would be reviewed and relocated if appropriate. Other controls include a reduction in site traffic and significant particulate generating activity (e.g. dozer, loading, dumping). The continuous PM$_{10}$ and PM$_{2.5}$ monitoring instruments will be checked regularly to review the effectiveness of the corrective action(s) implemented.
Maximum trigger response level (MaxTRL)

This is the maximum allowable TRL for the one hour and 24 hour measured PM$_{2.5}$ and PM$_{10}$ concentrations. The one hour MaxTRL for PM$_{2.5}$ and PM$_{10}$ is based on predicted concentrations plus background (cumulative) levels. The 24 hour MaxTRL for both particulate fractions is 92% of the PEM 2007 criteria.

If predicted or monitored particulate concentrations exceed the MaxTRL, an exceedance notification would be sent via mobile phone SMS and / or email to the appropriate site personnel. The source of the elevated particulate level would be identified and corrective action taken. In the event that particulate concentrations exceed the 24 hour rolling MaxTRL, works would be suspended. The source activity would be investigated and major particulate generating operations would not recommence until conditions contributing to the exceedance subsided and appropriate controls targeted to the source activity had been implemented. The continuous PM$_{10}$ and PM$_{2.5}$ monitoring instruments would be checked to review the effectiveness of the corrective action(s) implemented.

The proposed site specific one hour and 24 hour rolling PM$_{10}$ and PM$_{2.5}$ TRL’s for the Project as measured at the site boundary are presented in Table 8-64. Continuous monitoring results will be compared against these levels, with preventative or corrective action applied as required.

Table 8-64 Proposed Project specific Trigger Response Levels for particulate matter

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Averaging period</th>
<th>Concentrations (µg/m$^3$)$^1$</th>
<th>TRL1</th>
<th>TRL2</th>
<th>Max TRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{10}$</td>
<td>1-hour</td>
<td>80$^2$</td>
<td>100</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>PM$_{10}$</td>
<td>24-hour</td>
<td>40</td>
<td>50</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>1-hour</td>
<td>50$^3$</td>
<td>60</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>24-hour</td>
<td>24</td>
<td>30</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: The TRLs are based on 1 hour and 24 hour rolling averages.
Note 2: Based on SEPP PM$_{10}$ design criterion (1 hour averaging time)
Note 3: Based on the SEPP PM$_{2.5}$ design criterion (1 hour averaging time)

In the event that the one hour and rolling 24 hour TRL1, TRL2 and MaxTRL’s are exceeded, site specific management measures would be implemented. Table 8-65 outlines the strategy for site specific management and the range of mitigation options available.
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Table 8-65  Site specific management and control measures when TRLs are exceeded

<table>
<thead>
<tr>
<th>Exceedance of TRL1</th>
<th>Exceedance of TRL2</th>
<th>Exceedance of MaxTRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations Responsibility</td>
<td>Supervisory Responsibility</td>
<td>Management Responsibility</td>
</tr>
<tr>
<td>Identify major dust sources</td>
<td>Identify major dust sources</td>
<td>Identify major dust sources</td>
</tr>
<tr>
<td>Continue to implement existing control measures.</td>
<td>Continue to implement TRL1 measures until such time that recorded concentrations fall below TRL2.</td>
<td>Continue to implement increased mitigation measures until such time that recorded concentrations fall below TRL2.</td>
</tr>
<tr>
<td>Review of real-time weather data (wind speed/direction) to determine extent of mine contribution to an exceedance and if additional controls are required</td>
<td>Regular checking and monitoring of 1 hour and rolling 24 hour real-time PM$<em>{10}$ and PM$</em>{2.5}$ concentrations (when TRL1 is exceeded) at air monitoring stations to determine effectiveness of implemented controls.</td>
<td>Half hourly checking and monitoring of 1 hour and rolling 24 hour real-time PM$<em>{10}$ and PM$</em>{2.5}$ concentrations at AAQMSs (when MaxTRL is exceeded) to determine effectiveness of implemented controls.</td>
</tr>
<tr>
<td>Increase watering with dust suppression chemicals.</td>
<td>Modified work practice, including relocation and/or activity reduction.</td>
<td>Suspend work in high dust areas and/or Shut down on-site mining operations until directed by management.</td>
</tr>
<tr>
<td>Increase watering with dust suppression chemicals.</td>
<td>Regular checking of wind speed and wind direction to determine whether the mine is contributing to a TRL2 exceedance and if additional controls are required.</td>
<td>30 minute checking of wind speed and wind direction to determine whether the mine is contributing to a MaxTRL exceedance and if additional controls are required.</td>
</tr>
</tbody>
</table>

Document whether off-site sources (e.g. agricultural, dust storms, controlled/uncontrolled burns) are potentially making a contribution to dust levels.

Document sources and responsive actions associated with managing for exceedances.

The following lists a number of mitigation measures that on-site personnel can consider in the event that a TRL is exceeded:

- Increase use of dust suppressants where appropriate
- Use of water cannon on working faces of North and South Pit
- Increase the use of fixed automatic sprays on TPRS/ROM stockpiles during periods of high winds (e.g. >5 m/s) or when dust emissions are visible
- Increase watering of active surfaces with dust suppression chemicals on unsealed haul roads, stockpiles, and active mine areas
- Addition of chemical dust suppressants for all areas that have the potential to generate dust (in addition to unsealed haul routes and ramps)
- Specifically target areas where dust is being generated on-site with continued watering / chemical dust suppressants (where practicable)
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- Suspend all drilling/blasting operations until directed by management to recommence
- Move active work areas further away from nearby off-site receptors
- Increase flow rate of fixed sprays on haul routes / ramps.

8.7.5.5 Contingency planning

The AQMP will include details of a contingency plan in the event that unintended or upset conditions occur. The objective of the contingency plan is to address abnormal conditions that may arise during operations at the Project site. These include:

- weather events that may increase the dispersion of particulate matter
- failure of dust control
- failure of primary monitoring systems.

The contingency plan proposes the following measures to minimise particulate matter impacts on the receiving environment.

Adverse weather conditions

In the event of unfavourable weather conditions at the Project site, the following actions should be taken:

- continued application of the on-site weather and particulate matter forecasting system, linked to the real-time ambient air quality monitoring program
- review local and regional weather forecast daily and weekly to identify future adverse conditions
- identify the potential impacts from these conditions
- identify adequate measures to control emissions in accordance with the TRL actions
- plan and prepare modifications to on-site activities should these conditions arise
- implement appropriate responsive mitigation measures and actions in the event of TRL exceedances.

Failure of particulate matter controls

The following measures are proposed should particulate controls fail:

- check sufficient water supply and storage is available on a weekly basis
- check there is sufficient chemical suppressant available
  - ensure there is always at least 2 month back-up supply available on-site
- ensure a functioning water cannon is available
- implement operational changes e.g. if there are no required dust controls available, limited or no mining operations to be undertaken.
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Primary monitoring systems

The following contingency measures are proposed in the event that on-site monitoring systems fail:

- ensure there is a back-up power supply to systems
- redundancy for key monitoring equipment
- multiple monitoring stations (minimum of two)
- additional mobile monitoring equipment to be available at the Project site e.g. DustTrak, E-Sampler
- implementing operational changes e.g. if there are no primary monitoring systems operating, restricted mining work to be undertaken.

8.7.6 Conclusion

This chapter has outlined the approach used to assess the potential air quality impacts associated with the Project.

Air quality data from an EPAV air monitoring station at Bendigo (PM$_{10}$, CO and NO$_2$) has been used as inputs to the dispersion models in the absence of 12 months of local background data at Stawell being available. Data currently being collected at the two SGM AAQMSs indicates to date, that the air quality at Stawell is comparable to the data collected at Bendigo used in the modelling. The Bendigo data used was therefore considered representative and fit for the purposes of this assessment. Stawell data will continue to be compared with the Bendigo data as monitoring progresses and will allow further validation of the modelling outputs.

The quantitative assessment of Years 2 and 5, when particulate matter emissions are likely to be greatest, has considered the potential local air quality impacts during the construction, operation and rehabilitation of the Project. Dispersion modelling using the CALPUFF model has been used to predict off-site incremental and cumulative pollutant concentrations for the Project based on available BoM meteorological data and appropriate background concentrations.

Inputs to the dispersion model have incorporated a range of best practice mitigation measures (primarily around the mine plan/pit design) to minimise pollutant emissions at the source. The range of management and mitigation measures to address air emissions, in particular particulate matter, for the Project can be considered best practice measures and some are ‘beyond’ best practice and facilitate MEA.

To gain an understanding of the extent of the mitigation measures proposed for this Project, a comparative assessment against current practice in Australia and internationally was undertaken (Katesone report). These results clearly demonstrate that the Project has incorporated almost all of the management measures including best practice measures when compared to existing mines in NSW. In all cases, the Project either equals, or in most cases, exceeds the numbers of mitigation measures currently being implemented. There is a clear demonstration that the proposed mitigation measures, when taken together, is not only best practice in Australia and internationally, but are ‘beyond’ best or leading practice.
The air quality modelling shows that a number of exceedances of the 24 hour PM$_{10}$ are predicted at residential properties adjoining the Project site in the absence of active management and mitigation. Analysis of the air quality modelling results has identified the sources of particulate matter and variations in concentrations throughout the day which has enabled the development of specific mitigation measures that will be employed to minimise potential impact and ensure compliance.

In addition to the engineering mitigation measures to minimise emissions at source and the management techniques (watering, use of dust suppressants), the site will use a fully integrated approach to managing potential emissions that includes implementation of an AQMP, continuous on line monitoring, a predictive meteorological and dust impact modelling system, trigger levels and associated response plans, and contingency plans to deliver compliance and minimise impacts. Under extreme conditions, where background levels of particulate matter are high (e.g. bushfires, dust storms, controlled burns), the proposed real time monitoring program enables SGM to not only implement management responses but to cease operations if required to achieve compliance.

On the basis that the management measures proposed are implemented, compliance with relevant criteria (PEM and NEPM) is achievable despite the proximity of mining activities to sensitive receptor locations.

In summary, the air dispersion modelling assessment has predicted exceedances for some of the air quality indicators at several receptor locations near to the Project site. In consideration of these predicted exceedances, a range of engineering, planning and operational controls have been proposed to minimise the potential for adverse impacts. An analysis of the contribution of particulate matter generating sources to the overall predicted dust loading has indicated the majority of sources (up to 80% for Year 2 and more than 90% for Year 5) are associated with active mining operations e.g. hauling, excavating, loading/unloading rather than non-active sources e.g., exposed areas, stockpiles. This enables SGM to actively manage its major dust generating sources through an integrated Air Quality Management Plan that incorporates an ambient air quality monitoring program, best practice management measures, planning tools such as a forecasting meteorological system, hierarchal control through the implementation of trigger response levels and ultimately intervention by SGM through the reduction or cessation of operational activity during periods of high background (non-mine related) particulate matter concentrations e.g. dust storms, controlled burns or bushfires.

Given SGM’s commitment to ensuring that predicted adverse air quality impacts will not occur from its mining operations, exceedances of the criteria prescribed in the PEM 2007 can be prevented during the lifetime of the Project.
8.8
Greenhouse Gas
8 Environmental Impact Assessment

8.8 Greenhouse Gas

8.8.1 Introduction

This section of the EES describes the implications of the Project for greenhouse gas (GHG) emissions and energy consumption, including potential impacts of the Project; measures to manage and mitigate potential adverse impacts; and the overall impacts of the Project following implementation of proposed management and mitigation measures.

This section is based primarily on information presented in:

- URS Australia Pty Ltd (October 2013) *Big Hill Enhanced Development Project Energy Use and Greenhouse Gas Assessment*, prepared for CGC.

This report is included in Technical Appendix 8 of this EES and should be referred to for more detail on the issues discussed in this section.

The EES Scoping requirements do not specifically address GHG emissions and energy consumption.

**Key issues emerging from EES studies and community consultation:**

There were no key issues related to GHG emissions and energy consumption arising from the community during the preparation of EES studies or community consultation process.

**Summary of findings**

- Total emissions for the Project are estimated to be 161.5 kilotonnes of carbon dioxide-equivalent (kt CO₂-e).
- Consumed energy for the Project is calculated to be approximately 919.9 tetra joules (TJ).
- Total GHG emissions averaged over the five year life of the Project represent a 67 per cent reduction in emissions when compared to the 2011-12 reporting year.
- Total consumed energy represents a 59 per cent reduction in annual consumed energy when compared to the 2011-12 reporting year (which would represent the GHG emissions in the event that the existing operations continued in its current form into the future).

GHG emissions and the total consumed energy would be zero under a 'no Project' scenario as existing SGM operations will cease.

8.8.2 Existing Conditions

Stawell Gold Mines reports annually for the *National Greenhouse and Energy Reporting (NGER) Scheme* under the *NGER Act 2007* due to the amount of energy consumed by its operation and GHG produced annually. Facilities are required to report under the NGER Act if they exceed the GHG emission threshold of 25 kt CO₂-e/year (kilotonnes of carbon dioxide-equivalent per year) or the energy threshold (produced or consumed) of 100 TJ/year (tetra joules per year).

CGC reports annually for the Energy Efficiency Opportunities (EEO) program due to the amount of energy consumed by the corporation. Corporations using more than 500 TJ of energy are required to participate in the EEO program.
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**Greenhouse gas and energy profiles**

The quantities of electricity and GHG emissions, relative to ore processed, for the current operation are shown in Figure 8-62 for the 2009 to 2012 reporting periods.

![Figure 8-62 Greenhouse gas emissions and energy consumed relative to ore processed (2009 to 2012)](image)

**Major energy using activities**

The most energy intensive activities that currently occur at the existing site include:

- electricity consumption at the processing plant
- ventilation of the underground mine
- diesel consumption from underground truck movements (ore and waste rock handling).

8.8.3 Impact Assessment

Greenhouse gas is an environmental impact which requires assessment as part of any major development proposal. The GHG assessment of the Project has considered the following:

- national policies in regards to GHG emissions
- existing energy usage / GHG assessments to identify on going energy use and greenhouse gas emissions (e.g. processing, lighting, admin)
- the energy usage and associated GHG emissions for any construction activities (e.g. road works)
8 Environmental Impact Assessment

- the annual energy usage and associated GHG emissions from operations (e.g. truck movements, excavation, processing, admin, including fuel usage, gas usage, electricity usage)
- potential energy usage reduction and greenhouse gas mitigating measures.

Information provided by mine design engineering consultants (Mining One, June 2013) has been used as the basis for fuel consumption and explosive use for the Project. Historic environment and resource efficiency plans (EREP) and EEO reports have been used as the basis for energy and electricity use from the processing plant and tailing storage facility (TSF).

**Greenhouse gas calculation approach**

The methodology described in the *NGER (Determination)*, has been used for this assessment and involves assessment of direct GHG emissions associated with the SGM operation (Scope 1) and indirect GHG emissions associated with electricity consumed (Scope 2).

**Scope 1: direct GHG emissions**

Direct GHG emissions occur from sources that are owned or controlled by the company, for example emissions from combustion in owned or controlled boilers, furnaces, vehicles etc.; and emissions from chemical production in owned or controlled process equipment.

Scope 1 emissions for the Project operations have been calculated using National Greenhouse Accounts (NGA) factors to provide data on the emissions of CO₂-e generated during mining, processing, and rehabilitation operations. The NGA factors take into account emissions of the three main greenhouse gases, CO₂, CH₄ (methane) and N₂O (nitrous oxide) and are provided by the Department of Climate Change and Energy Efficiency\(^\text{10}\).

Scope 1 emissions for the Project are detailed in Table 8-66.

<table>
<thead>
<tr>
<th>Emission source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport fuel (diesel)</td>
</tr>
<tr>
<td>Stationary fuel (diesel)</td>
</tr>
<tr>
<td>Explosives (heavy ANFO)</td>
</tr>
<tr>
<td>Process chemicals</td>
</tr>
<tr>
<td>Natural gas</td>
</tr>
<tr>
<td>Liquefied petroleum gas (LPG)</td>
</tr>
</tbody>
</table>

**Scope 2: electricity indirect GHG emissions**

This accounts for GHG emissions from the generation of ‘purchased electricity’ consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.

\(^\text{10}\) Department of Climate Change and Energy Efficiency (2008); Department of Climate Change and Energy Efficiency (2012)
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Energy consumption for the existing operation has decreased over the past three reporting periods. As such, the projected electricity consumption for each operating year has been determined based on the processing plant electricity consumption from the July 2011 to June 2012 reporting year to reflect any recent energy saving initiatives (EPA Victoria, 2012). The 2011-2012 electricity use has been used together with NGA factors for electricity use in Victoria to define the Scope 2 emissions. The NGA factors take into account emissions of the three main greenhouse gases, CO₂, CH₄ (methane) and N₂O (nitrous oxide) generated through generation of electricity¹¹.

Scope 3: other indirect GHG emissions

This is not a reporting class required under the NGER Act. These emissions account for all other indirect GHG emissions resulting from a company’s activities, but occurring from sources not owned or controlled by the company. Examples include extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

Scope 1 and 2 emissions together are called the total greenhouse gas emissions for a facility. Scope 3 is not required to be reported to NGER, and have not been estimated in this assessment.

Assumptions

The estimated fuel and electricity consumption is shown in Table 8-67 and assumes:

- all fuel consumption is diesel
- equipment has been classified as either a mobile source (trucks, excavators, compactors) or a stationary source (drills, processing plant, lighting plant) of emissions
- electricity use for the Project has been estimated based on historical grid electricity consumption by SGM from the 2011-2012 reporting period, excluding the portion of the electricity used for underground mining
- it is expected that the electricity consumption of the processing plant will decline to at least 10 per cent of its historical use after Quarter 14 when ore processing and chemical use will cease
- land-use changes involving vegetation clearing resulting from the change to open-cut mining have not been accounted for as the mine will be rehabilitated once the proposed mining operations have ceased and temporary loss in vegetation is unlikely to have a significant impact on GHG emissions during mining operations.

Table 8-67  Approximate ore processing rates and fuel and electricity consumption

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Total ore processed (tonnes)</th>
<th>Diesel fuel consumption (litres)</th>
<th>Electricity consumption (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>184,984</td>
<td>366,252</td>
<td>7,379,433</td>
</tr>
<tr>
<td>2</td>
<td>226,639</td>
<td>406,758</td>
<td>7,421,211</td>
</tr>
<tr>
<td>3</td>
<td>162,834</td>
<td>410,088</td>
<td>7,292,095</td>
</tr>
<tr>
<td>4</td>
<td>159,047</td>
<td>432,078</td>
<td>7,104,738</td>
</tr>
<tr>
<td>5</td>
<td>194,917</td>
<td>480,880</td>
<td>7,379,433</td>
</tr>
<tr>
<td>6</td>
<td>162,020</td>
<td>543,795</td>
<td>7,421,211</td>
</tr>
<tr>
<td>7</td>
<td>79,012</td>
<td>538,470</td>
<td>7,292,095</td>
</tr>
</tbody>
</table>

¹¹ Department of Climate Change and Energy Efficiency (2012)
8 Environmental Impact Assessment

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Total ore processed (tonnes)</th>
<th>Diesel fuel consumption (litres)</th>
<th>Electricity consumption (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>83,950</td>
<td>547,063</td>
<td>7,104,738</td>
</tr>
<tr>
<td>9</td>
<td>104,182</td>
<td>531,305</td>
<td>7,379,433</td>
</tr>
<tr>
<td>10</td>
<td>131,919</td>
<td>507,144</td>
<td>7,421,211</td>
</tr>
<tr>
<td>11</td>
<td>107,894</td>
<td>522,840</td>
<td>7,292,095</td>
</tr>
<tr>
<td>12</td>
<td>143,636</td>
<td>495,850</td>
<td>7,104,738</td>
</tr>
<tr>
<td>13</td>
<td>199,159</td>
<td>530,875</td>
<td>7,379,433</td>
</tr>
<tr>
<td>14</td>
<td>251,498</td>
<td>419,413</td>
<td>7,421,211</td>
</tr>
<tr>
<td>15</td>
<td>-</td>
<td>448,798</td>
<td>729,209</td>
</tr>
<tr>
<td>16</td>
<td>-</td>
<td>448,798</td>
<td>710,474</td>
</tr>
<tr>
<td>17</td>
<td>-</td>
<td>448,798</td>
<td>737,943</td>
</tr>
<tr>
<td>18</td>
<td>-</td>
<td>448,798</td>
<td>742,121</td>
</tr>
<tr>
<td>19</td>
<td>-</td>
<td>447,276</td>
<td>729,209</td>
</tr>
<tr>
<td>20</td>
<td>-</td>
<td>617,406</td>
<td>710,474</td>
</tr>
<tr>
<td>Total</td>
<td>2,191,691</td>
<td>9,592,683</td>
<td>106,752,502</td>
</tr>
</tbody>
</table>

**Emission assessment results**

GHG emissions and consumed energy estimates have been assessed for Project over a five year period (Year 1 – Year 5) relative to the current site operations (average from 2009 – 2012). Results of the assessments are shown in Table 8-68 and Figure 8-63.

Table 8-68 Summary of Greenhouse gas emissions and consumed energy for the Project

<table>
<thead>
<tr>
<th>Type</th>
<th>Year 1 (tCO₂-e)</th>
<th>Year 2 (tCO₂-e)</th>
<th>Year 3 (tCO₂-e)</th>
<th>Year 4 (tCO₂-e)</th>
<th>Year 5 (tCO₂-e)</th>
<th>Total (tCO₂-e)</th>
<th>Total consumed energy (GJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SCOPE 1 EMISSIONS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport fuels</td>
<td>4,042</td>
<td>5,244</td>
<td>4,809</td>
<td>4,455</td>
<td>5,160</td>
<td>23,709</td>
<td>339,187</td>
</tr>
<tr>
<td>Stationary fuels</td>
<td>2,009</td>
<td>2,143</td>
<td>2,433</td>
<td>2,223</td>
<td>1,830</td>
<td>10,638</td>
<td>196,368</td>
</tr>
<tr>
<td>Explosives</td>
<td>-</td>
<td>30</td>
<td>46</td>
<td>48</td>
<td>-</td>
<td>124</td>
<td>-</td>
</tr>
<tr>
<td>Process based emissions</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td>-</td>
<td>36</td>
<td>-</td>
</tr>
<tr>
<td><strong>SCOPE 1 TOTALS</strong></td>
<td>6,062</td>
<td>7,426</td>
<td>7,298</td>
<td>6,732</td>
<td>6,989</td>
<td>34,507</td>
<td>535,555</td>
</tr>
<tr>
<td><strong>SCOPE 2 EMISSIONS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchased grid electricity</td>
<td>34,745</td>
<td>34,745</td>
<td>34,745</td>
<td>19,326</td>
<td>3,474</td>
<td>127,035</td>
<td>384,309</td>
</tr>
<tr>
<td><strong>SCOPE 2 TOTALS</strong></td>
<td>34,745</td>
<td>34,745</td>
<td>34,745</td>
<td>19,326</td>
<td>3,474</td>
<td>127,035</td>
<td>384,309</td>
</tr>
<tr>
<td><strong>TOTAL EMISSIONS</strong></td>
<td>40,807</td>
<td>42,171</td>
<td>42,043</td>
<td>26,058</td>
<td>10,464</td>
<td>161,542</td>
<td>919,864</td>
</tr>
</tbody>
</table>
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Compared to the results reported for 2011-2012, the total GHG emissions averaged over the five year life of the Project represent a 67 per cent reduction in annual GHG emissions, and the total consumed energy represents a 59 per cent reduction in annual consumed energy.

8.8.4 Management and Mitigation Measures

Steps have been taken in the Project design phase to minimise emissions arising from the Project mining and processing activities. The following sections highlight the GHG emission mitigating measures and energy efficient opportunities that have been adopted for the Project.

**Greenhouse Gas emission mitigation**

Major climate change considerations for large mining projects include loss of carbon dioxide uptake from vegetation clearing and carbon dioxide emitted by machines and ore processing. In addition to rehabilitating the mine site at the completion of the proposed mining period, SGM has incorporated the following considerations into the proposed works:

- SGM has elected to have a reduced project duration when compared to a much longer project life if optimising resource recovery was the only development criterion. While GHG emissions reduction was not the reason for selecting a shorter duration project, it has the effect of reducing overall emissions when compared to other options considered for the development (e.g. the project is approximately five years compared to the proposed eight year timeframe proposed as part of the 1999 EES).
- Optimisation of the mining fleet size to minimise haulage (e.g. 100 tonne haul trucks instead of 50 tonne trucks reduces the number of truck movements required).
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- Location of the TWRS adjacent to the North and South Pits utilising GWMWater land will reduce GHG emission by about 4 per cent compared to utilising Wonga Pit which was considered for waste rock storage at the Project outset; and
- Progressive rehabilitation will increase uptake of GHG emissions as a result of revegetation commencing 18 months from the start of mining.

**Energy efficiency opportunities**

Energy consumption, particularly electricity consumption from the national grid, is the mine’s largest contributor to GHG emissions.

As part of the Project planning process, SGM has evaluated energy efficiency opportunities including optimisation of waste rock movements (mining fleets, waste rock volumes, and haulage distances). Considerations for ongoing maintenance of mobile and processing plant equipment have also been incorporated into the Project to reduce energy consumption and GHG emissions.

**8.8.5 Conclusion**

Evaluation of the potential GHG emissions resulting from the Project demonstrate that the Project will exceed the NGER Act reporting threshold of 25 kt CO$_2$-e/year for Year 1 to 4.

Through an iterative design process, the Project has been designed to incorporate a number of mitigation measures that will reduce GHG emissions resulting from energy consumption and improve uptake of GHG emissions by vegetation when compared with the concept at project inception.

If the Project does not proceed and the existing mine closes, the GHG emissions and total consumed energy would be zero.

When compared to the 2011-2012 reporting year (which would represent GHG emissions if the operation continued in its present form into the future), the total GHG emissions averaged over the five year life of the Project represent a 67 per cent reduction in annual GHG emissions, and the total consumed energy represents a 59 per cent reduction in annual consumed energy.

Emissions that could result from mining and rehabilitation activities were modelled and presented for the Project. The creation of 161.5 kt CO$_2$-e of total GHG emissions and consumption of approximately 919.9 TJ of energy over five years of the Project compared to the ‘no Project’ scenario is considered to be an acceptable impact in the context of the potential benefit to the local economy.
8.9
Geotechnical
8 Environmental Impact Assessment

8.9 Geotechnical

8.9.1 Introduction
This section of the EES describes and assesses the potential geotechnical stability impacts of the Project; identifies measures to manage and mitigate potential adverse impacts and assesses overall impacts on geotechnical stability following implementation of management and mitigation measures.

This assessment is based primarily on information provided in:

- Mining One Pty Ltd (December, 2013), Big Hill Enhanced Development Project: Geotechnical Investigation, prepared for CGC.

This report is included in Technical Appendix 9 to this EES.

### Relevant sections of EES Scoping Requirements

This section of the EES covers the following components of the EES Scoping Requirements insofar as they relate to geotechnical stability:

#### ‘4.5 Health and Social Impacts

**Evaluation Objective**
To protect the health, safety and wellbeing of residents and the social fabric of the community in the area in the context of project hazards.

#### 4.5.1 Public Health and Safety

**Key issues**
- Public safety hazards during mine construction, operation, rehabilitation and post-closure, including in relation to the presence of deep pits in close proximity to existing residential areas and the geotechnical stability of the mine and rehabilitated landform.

**Priorities for characterising the existing environment**
- Describe the physical and chemical characteristics of overburden, ore and waste rock to be removed during mine development and operations, following mechanical extraction, including specific aspects relevant to human health.

**Design and mitigation measures**
- Describe and evaluate potential and proposed design and mitigation measures that could:
  - ensure public safety during mine development, operation and rehabilitation, that is prior to the completion of the restoration and rehabilitation of Big Hill.

**Assessment of likely effects**
- Assess potential safety hazards to the public arising from the project.

**Approach to manage performance**
- Describe and evaluate any proposed measures to mitigate or manage public safety hazards.”

---

12Assessment should be completed to a level commensurate with the detailed hazard and risk assessment required for the Work Plan under Mineral Resources (Sustainable Development) Act 1990.
Key issues emerging from EES studies and community consultation:

The EES Scoping Requirements outlined above provide a detailed list of the issues requiring attention in the EES. In addition, community concerns arising from the ongoing community engagement and communications program indicated that concern exists about the potential for damage to public infrastructure, subsidence of the rehabilitated landform, as well as concern that mining may cause historic voids to collapse beyond the Project footprint.

Summary of findings

- The geotechnical investigation work completed for the Project builds on previous site investigations and operational experience to provide confidence in the assessment of potential impacts.
- Potential impacts relate to stability of the mine slopes, the TWRS, the final rehabilitated landscape post-closure, and historic voids within the pit area.
- Three-dimensional (3D) modelling has been undertaken to assess mine slope stability and potential impacts to surrounding infrastructure. This work suggests that overall pit slopes will remain stable, and that all buildings and infrastructure lie outside of strain and distortion limits suggested by the Society of Mining Engineers (SME) and so are unlikely to be affected.
- The potential for collapse of underground workings has been examined using 3D modelling and this suggests some localised collapse may occur within the Project area. This would affect small scale pit wall stability (which will be managed as an operational hazard) but is not predicted to extend far beyond the pit walls, so is unlikely to impact infrastructure.
- There is effectively no risk of longer term mine slope instability and degradation because the pits will be backfilled at closure.
- Stability analysis suggests that the TWRS and the final rehabilitated Big Hill landscape will remain stable.
- The mitigation measures outlined here are considered sufficient to reduce the risk of potential impacts to the community to acceptable levels.

8.9.2 Existing Conditions

A geotechnical assessment was conducted for the North and South Pits in 1999. The assessment at that time was based on information from a small number of geotechnical boreholes but was primarily based on the exposed faces of Davis Pit, which was open at the time.

The geotechnical investigation for this Project builds on the 1999 work with significant additional data collection and analysis, including data from 28 fully cored geotechnical boreholes totalling 1,840 metres, a comprehensive set of laboratory tests, geotechnical mapping, field observations, historical slope performance data and SGM’s geological models and information.
8 Environmental Impact Assessment

8.9.2.1 Characteristics of In-Situ Material
Details on the regional and local site geology are discussed in Chapter 4, Section 4.6.1.

The material to be mined is dominated by low-strength schists that are weathered to varying degrees in the pits. The ore zones and the area immediately surrounding them tend to have higher strength due to the presence of thick zones of blocky quartz, and quartz veining and replacement.

There is a fault zone in the western wall of the North Pit called the Cross Course Fault Zone. As the faults that make up the zone dip towards the northeast, the implications for in-pit mine slope stability in that area have been assessed and are discussed in the impact assessment.

8.9.2.2 Characteristics of Extracted Material
Waste rock will be generated during excavation of the North and South Pits. This will be made up of the natural in-situ rock that is not ore (schist) in various weathering conditions. Strength properties have been determined from the statistical range of values generated from logging and laboratory testing parameters of the rock.

Soil properties are important because the pits will be backfilled with a mixture of soil and waste rock, with the objective of creating a stable rehabilitated landscape. Testing indicates that the soils have low plasticity, very low swelling and shrinking potential, and compaction characteristics that are not significantly impacted by moisture content. However, some soils within the pit area have a high potential for erosion and dispersion. This is considered in the impact assessment.

8.9.3 Impact Assessment
Potential impacts of the Project have been assessed to determine the level of geotechnical risk to the community, infrastructure and mine operations. The assessment outcomes have been used to inform project design and management measures in order to provide safe and stable ground conditions during construction, operation, rehabilitation and post-closure.

The key potential impacts relate to stability of the mine slopes, the TWRS, the final rehabilitated landscape, and historic voids within the pit area. These are discussed below.

8.9.3.1 Mine Slope Stability

Assessment methodology
Mine slope stability has been assessed within the area known as the potential Geotechnical Risk Zone (GRZ) surrounding the North and South Pits. This location of this area in relation to key infrastructure is shown in Figure 8-64. The GRZ is the area defined by the limit of potentially significant ground movements resulting from mining activities. The boundaries of the GRZ were defined according to the Victorian guidelines: Guidance Material for the Assessment of Geotechnical Risks in Open Pit Mines and Quarries13 (Earth Resources, DSDBI).

The stability of potential sliding and failure surfaces within the GRZ is expressed in terms of factor of safety (FOS) and probability of failure (POF). FOS is a ratio of the forces that act to stabilise a system to the forces that act to destabilise it. A stable system has a FOS greater than 1.0, and a FOS of 1.5 implies that the slope is 50 per cent stronger than is required to prevent failure. POF is the probability that the FOS will be less than 1.0, which means the probability that the slope will fail. This is expressed in terms of probability because all natural materials in the environment have a range of characteristics, including rock strength.

The assessment was carried out as follows:

- initial 2D slope stability assessment along cross sections through the proposed pit slopes in order to inform more detailed 3D modelling
- 3D modelling using the software FLAC3D, in order to simulate the geological conditions (including fault structures), the North and South Pit slope designs, potential impact to historic voids, and potential damage to surrounding infrastructure
8 Environmental Impact Assessment

- risk assessment of potential impacts to infrastructure within the zone of FOS less than 2.0 (for public infrastructure) based on the modelling results.

A berm and batter assessment was also carried out to identify potential local stability issues within the pit area, including batter scale collapse and rock falls. However, this is only relevant to SGM operations and does not affect infrastructure.

The assessment was conducted in accordance with the Victorian guidelines referenced above. The outcomes of the assessment and the potential impacts to infrastructure are described below.

**Stability design acceptance criteria**

Slope stability risks need to be assessed quantitatively as the Victorian guidelines do not provide definitive FOS and POF targets for assessment for varying levels of exposure. Therefore, this assessment has used the commonly accepted, industry and regulatory standard acceptance criteria shown in Table 8-69 below. As shown in the table, the most stringent criteria apply to areas with public infrastructure. The most lenient criteria apply to the pit areas with no existing major infrastructure.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Minimum FOS</th>
<th>Maximum POF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall slope failure – any extent</td>
<td>1.3</td>
<td>3-5 %</td>
</tr>
<tr>
<td>Overall slope failure – affecting major infrastructure</td>
<td>1.5</td>
<td>1 %</td>
</tr>
<tr>
<td>Overall slope failure – affecting public infrastructure</td>
<td>2.0#</td>
<td>0.3 %</td>
</tr>
</tbody>
</table>

# This value applies to long-term post-closure periods where there is no ongoing monitoring. It is conservative in this case because the pits will be backfilled at closure.

**Assessment Results**

Numerical 3D modelling in FLAC3D was used to simulate the mining sequence and the effects of unloading on ground movement and wall stability. An example out of a series of modelling outputs for the Project is shown in Figure 8-65 below.
The modelling results show that FOS values generally meet or exceed minimum design criteria. However, the following issues are noted:

- Minor bench scale instability is predicted in the Cross Course Fault Zone, which will be managed as an operational hazard via the Ground Control Management Plan (GCMP).

- When an extreme worst case fault strength is used (Figure 8-64) to assess sensitivity of the west wall of North Pit (not observed in investigations), a multi-bench failure is predicted in the Cross Course Fault Zone. This would extend a small distance beyond the pit crest within the Project area and would not extend to any properties or infrastructure.
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- Isolated slope instability is predicted along the northern crest of the North Pit due to the presence of the underground voids.

All POF results also satisfy the design criteria (i.e. POF are below required thresholds). Furthermore, the POF is much less than 0.3 per cent for cases where the FOS is in the range of 1.5 to 2.0. Areas of public properties or infrastructure where the FOS is less than 2.0, and the POF is better than the design criteria, have been assessed as part of a formal risk assessment process.

The modelled FOS=1.5 and FOS=2.0 contours are shown in Figure 8-66.

Figure 8-66 Geotechnical risk zone and modelled factor of safety contours

A slope design profile has been prepared following the outcomes of this modelling. This is shown in Figure 8-67.
8.9.3.2 Potential Impacts to Infrastructure

The following infrastructure was considered as part of this assessment:

- properties along Upper Main Street and Fisher Street
- upper Main Street infrastructure including roads, water mains, power poles and gas pipelines
- GWMWater potable water tank 1 along the eastern wall of North Pit (although this will be taken out of service during the mining of North Pit).

For all cases modelled in FLAC\textsuperscript{3D}, the overall North and South Pit slopes are predicted to remain stable, with FOS values of 2.0 for both pits.

Minor instability is predicted where the Cross Course Faults intersect the southern limits of the North Pit, for the likely lower bound estimated fault strength. An extreme worst case fault strength would potentially lead to two areas of multi-bench instability within the North Pit, that would extend a small distance beyond the pit crest. This instability would remain within the Project area and would not impact on nearby properties or infrastructure.

Isolated slope instability is predicted along the northern crest of the North Pit which is caused by the presence of the underground voids. However, this is unlikely to extend beyond the pit boundaries. Localised void collapse within the pit will be managed as an operational hazard.

All buildings and critical infrastructure fall outside the likely horizontal strain and angular distortion damage limits suggested by the SME. This includes the GWMWater potable water tank 1 on the eastern wall of the North Pit (Figure 8-66).

Backfilling the pits at closure effectively remove any risk of longer term mine slope instability and degradation.
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8.9.3.3 TWRS Stability

A two-dimensional slope stability assessment of the TWRS was conducted using the software Rocscience Slide. Properties of the waste rock within the TWRS were assumed to be consistent and two groundwater cases were considered: unsaturated (as it is at present) and a perched water table at the ground surface (which could reduce the stability).

The stability design acceptance criterion for the TWRS is a FOS exceeding 1.5, based on a short-term structure that has the potential to impact infrastructure. The 2D modelling indicates that the FOS ranges from 1.7 to 2.5 for the preliminary TWRS design. Thus the facility meets slope stability design criteria.

Potential impacts to GWMWater water storage reservoir 7

The GWMWater water storage reservoir 7 raw water storage facility is located approximately 15 metres to the north of the TWRS at its closest point.

The results of the stability assessment indicate that large scale failure of the TWRS is extremely unlikely based on the current design. The TWRS will be kept at a FOS above 1.5 for the duration of the Project.

In addition, a bund will be maintained at the toe of the TWRS to provide a barrier for material that may escape during dumping activities or heavy rainfall. Due to the very low potential for large-scale failure of the TWRS, impacts to the GWMWater water storage reservoir 7 are considered unlikely and no further mitigation measures are considered necessary.

8.9.3.4 Rehabilitated Landscape Stability

The North and South Pits will be backfilled and rehabilitated in order to return the land use to recreational reserve. Public infrastructure, including the Pioneer Memorial and Rotunda, Dane Memorial Seat, Water Supply Memorial and Big Hill Road, will be reinstated in accordance with an End Use Master Plan. The North Pit, which includes the most visible section of Big Hill, will be reinstated first while the South Pit is being excavated.

Based on a series of laboratory tests on material extracted from geotechnical boreholes, a plan for filling and compaction has been prepared to enhance the stability of the final landscape and is discussed further in Chapter 10. The testing suggests that total settlement (the depth that material will move down) will be 1-2.6 metres. This total settlement includes settlement occurring while filling activity is still taking place and as such is not expected to impact the final land form to this degree. Up to 90 per cent of this settlement will be achieved within 18 months once backfilling is fully completed. The remaining 10 per cent will occur slowly over approximately 10 years.

The laboratory testing indicated that some soils are dispersive, which means that they have a higher potential to erode. The filling plan takes this into account by avoiding using these soils at the base of the pit (where there could be groundwater), and at the top of the pit where surface runoff could erode the soils. The surface layer of the rehabilitated Big Hill will consist of material that is more resistant to erosion.

Stability analysis on the steepest slopes of the final rehabilitated Big Hill suggests that the landscape will be very stable, with FOS values equal to or exceeding 2.0.
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Potential impacts to public infrastructure
Exiting infrastructure on Big Hill will be removed during the Project and reinstated following completion of backfilling of the North Pit, once settlement has reduced to an acceptable rate. There is a potential for settlement to impact the reinstated structures. Management and mitigation measures are discussed below.

8.9.3.5 Void Collapse
Underground workings (voids) from historic mining activity dating back to 1853 exist within and beneath the walls of the pits. These voids have the potential to impact the stability of the mine slopes, and so all known void locations were included in the FLAC3D mine slope stability modelling. To be conservative it was assumed that all voids have already collapsed and propagated to three times their original height.

The 3D modelling shows that localised collapse may occur and that this will affect pit wall stability on a local scale. However, influences are unlikely to extend beyond the pit boundaries and will remain within the Project area. Localised collapse within the pit will be managed as an operational hazard.

8.9.4 Management and Mitigation Measures
The results of the impact assessments described above have been used to establish management and mitigation measures to ensure public safety during construction, operation, rehabilitation and post-closure. These measures are described below.

8.9.4.1 Mine Slope Stability

Risk assessment
Risks associated with mining operations and potential impacts to infrastructure were examined via a formal risk assessment at SGM on 28 November 2013. Hazard control options arising from this risk assessment will be implemented prior to commencement of mining as part of a Ground Control Management Plan (GCMP). This is discussed further below.

Runoff control
Surface water will be directed away from pit walls so that it does not pond near wall crests or flow over walls.

Pit wall protection from blasting effects
If blasting is required, critical walls will be buffered from vibrations in order to limit rock mass disturbance and ensure crests are maintained. This can be achieved through cushion or buffer blasting, with the aim of limiting maximum blast vibrations within walls to less than 100 millimetres per second peak particle velocity. Critical walls are classed as final pit walls or interim walls that contain ramps or other infrastructure.
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Ground Control Management Plan
A GCMP will be prepared prior to mining operations. This will include:

- roles and responsibilities
- geotechnical hazard control processes at all stages of operation, including:
  - pit design implementation and verification
  - drainage and water control
  - void hazard management processes
  - wall sign-off processes
  - rock fall controls
- hazard control zones and exclusion zones
- monitoring and inspection requirements
- alarm response processes
- training requirements.

Mine slope stability monitoring and reporting
Mine slope stability and performance will be monitored throughout the Project as follows:

**Prism monitoring** will be carried out on pit walls. If high risk areas are encountered then this may be done using mobile automated monitoring stations that will send data to a central computer for processing.

**Radar monitoring** may be required from time to time if critical movements are detected.

**Deformation monitoring** of water tanks and along Upper Main Street will be conducted.

**Visual inspection** by a geotechnical engineer (or similar competent person) will be carried out daily at a minimum and more often if required (Figure 8-64).

The pits will be backfilled at closure, which means that there is effectively no risk of longer-term slope instability or degradation.

Table 8-70 Geotechnical monitoring and reporting schedule

<table>
<thead>
<tr>
<th>Description</th>
<th>How often</th>
<th>By whom</th>
</tr>
</thead>
</table>
| Geotechnical mapping                             | Data collection – as new areas are exposed  
Assessment and reporting – monthly               | Geotechnical engineer         |
| to assess actual conditions against expected conditions |                                        |                              |
| includes rock mass quality, weathering, and structures |                                        |                              |
| Mine slope stability and slope performance       | Data collection – daily and weekly 
Assessment and reporting – monthly               | Geotechnical engineer         |
| Geotechnical review                              | Three times during the Project*:       | External reviewer           |
| formal review of monthly reporting               | 1. North Pit during initial exposure of northern wall (Quarter 2-3) |                              |
| also review the GCMP and other observations and conditions | 2. North Pit completion (Quarter 5) |                              |
|                                                  | 3. South Pit near completion (Quarter 13) |                              |

* Quarters are estimates only and may change based on Project progress.
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8.9.4.2 Rehabilitated Landscape Stability

Settlement monitoring
Settlement of the final rehabilitated Big Hill will be monitored to ensure accurate prediction of the total settlement and its rate over time. This monitoring may be carried out using multipoint borehole extensometers extended to the bedrock and surface settlement points. The elevation of surface settlement points is typically read at three month intervals.

Engineering controls on reinstated public infrastructure
Along with the settlement monitoring, engineering controls will ensure the stability of reinstated public infrastructure on Big Hill. Enhanced compaction will be carried out in key areas prior to establishment of infrastructure. The Pioneer Memorial and Rotunda will be constructed on an engineer-designed rigid slab with adjustable footings to minimise the impact of long-term settlement, if required. If post-rehabilitation monitoring suggests that the time to reach total settlement is unacceptable, the structures can also be built on stronger pile foundation.

8.9.5 Conclusion
The significant geotechnical investigation work completed for this Project builds on previous investigations and operational experience to provide confidence in the assessment of potential impacts.

Detailed 3D modelling suggests that the North and South Pit overall slopes will remain stable, with FOS values of 2.0 for both pits. Some localised collapse of voids in and beneath the pit walls may occur and that this will affect pit wall stability on a small scale. However, influences are unlikely to extend beyond the pit boundaries. Localised collapse within the pit area will need to be managed as an operational hazard.

All buildings and critical infrastructure surrounding the pits fall outside the likely horizontal strain and angular distortion damage limits suggested by the SME, so are unlikely to be affected. However, monitoring will be carried out during mining operations to confirm this. Two-dimensional stability analyses suggest that the final rehabilitated Big Hill landscape will be very stable, with FOS values equal to or exceeding 2.0. The results also show that large scale failure of the TWRS is extremely unlikely.

It should be noted that due to the Project design there is effectively no risk of longer term mine slope instability and degradation, as the pits will be backfilled at closure.

Residual risks associated with mining operations and surrounding infrastructure will be managed via regular monitoring and review, and development of a GCMP.

The assessment is considered to be appropriately conservative for the nature of the Project and the proximity to public infrastructure. The mitigation measures are considered sufficient to reduce the risk of potential impacts to the community to acceptable levels.
8.10
Potable Water
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8.10 Potable Water

8.10.1 Introduction
This section of the EES describes and assesses the potential impacts of the Project on potable water quality and supply to the Stawell township; identifies measures to manage and mitigate potential adverse impacts and assesses overall impacts on potable water supply following implementation of the proposed management and mitigation measures.

This assessment is based primarily on information provided in:

- URS Australia Pty Ltd (2014), *Predicted Dust Impacts on GWMWater Reservoir - Stawell*, prepared on behalf of CGC for GWMWater
- URS Australia Pty Ltd (2013), *Big Hill Enhanced Development Project: Surface Water Assessment*, prepared for CGC.

These reports are included as Technical Appendices 10 and 11, respectively to this EES.

<table>
<thead>
<tr>
<th>Relevant sections of EES Scoping Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>This section of the EES covers the following components of the EES Scoping Requirements as they relate to potable water supply:</td>
</tr>
<tr>
<td><strong>4.7 Water</strong></td>
</tr>
<tr>
<td><strong>Draft Evaluation Objective</strong></td>
</tr>
<tr>
<td>To ensure that surface water and groundwater quality and potable water supply are adequately protected from adverse impacts arising from the project.</td>
</tr>
<tr>
<td><strong>Key issues</strong></td>
</tr>
<tr>
<td>Potential impacts on the potable water supply, particularly in Reservoir No. 7 due to run-off from the proposed temporary waste rock storage, and any downstream impacts on provision of potable water supply.</td>
</tr>
<tr>
<td><strong>Priorities for characterising the existing environment</strong></td>
</tr>
<tr>
<td>Describe the current town water supply in terms of the role of local storage reservoirs.</td>
</tr>
<tr>
<td><strong>Design and mitigation measures</strong></td>
</tr>
<tr>
<td>Identify the elements of the town water supply infrastructure to be decommissioned during the course of the project, and proposed measures to ensure the continued provision of a water supply of required quality over that period.</td>
</tr>
<tr>
<td>Describe the process for reinstatement or recommissioning of water supply infrastructure following the completion of mining activities.</td>
</tr>
<tr>
<td><strong>Assessment of likely effects</strong></td>
</tr>
<tr>
<td>Assess the risks of the project for the town water supply, including with respect to airborne matter and run-off as well as maintaining the structural integrity of infrastructure.</td>
</tr>
<tr>
<td><strong>Approach to manage performance</strong></td>
</tr>
<tr>
<td>Describe plans to deal with residual impacts or contingencies such as interruption of alternative sources of town water supply.</td>
</tr>
</tbody>
</table>
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- Describe monitoring programs to be implemented to ensure prompt detection of water supply or water quality issues with respect to potable water, surface water and groundwater.

Key issues emerging from EES studies and community consultation

The key issues that emerged from the community in the course of the EES investigations and as a result of the ongoing community engagement and communications program are:

- concern about the availability of sufficient water for dust suppression activities at the mine
- the drainage of the two water reservoirs adjacent to Big Hill could impact upon the security and or quality of Stawell’s water supply
- concern about the potential for dust generated by the Project to contaminate the water supply in GWMWater reservoirs
- the impact of the open cut mine will cause water prices to increase for Stawell residents.

Summary of findings

- SGM will not require any additional raw water from GWMWater as a result of the Project. The open cut mine will use less water than the underground mine uses in its current operations.
- Taking GWMWater water storage reservoir 4 and 6 off-line will result in a reduced raw water storage capacity for the gravity fed supply from the Fyans Creek during the Project, which will result in a potential increase in the amount of raw water that must be pumped from Lake Fyans.
- Surface water diversion drains, ponds and basins have been designed to manage flows from a 1 in 100 year Average Recurrence Interval (ARI) storm event so that it is highly unlikely that any surface water will discharge into GWMWater water storage reservoirs.
- Very low concentration additions of dust into the raw water supply are highly unlikely to result in non-compliance with the Australian Drinking Water Guidelines (ADWG), with the exception of iron and aluminium; however both of these metals will be removed during the water treatment process to ensure a safe reticulated water supply.
- It is proposed that heavy metal monitoring be conducted quarterly on the water entering the reservoirs and the influent to the water treatment plant (WTP) to assess whether there is any impact from the mine operations due to dust. The program will be reviewed annually to assess whether the sampling frequency or analyte list should be modified.
- Any costs associated with changes to infrastructure, increased pumping costs or water treatment costs will be covered by SGM through a commercial agreement with GWMWater with no increase in water prices to the Stawell community associated with this Project.
- It is highly unlikely that potable water quality and supply to the Stawell township will be impacted.

8.10.2 Existing Conditions

The existing GWMWater raw water system and treatment facilities are described in Chapter 4, Section 4.9.4 (and shown in Figure 4-7 and 4-8).
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**GWMWater Stawell water supply infrastructure**

The Stawell water supply system is located on the northern slopes of Big Hill, adjacent to the Project. These water supply assets include three raw water supply open storages (GWMWater water storage reservoir 4, 6 and 7), three potable water supply tanks (tank 1, 2 and 3), potable and raw water supply pipework and associated water supply infrastructure.

For the purposes of this chapter, the terms raw water, potable water and fresh water have been defined as follows:

- **raw water** – surface water run-off from the Grampians catchment that is stored in GWMWater storage reservoirs 4, 6 and 7 prior to treatment
- **potable water** – raw water that has been treated to Australian Drinking Water Guidelines (ADWG) and is fit for human consumption
- **fresh water** – water sourced from surface water run-off at SGM, underground mine dewatering and also raw water from GWMWater, that is used for industrial purposes on-site.

The GWMWater water supply assets and storage capacities are shown in Table 8-71 and their location in context of the Project is shown in Figure 8-68.

Table 8-71  GWMWater water supply and storage assets

<table>
<thead>
<tr>
<th>Water storage asset</th>
<th>Storage capacity</th>
<th>Type of water storage</th>
<th>Construction details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Bellfield</td>
<td>78.5 GL</td>
<td>Raw water from the Grampians catchment</td>
<td></td>
</tr>
<tr>
<td>Lake Fyans</td>
<td>18.5 GL</td>
<td>Raw water from the Grampians catchment</td>
<td></td>
</tr>
<tr>
<td>GWMWater reservoir 4</td>
<td>45.4 ML</td>
<td>Raw water storage for Stawell, prior to treatment at the WTP</td>
<td>Earthen, open storage</td>
</tr>
<tr>
<td>GWMWater reservoir 6</td>
<td>110 ML</td>
<td>Raw water storage for Stawell, prior to treatment at the WTP</td>
<td>Earthen, open storage</td>
</tr>
<tr>
<td>GWMWater reservoir 7</td>
<td>350 ML</td>
<td>Raw water storage for Stawell, prior to treatment at the WTP</td>
<td>Earthen, open storage</td>
</tr>
<tr>
<td>GWMWater tank 1</td>
<td>10 ML</td>
<td>Potable water storage servicing the majority of the Stawell township</td>
<td>Steel roofed clear water storage tank surrounded by an historic non-serviceable concrete lined dam</td>
</tr>
<tr>
<td>GWMWater tank 2</td>
<td>0.5 ML</td>
<td>Potable water storage servicing elevated properties within Stawell</td>
<td>Steel covered tank</td>
</tr>
<tr>
<td>GWMWater tank 3</td>
<td>0.16 ML</td>
<td>Potable water storage servicing elevated properties within Stawell</td>
<td>Concrete covered tank</td>
</tr>
<tr>
<td>AquaTower WTP</td>
<td></td>
<td>15 ML/day processing capacity of raw water to potable water</td>
<td></td>
</tr>
</tbody>
</table>
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Existing potable water quality and usage

Water supplied from Fyans Creek typically has a total dissolved solids (TDS) concentration of 51 milligrams per litre (mg/L), while that from Lake Fyans is slightly higher at 140 mg/L.

TDS consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides and silica, fine enough to pass through a 0.45 micron filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise: sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate, nitrite and phosphates.

While no specific health guideline value is provided for TDS, as there are no health effects directly attributable to TDS, World Health Organization guidelines recommend that for good palatability, total dissolved solids in drinking water should not exceed 600 mg/L while levels in excess of 1,200 mg/L are unacceptable for human consumption.

In major Australian cities, TDS values can range from below 100 mg/L to more than 750 mg/L; regional supplies can have TDS values up to 1,000 mg/L and some rural and remote communities may have TDS in excess of 1,000 mg/L, owing mainly to groundwater characteristics. In this context, the quality of the raw water treated at the AquaTower Water Treatment Plant is considered to be relatively high-quality.

No data was provided by GWMWater for suspended solids in the raw water, however as discussed below, the impact of dust as suspended solids is minimal.
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Figure 8-68  Grampians Wimmera Mallee Water and AquaTower (water treatment) existing facilities
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According to the GWMWater 2012-13 annual report, the Stawell area consumed 1,315 megalitres of water over the 2012-13 financial year. This includes industrial and concessional users, non-residential and municipal, and residential users as shown in Table 8-72 below.

<table>
<thead>
<tr>
<th>Water use (ML)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial and concessional</td>
<td>546.9</td>
</tr>
<tr>
<td>Non-residential and municipal</td>
<td>162.6</td>
</tr>
<tr>
<td>Residential</td>
<td>605.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1315.0</td>
</tr>
</tbody>
</table>

The Stawell average daily water consumption is approximately 3.6 megalitres per day with a peak day demand of eight megalitres per day.

**SGM raw and potable water demand**

SGM uses fresh water on site (which includes raw water from GWMWater) for underground mining (including drilling, dust suppression and concreting), for above ground dust suppression and for processing activities. SGM has an existing Supply by Agreement with GWMWater for 365 megalitres per year of raw water. The average raw water use by SGM over the past 10 years is 220 megalitres per year, although since 2009 this has been reduced to approximately 88 megalitres per year. The reduction in raw water usage is due to the establishment of the processing plant’s return water protocol which balances the amount of process water that can be reused in the processing plant by the ore type. This protocol will continue to be in place during the Project.

SGM also use potable water supplied by GWMWater for staff amenities. For potable water use, SGM is classified as a commercial industrial customer and pays per kilolitre of potable water that they use in addition to service charges.

**AquaTower potable water treatment plant**

AquaTower operates the Stawell WTP under a 25-year Build, Own, Operate and Transfer (BOOT) Scheme. The WTP was commissioned in 2000 and has a capacity of 15 megalitres per day.

The WTP uses a treatment process that includes coagulation, flocculation, dissolved air flotation, multimedia filtration, disinfection and pre and post pH correction to treat raw water stored in the GWMWater water storage reservoirs (4, 6 and 7). This potable water is tested to ensure that it meets ADWG.

Turbidity is a measure of water clarity or of how much the material suspended in water decreases the passage of light. Turbidity is therefore a measure of the amount of sediment and organic material in a volume of water.
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Raw water from Lake Fyans and the Bellfield Reservoirs typically has a turbidity measure of about 12 nephelometric turbidity units (NTU). In an extreme dust event, dust deposited onto reservoirs may increase turbidity by one or two NTU. The WTP is able to treat water with a turbidity of up to 200 NTU. In recent years, flood and bushfire events have resulted in turbidity levels of greater than 100 NTU in GWMWater water storage reservoirs which is still well within the treatment capability of the WTP and was treated by the WTP without impact on potable water supply.

8.10.3 Impact Assessment

The potential impacts of the Project (including mining, haulage, stockpiling and backfilling activities) on the potable water supply have been assessed and plans have been developed to ensure continuity of water supply and water quality for the Stawell township. SGM will enter into a contractual agreement with GWMWater that will ensure that there are no short or long term impacts on water supply or infrastructure.

Assessment of potential impacts on GWMWater assets

The following GWMWater assets will be impacted by the Project due to their proximity to the North and South Pits and the following actions are required:

- install temporary potable water tanks (refer to Chapters 5 and 6)
- decommission the existing potable water supply tank 3 and associated infrastructure
- drain the potable water supply tank 2 so that it is out of service prior to the commencement of mining activities
- take the Byrne Street pump and associated infrastructure out of service for the duration of the Project
- drain the GWMWater potable water tank 1 so that it is out of service for the duration of mining and backfilling of the North Pit
- construct surface water management infrastructure (drainage channels, sediment basin, flood pond and bunding) along the north side of the TWRS to prevent surface water run-off or slump into GWMWater water storage reservoir 7 and the west side of GWMWater water storage 4 and 6 to direct surface water flow away from the reservoirs
- drain GWMWater water storage reservoir 4 so that it is out of service during the mining and backfilling of North Pit
- drain GWMWater water storage reservoir 6 so that it is out of service during the mining and backfilling of South Pit
- construction of a 375 millimetre supply pipe from the water treatment plant to the temporary potable water storage tanks. This would enable the existing 375 millimetre pipe to be plumbed to enable supply directly from the raw water supply when GWMWater water storage reservoir 4 and 6 are offline should GWMWater water storage reservoir 7 need to be taken offline for any reason.

All of these assets will need to be taken offline for either some or all of the Project duration and alternative supply and storage arrangements will be implemented if the Project proceeds to ensure continuity of water supply and quality to the Stawell community. These are discussed in Chapter 6 and in Section 8.10.4.
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The potential impacts of the Project on the following aspects of potable water supply have also been assessed and are discussed below:

- SGM raw and potable water demand
- raw water supply (including raw water supply quality and pumping)
- raw water storage quality impacts from dust (including GWMWater water storage reservoir 7)
- raw water storage quality impacts from stormwater run-off.

**SGM raw and potable water demand**

If the Project proceeds, SGM will continue to use potable water for staff amenities and fresh water (which includes raw water) in the processing plant and to supplement water captured on site for dust suppression. Underground mining water consumption has already reduced considerably as operations are now in the remnant phase of mining.

Additional fresh water will be available for dust suppression and processing as a greater proportion of the catchment surface water run-off will be collected during the Project (as discussed in Section 8.11). This means that the current raw water entitlement from GWMWater will be sufficient to meet the water requirements for the Project. There will be no additional raw or potable water requirements from SGM as a result of the Project proceeding and, in fact, the SGM demand for raw and potable water may decrease when compared with the current demands from underground mining. Irrespective of constant or reducing water demands by SGM, adequate potable water will be available to meet the requirements of the Stawell township.

**Assessment of potential impacts on raw water supply**

During mining operations for the Project, two of the three water storage reservoirs (Figure 8-68) supplying Stawell will be drained and taken out of service (or off-line). This will be undertaken in a staged approach that corresponds with the staged mining and backfilling of the North Pit and South Pit with:

- GWMWater water storage reservoir 4 off-line during mining and backfilling of North Pit
- GWMWater water storage reservoir 6 off-line during mining and backfilling of South Pit.

Each reservoir will be drained and remain in-situ for re-commissioning at the end of the stage.

GWMWater water reservoir 7 will remain on-line throughout the Project. The duration and potential impacts on the combined raw water storage is shown in Table 8-73.
Table 8-73  GWMWater raw water storage reservoir capacity at various stages of the Project

<table>
<thead>
<tr>
<th>Stage</th>
<th>Combined raw water storage (ML)</th>
<th>Schedule</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>505</td>
<td>-</td>
<td>Includes reservoirs 4, 6 and 7</td>
</tr>
<tr>
<td>North Pit works</td>
<td>460</td>
<td>Quarter 1 – 9(^1)</td>
<td>Reservoir 4 off-line</td>
</tr>
<tr>
<td>North Pit and South Pit overlap</td>
<td>350</td>
<td>Quarter 5 – 9(^1)</td>
<td>Reservoir 4 and 6 off-line</td>
</tr>
<tr>
<td>South Pit</td>
<td>395</td>
<td>Quarter 5 – 20(^2)</td>
<td>Reservoir 6 off-line</td>
</tr>
<tr>
<td>Post Project</td>
<td>505</td>
<td>-</td>
<td>Includes reservoirs 4, 6 and 7</td>
</tr>
</tbody>
</table>

\(^1\) includes Year 2
\(^2\) includes Year 5

The main potential impact of taking GWMWater water storage reservoirs 4 and 6 offline at different stages of the mining operation is the reduced storage potential available to GWMWater and any associated risk to surety of supply. However, involvement of GWMWater in this issue indicates that the reduced storage potential can be offset by additional and more frequent pumping of raw water from Lake Fyans to maintain supply in the remaining storages.

Increased costs associated with pumping, and possibly water treatment, as a result of the Project will be covered by a contractual agreement between SGM and GWMWater so that there will be no increase in water costs to customers.

Assessment of potential impacts on raw water quality from dust

Impacts of dust deposition on GWMWater water storage reservoirs

Due to the proximity of the mining pits to the GWMWater water storage reservoirs (Figure 8-68), there is the potential for dust from mining operations and transport of materials to be deposited in the water storage reservoirs and surrounding catchments. An assessment of the potential impact of dust deposition on the GWMWater water storage reservoirs (4, 6 and 7) has evaluated the potential impacts on the quality of raw water prior to undergoing treatment at the WTP. This initial assessment followed a conservative approach to establish whether dust will result in non-compliance with the ADWG.

Table 8-74 presents a summary of the storage characteristics for each reservoir used as a basis for the assessment of dust deposition impacts.

Table 8-74  Storage characteristics of GWMWater raw water storage reservoirs 4, 6 and 7

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Volume (ML)</th>
<th>Approx. surface area of reservoirs (m^2)</th>
<th>Approx. surface area of reservoirs plus associated catchments (m^2)</th>
<th>Nominal Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir 4</td>
<td>45.4</td>
<td>7,601</td>
<td>18,010</td>
<td>6.1</td>
</tr>
<tr>
<td>Reservoir 6</td>
<td>110</td>
<td>21,887</td>
<td>39,420</td>
<td>6.1</td>
</tr>
<tr>
<td>Reservoir 7</td>
<td>350</td>
<td>53,441</td>
<td>84,620</td>
<td>7.5</td>
</tr>
</tbody>
</table>
Dust deposition has been modelled for Year 2 and Year 5 of the Project. These are the years in which there will be maximum movement of materials that have the potential to generate elevated particulate matter (or sediment). Air quality modelling assumptions and results are discussed in detail in Section 8.7. Water quality data from the current storages were used to establish baseline conditions for assessing the additive effects of dust deposition from the Project.

The assessment consisted of first calculating the annual average dust deposition into the reservoirs. The predicted average dust deposition rate was based on the sum of:

- the existing background dust monitoring (1.4 g/m²/month) based on data from two monitoring stations located adjacent to the Project area (refer to Section 8.7 for details of these locations)
- the predicted dust deposition from the Project (during Year 2 and Year 5)

The dust deposition rate together with the water flow rate was used to obtain a concentration of dust per litre of water.

With this concentration, data from recent soil and rock samples at SGM (collected in July 2013) were then used to estimate the concentrations of selected heavy metals.

The assessment has been based on the following assumptions:

- the flow of water into the reservoir equals the flow of water out of the reservoir, therefore representing constant surface area
- during Year 2 only reservoir 7 is in service
- during Year 5 reservoirs 4 and 7 are in service
- the surface areas of reservoirs include the stormwater catchments were used for these calculations
- steady state conditions for dust deposition, mixing and water flow from the reservoirs to the water treatment plant
- the average daily water demand of 3.8 megalitres per day is assumed to be the influent to the WTP).

Predicted heavy metal concentrations in the reservoir outflow prior to any treatment based on the existing water quality data and the predicted additive concentrations from dust associated with mining are presented in Table 8-75 and are compared to ADWG (where available).

Table 8-75 Comparison of heavy metals concentrations (mg/L) in GWMWater reservoir outflows and dust deposition (mg/L) compared to ADWG values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ADWG values (mg/L)</th>
<th>Annual average (mg/L)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Health</td>
<td>Aesthetic</td>
<td>Year 2</td>
<td>Year 5</td>
</tr>
<tr>
<td>Total dust (as suspended solids)</td>
<td>2.39&lt;sup&gt;1&lt;/sup&gt;</td>
<td>2.09&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>0.1</td>
<td>0.0005</td>
<td>0.0005</td>
<td></td>
</tr>
<tr>
<td>Aluminium</td>
<td>0.2&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.2387&lt;sup&gt;3&lt;/sup&gt;</td>
<td>0.2351&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.01</td>
<td>0.0017</td>
<td>0.0015</td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td>4</td>
<td>0.0300</td>
<td>0.0300</td>
<td></td>
</tr>
</tbody>
</table>
The findings indicate that all concentrations are predicted to be below the ADWG values, with the exception of aluminium and iron for aesthetic values. It should be noted that the aluminium criteria is acid soluble aluminium and the analyses are for total aluminium. This adds a degree of conservatism to the analysis as acid soluble aluminium will be less than total aluminium. Table 8-76 shows the predicted impact of the Project on aluminium, iron.

### Table 8-76 Predicted Project impacts on aluminium and iron in raw water

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Lake Fyans concentration (mg/L)</th>
<th>Estimated increase due to Project (mg/L)</th>
<th>Total concentration (mg/L)</th>
<th>ADWG criteria (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>0.21</td>
<td>0.029</td>
<td>0.239</td>
<td>0.2</td>
</tr>
<tr>
<td>Iron</td>
<td>0.36</td>
<td>0.145</td>
<td>0.505</td>
<td>0.3</td>
</tr>
</tbody>
</table>

These results demonstrate that the raw water does not comply with the ADWG guidelines for these metals. However, the expected increase as a result of the Project is minimal. Similarly the contribution of suspended solids (dust) is minimal. The expected concentrations of these three parameters are well within the capacity of the treatment plant, ensuring a safe reticulated water supply.
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Assessment of potential impacts to raw water quality from surface water flows

Surface water run-off along the haul road and TWRS will be managed via a series of drainage channels, flood ponds and sediment basins. Surface water management infrastructure has been designed to carry the maximum expected flows based on a 1 in 100 year Average Recurrence Interval (ARI) peak flow as discussed in detail in Section 8.11.

The geotechnical stability of the TWRS is discussed in Section 8.9 and the potential for slump has been mitigated by the factors of safety used in the design of the TWRS and the buffer distance between the toe of the stockpile and the reservoir.

On this basis, release of contaminated runoff or waste rock to GWMWater water storage reservoirs is considered to be highly unlikely.

8.10.4 Management and Mitigation Measures

The following sections describe the management and mitigation measures that have been developed in consultation with GWMWater to maintain the continuity and quality of potable water supply to the Stawell township. The detailed design for the asset relocation will be completed if the Project is approved to proceed and the proposed arrangements are discussed in detail in Chapter 6.

Water quality

As outlined above, the Project is expected to result in only minimal increases in suspended solids and heavy metals concentrations as a result of dust entering water storages. Aluminium and iron concentrations resulting from modelled dust deposition may exceed ADWG guidelines prior to treatment; however both of these metals will be removed during the water treatment process to ensure a safe reticulated water supply.

The Project is similarly unlikely to have an adverse impact on turbidity levels of the potable water supply. Raw water from Lake Fyans and the Bellfield Reservoirs typically has a turbidity measure of about 12 NTU, which may increase by one or two NTU in the event of an extreme dust event, which is well within the treatment capability of the WTP.

Heavy metal monitoring be conducted quarterly on the water entering the reservoirs and the influent to the water treatment plant (WTP) to assess whether there is any impact from the mine operations due to dust. The program will be reviewed annually to assess whether the sampling frequency or analyte list should be modified.

Continuity of water supply

Continuity of water supply will be assured for the duration of the Project despite reduced storages by additional pumping from Lake Fyans to top-up remaining reservoirs.

Installation, relocation and decommissioning of GWMWater assets

If the Project proceeds, a temporary potable water supply system (including two temporary 5 megalitres tanks (or equivalent) and associated pump and piping infrastructure) will be installed (refer to Chapter 5, Section 5.7.6 and Figure 5-6). The pump system will be capable of servicing both the high elevation and lower elevation properties in Stawell and also provide backwash to the WTP if required. Additionally, the SGM raw and potable water supply pipelines will require modification.
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Management of changes to GWMWater assets
The proposed changes to the potable water supply system will be installed and commissioned prior to decommissioning the existing potable water infrastructure to maintain continuity of supply.

Management of taking GWMWater assets off-line and recommissioning
The condition of GWMWater assets that are taken out of service during the Project will be assessed prior to the Project commencing, after being drained and prior to bringing them back into service.

Additionally, any dust deposited on GWMWater water storage reservoirs 4 and 6 will be removed prior to recommissioning to ensure no unacceptable water quality impacts.

Any areas affected by the Project shall be reinstated to a condition that is satisfactory to GWMWater and/or the land manager. This will be managed by a contractual agreement between SGM and GWMWater.

8.10.5 Conclusion
Assessments of the potable water supply have considered GWMWater raw and potable water storage, treatment and supply requirements. Results show that water supply can be effectively managed such that there is no disruption to potable water supply to the Stawell township and no adverse impacts on water quality. If the Project proceeds, new infrastructure will be installed and commissioned prior to existing assets being taken out of service or decommissioned to maintain continuity of supply.

The Project design has considered the management of surface water within the site boundary and the minimisation of dust and other impacts. The assessment of potential impacts from dust generated by the Project has concluded that it is highly unlikely that the Project will result in non-compliance of raw water with ADWG with the exception of iron and aluminium (aesthetic values). However, the expected concentrations of these parameters are well within the capacity of the treatment plant. Metals and suspended solids will be removed during the water treatment process to ensure a safe reticulated water supply.

Taking GWMWater water storage reservoir 4 and 6 out of service will result in a reduced raw water storage capacity during the Project, which will result in a potential increase in the amount of raw water that must be pumped from Lake Fyans. Any additional pumping or water treatment costs associated with increased dust or sediment will be met by SGM.

The condition of GWMWater infrastructure that is taken out of service during the Project (such as tanks, pumps and reservoirs) will be assessed prior to and after the Project to ensure that it is returned in a similar condition.

The above assessment of potential impacts and the measures proposed to mitigate these potential impacts demonstrate that potable water quality and potable water supply to the Stawell township will not be impacted by the Project and that compliance with relevant water quality guidelines and requirements can be readily achieved.
8.11 Surface Water
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8.11 Surface Water

8.11.1 Introduction
This section of the EES describes the surface water environment of the Project area and adjacent land; identifies potential impacts of the Project on surface water; identifies measures to manage and mitigate potential adverse impacts and overall impacts on surface water following implementation of the proposed management and mitigation measures.

This assessment is based primarily on information provided in:

- URS Australia Pty Ltd (November, 2013), Big Hill Enhanced Development Project: Surface Water Assessment, prepared for CGC

This report is included in Technical Appendix 11 to this EES.

### Relevant sections of EES Scoping Requirements

This section of the EES addresses in part the following requirements of the EES Scoping Requirements:

#### ‘4.7 Water

**Evaluation Objective**

To ensure that surface water and groundwater quality and potable water supply are adequately protected from adverse impacts arising from the project.

**Key issues**

- Potential impacts on the potable water supply, particularly in Reservoir No. 7 due to run-off from the proposed temporary waste rock storage, and any downstream impacts on provision of potable water supply.

**Priorities for characterising the existing environment**

- Describe the current town water supply in terms of the role of local storage reservoirs.

**Design and mitigation measures**

- Identify the elements of the town water supply infrastructure to be decommissioned during the course of the project, and proposed measures to ensure the continued provision of a water supply of required quality over that period.
- Describe the process for reinstatement or recommissioning of water supply infrastructure following the completion of mining activities.

**Assessment of likely effects**

- Assess the risks of the project for the town water supply, including with respect to airborne matter and run-off as well as maintaining the structural integrity of infrastructure.

**Approach to manage performance**

- Describe plans to deal with residual impacts or contingencies such as interruption of alternative sources of town water supply.
- Describe monitoring programs to be implemented to ensure prompt detection of water supply or water quality issues with respect to potable water, surface water and groundwater.'
8 Environmental Impact Assessment

Key issues emerging from EES studies and community consultation:
The key issue that emerged from the community in the course of the EES investigations and as a result of the ongoing community engagement and communications program are:

- concern about erosion caused by surface water run-off impacting on adjacent residential properties if not properly managed.

Summary of findings

- all surface water within the Project area can be managed effectively during mining operations and once the Project area has been reinstated so that there is no impact on the surrounding environment
- clean water run-off from external catchments will be diverted away from the Project area via the use of channels to the council drainage system or natural environments
- during mining all surface water run-off from disturbed areas will be contained within the Project area and reused for dust suppression and for ore processing
- a water balance model was used to assess the flood storage volumes and confirmed that existing SGM storage dams have sufficient capacity to manage surface water run-off
- integrated erosion control and sediment management will be required to capture sediment from surface water run-off during and post mining operations to ensure impacts are within regulatory requirements
- a flood storage basin and a sediment basin will be required downstream of the TWRS to capture sediment and provide flood storage to protect the environment from overflows (refer to Figure 8-73 through to Figure 8-77 in this section)
- rainfall run-off from the rehabilitated site can be effectively treated via vegetated channels and sediment basins to a suitable quality prior to connection to the existing drainage network
- the stormwater management channels and basins will remain in place until vegetation is established on the rehabilitated landforms and the water quality is tested to ensure that the run-off from revegetated areas is of similar or better quality to that of the surrounding natural run-off.

8.11.2 Existing Conditions

Existing water catchment area

The surface water run-off from Big Hill that flows naturally towards the northeast is either collected in GWMWater water storage reservoirs or conveyed via open channel drains adjacent to the reservoirs. The run-off discharges at a paddock adjacent to GWMWater water storage reservoir 7 and continues to flow northeast. Creeks to the northeast drain into larger surface water features, such as Concongella Creek to the east of the site which is a tributary of the Wimmera River, and eventually discharges northwest towards the Murray Basin.

The portion of the Project area that falls to the southwest is generally bound by residential properties. This side of Big Hill is well vegetated and clean surface water run-off is collected into existing open drains along Scenic Road and eventually discharges into the local NGSC drainage network.
An existing retarding basin owned by NGSC is located at the corner of Albion Road and Duke Street. Surface water run-off from this retarding basin catchment is captured in the Albion Road basin. The basin retards the larger flows before discharging into the local NGSC drainage network. Run-off that is captured in the basin is reused by the adjacent school for irrigation.

Figure 8-69 below shows the existing surface water drainage and collection features of the site.
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Existing SGM water management infrastructure

SGM has three water storage dams (dam 1, 2 and 5) that are currently used for on-site water management as shown in Table 8-77 and in Figure 8-70.

<table>
<thead>
<tr>
<th>Storage</th>
<th>Water source</th>
<th>Water uses</th>
<th>Capacity (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam 1</td>
<td>Underground mine dewatering, rainfall run-off and raw water</td>
<td>Processing plant circuit water</td>
<td>49*</td>
</tr>
<tr>
<td>Dam 2</td>
<td>Underground mine dewatering, rainfall run-off, excess GWMWater water storage reservoir overflow and purchased water</td>
<td>Reuse on-site</td>
<td>250</td>
</tr>
<tr>
<td>Dam 5</td>
<td>Underground mine dewatering, rainfall run-off</td>
<td>Secondary processing plant circuit supply</td>
<td>360</td>
</tr>
</tbody>
</table>

* Currently there is a bund located in the middle of dam 1 which reduces the storage capacity to 20 ML.

Surface water is collected and stored on-site where it is reused in the processing plant and for dust suppression around the site and for the underground haul roads. SGM also has a raw water entitlement of one ML/day from GWMWater which is stored in dam 2 and used in the process plant. There are pumping arrangements from dam 2 to dam 1 and from dam 1 to dam 5 to manage water storage and supply at the mine. The existing water storage infrastructure is shown in Figure 8-70.

Figure 8-70 Existing SGM water storage infrastructure
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**Site Hydrology**

The long term climate statistics for Stawell (from 1 Jan 1900 to 27 May 2013) is shown in Table 8-78 and Table 8-79 below.

**Table 8-78  Long-term rainfall statistics for Stawell (commencing 1900)**

<table>
<thead>
<tr>
<th></th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average (mm)</td>
<td>28.1</td>
<td>30.9</td>
<td>28.9</td>
<td>36.7</td>
<td>53.9</td>
<td>60.3</td>
<td>62.3</td>
<td>61.9</td>
<td>55.5</td>
<td>49.9</td>
<td>38.6</td>
<td>33.4</td>
<td>540.3</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>39.1</td>
<td>33.5</td>
<td>28.4</td>
<td>29.7</td>
<td>33.3</td>
<td>34.5</td>
<td>28.5</td>
<td>32.2</td>
<td>34.0</td>
<td>31.7</td>
<td>29.3</td>
<td>27.6</td>
<td>136.6</td>
</tr>
</tbody>
</table>

*Source: SILO – an enhanced climate database hosted by the Queensland Government Department of Science, Information Technology, Innovation and the Arts (DSITIA)*

**Table 8-79  Long-term evaporation statistics for Stawell (commencing 1900)**

<table>
<thead>
<tr>
<th></th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average (mm)</td>
<td>183.1</td>
<td>147.9</td>
<td>117.0</td>
<td>67.8</td>
<td>37.3</td>
<td>23.5</td>
<td>27.6</td>
<td>47.6</td>
<td>75.8</td>
<td>114.1</td>
<td>141.6</td>
<td>171.8</td>
<td>1155.1</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>11.7</td>
<td>10.0</td>
<td>7.5</td>
<td>5.9</td>
<td>3.0</td>
<td>1.9</td>
<td>1.9</td>
<td>3.9</td>
<td>6.1</td>
<td>9.2</td>
<td>11.0</td>
<td>12.4</td>
<td>72.3</td>
</tr>
</tbody>
</table>

*Source: SILO – an enhanced climate database hosted by the Queensland Government Department of Science, Information Technology, Innovation and the Arts (DSITIA)*

This information shows that in general Stawell climate is dry in summer and wet in winter. On average, the evaporation rate is higher than rainfall except during the months of May through to August. The data also indicate that there is significant variability in annual rainfall during the past 112 years which ranges from 230 to 900 mm/year. During some months, additional raw water (from the GWMWater raw water allocation) may be required to meet dust suppression requirements.

8.11.3 Impact Assessment

8.11.3.1 Water Balance Model

The objectives for surface water management are to:

- Contain all surface water run-off from disturbed areas (such as the pits, haul roads and TWRS) within the site i.e. no discharge of surface water off-site. This means that any rainfall is required to be collected and stored in on-site water storage dams.

- To reuse the collected surface water for dust suppression and for ore processing.

A water balance model (model) was developed to assess the adequacy of the current on-site water storage capacity to manage surface water collected from the Project area. It has been used to validate that the management and mitigation strategies developed for surface water are achievable, and that impacts can be managed within required guidelines to ensure no off-site impact.
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The model included the North Pit, South Pit, dam 1, dam 5 and the proposed flood storage basin 2 (FSB2) located next to the TWRS, which will be adjacent to the GWMWater water storage reservoir 7. For each catchment, it was assumed that water entered the catchment through direct rainfall and catchment run-off; and left through evaporation and reuse.

A conceptual model of North Pit, South Pit, dam 1, dam 5, FSB2 and the interaction between these storages and pits is presented in Figure 8-71 below. This figure shows that dam 1 will receive collected surface water from the North and South Pits and FSB2, which will be used in the processing plant or for dust suppression. When dam 1 is full, water will flow (by gravity) to dam 5, where it can also be pumped back to dam1 for reuse as needed.

The pumping rates for the water transfer between the water storages shown in Figure 8-71 were optimised to provide a balance between required storage capacity and realistic pumping rates.

Figure 8-71 Conceptual model of the water balance undertaken for the Project
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Modelling results

The model was developed using the GoldSim™ software package, a graphical object-oriented modelling environment with a capacity to carry out dynamic probabilistic simulations.

Model simulations were run on daily time steps over a period of five years with randomly selected start dates (controlled by annual periodicity). The modelling was based on Monte Carlo simulation generated using 112 years of historical climatic data (SILO data) at Stawell. This method of simulation allows the results to be presented as a probability distribution. Sufficient runs (112 realisations14) were modelled to ensure that periods of known flooding were modelled including the September 2010, January 2011 and December 2011 storms there were considered to be in excess of a 100 year average recurrence interval (ARI) storm event.

The GoldSim modelling results (presented in Technical Appendix 11) demonstrate that there is less than 0.01 per cent probability that overflows would occur from the storages and the maximum volume stored in dam 5 would be less than 100 megalitres (or less than one third of its capacity (360 megalitres)). As dam 5 acts as backup water storage when dam 1 is full, the results provide confidence that there is sufficient capacity to manage surface water on-site.

8.11.4 Management and Mitigation Measures

The objective of the surface water assessment is to effectively manage all surface water run-off within the Project during operations and rehabilitation so that there is no impact on the surrounding environment. The following section describes how surface water will be managed at each stage of the Project and the key infrastructure (drainage channels, sediment basins, flood basin and pumps) that are required.

8.11.4.1 Surface Water Management

The implementation of surface water management measures for the Project will be undertaken in several stages to correspond with the progressive development of the mining operations and the progressive site rehabilitation.

Site preparation

Prior to commencing mining, sediment and erosion control measures will be put in place in accordance with an approved Environmental Management Plan (EMP). Sediment basins, flood storage basins and open drainage channels will be constructed (Figure 8-72).

Drainage channels will divert surface water run-off from undisturbed areas away from the Project area as per the current conditions. An open drainage channel (channel 1) will be constructed along the haul road to divert surface water containing sediment away from GWMWater water storage reservoir 4 and 6 to dam 1 for storage and reuse. The channel will continue along the haul road, but downstream of dam 1, run-off will be collected in small sediment basins adjacent to the channel for transfer to dam 5. All channels are designed for a 100 year peak flow and the flood storage basin is designed to capture the maximum flood volume, based on the past 112 years of local rainfall data.

14 A realisation is defined as a single model run within a Monte Carlo simulation.
Although not all basins and channels are required until the backfilling and rehabilitation stages, the early construction of these will provide contingency in the highly unlikely event that any surface water breaches the pit boundaries. Early establishment is also sound practice as vegetated basins and channels provide more effective water treatment.

![Figure 8-72](image)

**Figure 8-72** Location of proposed sediment and flood storage basins for the Project

**Stores area**
As part of the Project, the DEPI fire watch building and communications tower will be relocated to the SGM stores area. Surface water around the new site will be collected and conveyed via gravity drainage pipes to the drainage channel (channel 1) adjacent to the nearby haul road. This will carry surface water run-off to dam 1 for storage and reuse.
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Surface water run-off from the access road will be collected via a roadside drain and flow by gravity to small sediment basins along the access track. The treated run-off will discharge to the existing Retarding Basin owned by NGSC. The steepness of the access track may impact the velocity of water in the roadside channel and if required, rock checks will be installed to managed flow velocity and prevent erosion.

Temporary waste rock stockpile

The TWRS area is bounded by the haul road to the south, GWMWater water storage reservoir 7 to the northwest, and Crowlands Road on the northeast. Figure 8-73 shows the layout of the surface water management infrastructure for the TWRS.

Surface water from the stockpile will be managed via drainage channels 2 and 3 along the toe of the stockpile. On the north side, there will be 15-20 metres between the toe of the stockpile and the toe of water reservoir number 7 and on the south side of the stockpile there will be approximately 10 metres between the stockpile toe and the property boundary. The drainage channels direct flow to the northeast side of the stockpile (adjacent to Crowlands Road) to sediment basin 2 (SDB2) to remove sediment from low flows and to flood storage basin 2 (FSB2).

The drainage channels will have 4–6 metre top widths and 0.4-0.7 metre depths and have been designed to carry the maximum expected flows based on a 100 year peak flow. The last 100 years of data include the significant storm events of September 2010, January 2011 and December 2011 that were considered to be greater than a 100 year ARI storm. On this basis, release of contaminated run-off from the Project area or to GWMWater water storage reservoir 7 is considered to be highly unlikely.
Figure 8-73  Surface water management around the temporary waste rock stockpile
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**Mining and backfilling**

During mining operations, all stormwater run-off within the pits will be directed by gravity to mobile collection sumps that are positioned at the low points of the North Pit and South Pit. The storage capacity of the sumps has been designed to contain run-off for up to a peak 100 year ARI storm event. Even in the unlikely event that the sumps overflowed into the pit (as they have been designed for a 100 year storm event), this is not deemed a risk in terms of off-site contamination or flooding as surface water will be contained within the pit. Water run-off that is collected in the sumps will be used for in-pit dust suppression and excess water will be pumped to dam 1. Water from dam 1 will be used within the processing plant and for dust suppression. Once dam 1 reaches capacity, it will overflow to dam 5. Sediment collected in the sumps will be periodically cleaned out to maintain the capacity of the sumps.

It is expected that some surface water will infiltrate the ground through cracks, voids and existing shafts. Groundwater levels and quality will not be impacted due to the localised groundwater depression from underground mining which means that the water table in the area is at great depth as discussed in more detail in Section 8.12.

During backfilling, ponding of water in the pits will be managed by grading and establishing sumps to ensure that surface water does not pool and saturate the uncompacted fill material. The likelihood of infiltration will reduce as the pits are backfilled because existing voids will be closed up as the surface level increases.

The conceptual surface water management plans and preliminary design calculations for Years 1 to Year 4 are included in Technical Appendix 11 and are summarised below.

**Year 1**

During Year 1, GWMWater water storage reservoir 4 will be taken offline for geotechnical stability and mining will commence in the North Pit. The North Pit will be excavated to follow the perimeter “lip” of the pit and surface water run-off will flow into the pit. A bund around the southwest perimeter of the open pit will be constructed during the initial stages of construction to prevent overflow from the pit and off-site discharge. The bund will be created by ensuring the excavated work area is approximately 0.5 metre lower than the existing natural surface level on the downstream end to ensure that the water is always contained within the pit. A silt fence will be erected on the downstream side beyond the extent of excavation to prevent sediment laden surface water from leaving the site.

During this period channels 1, 2 and 3 and SDB2 will be constructed to collect contaminated surface water run-off from around the pits and from the TWRS. Surface water run-off from channels 2 and 3 will discharge into SDB2.

Figure 8-74 shows the surface water management of the North Pit in Year 1.
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Figure 8-74  Surface water management for mining in the North Pit (Year 1)
Year 2

Mining in the North Pit will be completed at the end of Quarter 6 and mining in the South Pit will commence. Excavated material from the South Pit will be used as backfill in the North Pit and surplus material will be stockpiled at the TWRS.

Figure 8-75 outlines the surface water management of both North Pit and South Pit during the second production year of the mining schedule.

Channel 1 will continue to run parallel to the haul road and discharge into dam 1. All surface water run-off collected within the pit boundaries will be contained and pumped to dam 1.

A bund will be constructed around the southwest perimeter of the South Pit during the initial stages of construction to prevent overflow from the pit into undisturbed areas and off-site.

The South Pit will be excavated to follow the perimeter “lip” of the pit and surface run-off will flow into the pit and be collected into sumps.

Although all water that falls within the pit boundaries will be contained within the pits, sediment basins (SDB3 and SDB4) and associated channels will be constructed early to contain water runoff in the unlikely case of any overflow from the pits.
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Figure 8-75  Surface water management for mining in the North Pit and South Pit (Year 2)
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Year 3
The backfilling of the North Pit will be completed at the end of Year 3 and mining will continue in the South Pit.

Open drainage channels 4 and 5 will convey the catchment flows from the rehabilitated North Pit to sediment basins 1 and 3 (SDB1 and SDB3). Sediment basins will capture stormwater run-off and remove sediment so that the water can be re-used. The sediment basins and channels will contain all flows from the pit and will be pumped to dam 1 as required.

Erosion control measures will remain in place until the site has been rehabilitated and run-off water quality meets SEPP (WoV) criteria. Surface water management of the North Pit is shown in Figure 8-76 and of the South Pit is shown in Figure 8-77.
Figure 8-76  Surface water management for mining in the South Pit (Year 3)
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Year 4

During Year 4, the North Pit will be rehabilitated and mining in the South Pit will be completed. In-pit sumps will be maintained at the low point(s) of the South Pit and will need to be relocated as mining progresses. Figure 8-77 presents the surface water management of the South Pit during Year 4.

Open drainage channels (channels 6 and 7) will convey catchment flows from the South Pit once backfilling is complete. Backfilling of the South Pit will commence during Quarters 15 and 16.

Sediment basin 4 (SDB4) will capture and treat stormwater run-off from areas adjacent to the South Pit. The stormwater management controls (channels and basins) will remain in place until vegetation is established in the rehabilitated pits and the water quality is tested to ensure that the run-off from revegetated areas is of similar or better quality that the surrounding natural run-off.

Erosion and sediment management features will be installed prior to rehabilitation work commencing at the North Pit. Standard erosion and sediment control measures are outlined in Technical Appendix 11. After vegetation has been established and the run-off water quality meets SEPP (WoV) criteria, the temporary sediment devices will be decommissioned. A similar process will be adopted for the rehabilitation stage of the South Pit.
Figure 8-77 Surface water management for mining in the South Pit (Year 4)
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Rehabilitation
Stormwater run-off on the rehabilitated slope on the south-western side of the hill (between the pits and the Fisher Street properties) will be managed by constructing level containment benches on the rehabilitated slope at a spacing of 40-50 metres to capture the flow and promote infiltration. The benches will shorten the slope length thus minimising erosion and contain some of the run-off by promoting infiltration. This is discussed in further detail in Chapter 10. Any flow that is not contained by the containment benches will be collected by open drain channels (channels 5, 6, 7 and 8) and conveyed to SDB3 and SDB4 for treatment. The level in the sediment basins will be maintained by level control such that excess water is pumped to dam 1 to prevent any discharge of water to the surrounding environment.

The rehabilitated surface will include the construction of grass swales to convey surface water and provide treatment such that surface water leaving the site is of similar quality to that of the run-off from the natural environments. The water quality features that will be utilised in the closure stage will be the swales and sediment basins which have been designed to capture sediment to best practice standards.

All erosion and sediment controls shall remain in place post mining until vegetation has established.

8.11.4.2 Surface Water Mitigation Measures
Drainage channels, sediment basins, flood basin, water storages and pumps have been designed to manage surface water run-off within the Project area during and after mining operation. Additional mitigation measures required to prevent potential impacts to the surrounding environment are outlined below.

During the operational phase of the Project
Contamination of surface or ground water by polluted surface water run-off containing silt, sediment, oils and chemicals coming from mining pits will be prevented by:

- Retaining all contaminated water in on-site storages. The on-site water storage capacities have been assessed and have more than sufficient capacity to capture all rainfall during a 100 year ARI storm event.
- Reusing water within the processing plant (even if it contains higher sediment loads or contaminants such as hydrocarbons), or blending it with raw water if necessary.
- Disposing of sediment removed from sediment basins in the tailings storage facility.
- Containment and clean-up of any chemical spills with spill kits provided at the mine site.
- All waste materials will be properly disposed of under EPA waste regulations.
- The run-off from vehicle and machine wash down will be directed to collection basins and passed through a series of oil separators and sediment traps prior to discharging to dam 1 for reuse.

Water reuse will be maximised and raw water demand reduced by:

- Maximising water collection, treatment and reuse across the site. SGM has achieved a decrease in freshwater consumption since 2008. Underground mining also has higher water consumption than above ground mining (due to longer haul routes requiring dust suppression and water required for drilling and concreting) and therefore current water demand across the site is expected to decrease.
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- Use of collected surface water for dust suppression for haul roads, pits and stockpiles.

Water catchment integrity will be assessed by:
- Undertaking a consequence assessment on both dam 1 and 5 prior to the Project commencing in accordance with the ANCOLD guidelines.

Sediment basins and channel integrity will be maintained by:
- Periodic monitoring and cleaning of drains, channels and sediment basins to maintain the capacity and treatment quality.
- Maintaining low water levels in sediment basins and the flood storage basin so that there is sufficient capacity for flood storage. Water that is not used for dust suppression shall be pumped to dam 1 automatically.

Post operational phase of the Project

To maintain surface water quality and prevent off-site pollution of water ways:
- contaminated water will be collected via drainage channels and treated on-site before discharge into existing Council drainage network or natural waterways
- erosion control will be maintained through continuous rehabilitation and revegetation of bare areas (especially in areas where stormwater run-off flows directly into the natural waterway)
- appropriate guidelines, legislation and approvals will be obtained prior to discharge into natural waterways and / or Council drains
- monitoring will be undertaken to assess compliance with SEPP (WoV) prior to removal of temporary erosion and sediment controls.

8.11.5 Conclusion

The surface water assessment has demonstrated that all surface water within the Project area can be effectively managed during operations and rehabilitation so that there is no impact on the surrounding environment.

During mining operations, all run-off from disturbed areas will be captured on-site and utilised for dust suppression and general site works. Water that is not used immediately will be pumped to dam 1 where water is extracted for processing. When dam 1 reaches capacity, water will be transferred to dam 5 under current site arrangements. It is estimated that only one third of dam 5 storage capacity (approximately 100 megalitres) will be utilised to contain water run-off for a 100 year ARI storm event.

A sediment basin (SDB2) will be constructed downstream of the TWRS to capture sediment from dirty water run-off with clean water diversions proposed around the work site. In addition to SDB2, a flood storage basin (FSB2) will be constructed (also designed for a 100 year ARI storm event) to ensure no overflow to the environment.
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As the Project area is reinstated, standard construction erosion and sediment control techniques will be employed to ensure that dirty water run-off is contained on-site. Vegetated cut-off drains and sediment basins will convey and capture surface run-off which will be pumped to dam 1 as required. After rehabilitation, the vegetated drains and sediment basins will remain in place until vegetation returns to a run-off that is typical to any vegetated area and water quality treatment is no longer required. The stormwater management controls (channels and basins) will remain in place until vegetation is established in the rehabilitated pits and the water quality is tested to ensure that the run-off from revegetated areas is of similar or better quality to that of the surrounding natural run-off.

Therefore the surface water impact associated with the Project is low and acceptable.
8.12
Groundwater
8 Environmental Impact Assessment

8.12 Groundwater

8.12.1 Introduction

This section of the EES describes the groundwater environment of the Project area and adjacent land; identifies potential impacts of the Project on groundwater; identifies measures to manage and mitigate potential adverse impacts; and overall impacts on groundwater following implementation of the management and mitigation measures.

This assessment is based primarily on information provided in:

- URS Australia Pty Ltd (2014), Big Hill Enhanced Development Project: Groundwater assessment, prepared for CGC.

This report is included in Technical Appendix 12 to this EES.

<table>
<thead>
<tr>
<th>Relevant sections of EES Scoping Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>This section of the EES addresses the following requirements of the EES Scoping Requirements as they pertain to groundwater:</td>
</tr>
</tbody>
</table>

‘4.7 Water

**Draft Evaluation Objective**

To ensure that surface water and groundwater quality and potable water supply are adequately protected from adverse impacts arising from the project.

**Key issues**

- Potential impacts on beneficial uses of groundwater, due to interception of flows or discharges to groundwater.

**Priorities for characterising the existing environment**

- Describe the existing groundwater environment in the vicinity of works proposed to be developed or used for project purposes, as known or inferred from available information.

**Design and mitigation measures**

- Describe the measures to be taken to ensure protection of surface water and groundwater during mining construction, operations, rehabilitation and post-closure.

**Assessment of likely effects**

- Assess the risks to surface water and groundwater quality resulting from the conduct of the project, and including risks which may continue after project works have been completed.

**Approach to manage performance**

- Describe monitoring programs to be implemented to ensure prompt detection of water supply or water quality issues with respect to potable water, surface water and groundwater.’

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**Key issues emerging from EES studies and community consultation:**

There were no key issues related to groundwater arising from the community during the preparation of EES studies or community consultation process.
8 Environmental Impact Assessment

Summary of findings

- Regional (background) groundwater levels are expected to be approximately 200 metres AHD in the vicinity of Big Hill, with regional groundwater flow in a north to north-westerly direction.
- Some perched shallow groundwater may be present above the basement rock as a result of rainfall infiltration and potentially leaking reservoirs located adjacent to the Project area.
- According to the State Environment Protection Policy (Groundwaters of Victoria), groundwater in the region is likely to lie within Segment C (i.e. a total dissolved solids (TDS) ranging between 3,501 to 13,000 milligrams per litre (mg/L)) with protected beneficial uses including maintenance of ecosystems, stock watering, industrial water use, primary contact recreation and buildings and structures.
- Within a two kilometre radius of the site there is only one registered groundwater bore installed approximately 1.1 kilometres north of Bill Hill for domestic use. Its current operational status is unknown.
- The closest mapped groundwater dependent ecosystem (GDE) is Jerrywell Creek which lies around 0.8 kilometres to the east and has ecosystems that potentially rely on the surface expression of groundwater.
- Due to historic and current dewatering activities related to underground mining, the groundwater table has been depressed by over 1,000 metres and it is unlikely that groundwater will be intercepted at the base of the pits.
- Groundwater recovery from dewatering activities (rebound) to background (pre-mining) levels is expected to occur slowly and it not expected to stabilise in less than the underground operational period (30 years).
- Potentially acid forming (PAF) materials are unlikely to be encountered and in the event that they are, they will be identified by a mine waste rock validation program.
- If PAF materials are encountered they will be isolated, backfilled into the base of the pits and sealed off with a compacted layer of non-acid forming mine waste rock to achieve a similar outcome with respect to rainfall protection and oxygen restriction.

8.12.2 Existing Conditions

Hydrogeological overview

The Project is located on a part of the bedrock highs that surround the Murray Basin which is within the Wimmera Mallee groundwater catchment (GC) and in a regional context has groundwater flowing north to the Murray River.

Groundwater beneath the Project area occurs within fractures and openings of the various bedrock geologies, all of which are typified by extremely low to low permeability. The only significant permeability occurs where major faulting or fracturing has occurred and has some degree of interconnection.

Alluvial or other recent sedimentary sequences only form a thin veneer across the bedrock within the immediate vicinity of the Project area and are not considered a groundwater resource in the area.
According to the South Western Victoria Water Table Map (DCNR, 1995) and the *State Environment Protection Policy (Groundwaters of Victoria)* (SEPP GoV), groundwater in the region is likely to lie within Segment C (i.e. total dissolved solids (TDS) ranging between 3,501 to 13,000 milligrams per litre (mg/L)) and therefore has the following beneficial uses:

- maintenance of ecosystems
- stock watering
- industrial water use
- primary contact recreation
- buildings and structures.

A groundwater bore search of registered bores within two kilometres of the site identified only one bore of domestic use installed to a depth of 70 metres approximately one kilometre north of Big Hill. Its current operational status is unknown.

In summary, groundwater is not utilised as a resource in or surrounding the Project area, based on the absence of registered groundwater bores in the area, the relatively high salinity, low yielding nature of the aquifer and the availability of surface water resources.

**Groundwater levels**

The aquifer beneath the Project area has been significantly depressed due to underground mining and associated dewatering that has occurred since 1981. The resulting cone of depression is not delineated, but is expected to extend several kilometres radially outwards from the centre of underground operations. Figure 8-78 shows the extent of underground workings relative to the North and South Pits.

Dewatering records from the underground mining operations show rates have declined from 45 cubic metres per hour in 1999 to about 20 cubic metres per hour in 2008 and about 15 cubic metres per hour in 2009. During 2011 and 2012 the volume pumped from the underground mine operations had reduced even further, but was more reflective of the fact operations had started to re-mine higher levels and pumps at the deepest sections had been turned off. However, given the depth of the local aquifer, the groundwater inflow rates illustrate the extremely low permeability of the host bedrock.

In the immediate area of Big Hill two boreholes have been drilled (1999 approximately 19 years after commencement of underground dewatering), which were located in the area of the north wall of the North Pit. The bore depth for both boreholes was 50 metres (approximately 228 metre AHD). The bores were measured as dry one week later. Additionally, some 200 exploration drill holes were put down along Big Hill ridge during 1997-1998 (in both the proposed North and South Pits) to depths in excess of 120 metres below the crest (approximately 180 metre AHD) of Big Hill and all were reported as dry.

The drilling information plus the know elevation of underground mining (and therefore dewatering level) all provide information to suggest that groundwater levels beneath Big Hill and the ridge line south are currently significantly below the proposed base of North and South Pits.

Given the extent of dewatering undertaken beneath the Project site and the relatively low permeability expected of the bedrock aquifer, it is likely that the recovery (rebound) of groundwater to pre-mining levels will take at least 30 years (i.e. as long as dewatering activities have been undertaken). The presence of extensive underground voids left by historic mining activities is shown in Figure 8-78.
Figure 8-78 Plan view and long section (looking northeast) showing potential Big Hill pit and underground voids (light green) and Davis Pit void as mined (dark green)
These make it difficult to predict the medium to long term recovery of groundwater levels for the site, as these voids may accumulate groundwater. The lack of pre-mining (underground) local groundwater data also makes it difficult to estimate the level to which groundwater may rebound. Historic mining voids would also act to delay the recovery of groundwater levels to above the base of the South pit.

**Groundwater quality**

The Snyder Bore is the registered name that represents all of the underground mine dewatering efforts undertaken by SGM. Sampling from this bore (i.e. from water collected in underground sumps) is the only available information on the local groundwater quality immediately beneath Big Hill. Analysis of the water taken from the Snyder Bore has been undertaken on a number of occasions and is summarised in Table 8-80 below.

The results of analysis from water collected underground show a significant variability in quality, with likely influences from drilling activities (elevated nutrient levels, low salinity) and sulphide rock interaction (elevated metals and salinity).

In summary, man-made influences appear to be dominating water chemistry reported for the Snyder Bore and are not considered representative of the local groundwater quality.

| Table 8-80 Snyder Bore water quality results |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Major anions and cations (mg/L) |                  |                  |                  |                  |                  |                  |
| Ca              | 160             | 6               | 6.8             | 3.9             | 350             | 140             |
| Mg              | 160             | 2               | 1.2             | 2.2             | 220             | 160             |
| Na              | 810             | 10              | 9.9             | 13              | 1,300           | 850             |
| K               | 21              | 1               | 1.3             | 1.5             | 30              | 23              |
| HCO₃            | 130             | 28              | 23              | 24              | 160             | 97              |
| Cl              | 1,400           | 10              | 19              | 21              | 2,400           | 1,400           |
| SO₄             | 840             | 2               | <2              | <2              | 1,200           | 840             |
| TDS             | 3,600           | 85              | 93              | 120             | 6,600           | 3,800           |
| Metals (mg/L)   |                  |                  |                  |                  |                  |                  |
| Te              | <0.005          | <0.005          | <0.005          | <0.005          | <0.005          | <0.005          |
| Hg              | <0.001          | <0.0001         | <0.0001         | <0.0001         | <0.0001         | <0.0001         |
| Fe              | 56.8            | 0.05            | <0.2            | 0.11            | 6.2             | 1.2             |
| Al              | 19              | 0.2             | 0.2             | 0.12            | 1.1             | 0.025           |
| As              | 0.34            | <0.001          | <0.005          | <0.001          | 0.081           | 0.015           |
| Mn              | 17              | 0.004           | <0.005          | 0.009           | 1.3             | 10              |
| Cu              | 0.082           | <0.001          | <0.005          | 0.003           | 0.008           | 0.003           |
| Pb              | 0.0016          | <0.001          | 0.019           | <0.001          | 0.002           | 0.01            |
| Zn              | 0.61            | <0.005          | 0.013           | 0.008           | 0.016           | 0.11            |
| Cr              | 0.066           | <0.001          | <0.005          | 0.002           | 0.033           | <0.001          |
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In the absence of bores in the wider area, it is difficult to accurately determine groundwater quality in the environs of Big Hill. However, as outlined earlier, the available literature suggests water quality suitable for uses such a stock watering and industrial can be expected (TDS 3501-13000 mg/L). Investigations to better define groundwater quality in the area were not carried out as part of this EES on the basis that the proposed above ground mining is not expected to come into contact with the water table, and even if it did, no adverse impact on regional water quality would be expected. This is discussed further in Section 8.12.3.

**Waste rock geochemistry and acid producing potential**

An issue requiring consideration in some mining projects is the potential for waste rock to become acid producing and interact with groundwater. Geochemical characterisation of the Big Hill waste rock material was conducted in 1999 as part of the *Mine Waste Rock Management and Emplacement Design Report (Big Hill Development Project EES, 1999)*. It included an assessment of the acid producing potential of mine waste rock and the solubility of elements in mine waste rock under leaching conditions. It was concluded that:

- The vast majority of mine waste rock samples exhibited low to very low sulphur levels and were non-acid forming.
- Some samples reported environmentally significant levels of certain metals, however, most showed that the metals present were not readily soluble in the shake solubility test (a test designed to indicate the immediate solubility of metals contained in waste rock using distilled water), thus indicating the material would not readily dissolve in rainfall runoff.
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- A small number of mine waste rock samples (most of which were taken from drill holes at depths below the floor of the proposed mining areas and thus will not be mined) exhibited elevated sulphur levels and tested as potentially acid forming. These samples also reported enriched levels of some metals and, in some instances; a degree of metal solubility was evident where these samples were subject to the shake solubility test. The proportion of mine waste rock expected to exhibit this behaviour, however, is very small (i.e. probably restricted to small quantities near the floor of the South Pit and close to or within the ore zone).

Measures to ensure that any acid producing waste rock arising from the above ground mining is managed without adverse impacts are discussed in Section 8.12.3.

Groundwater dependent ecosystems

There are no known groundwater dependent ecosystems (GDE) within the Project area. The closest GDE to Big Hill is Jerrywell Creek which lies around 0.8 kilometres to the east and has ecosystems that rely on the surface expression of groundwater. A Heath Woodland is also located around one kilometre to the northeast and reportedly relies on the subsurface presence of groundwater. Both GDEs are listed\textsuperscript{15} as having a high potential for groundwater interaction (unconfined water table).

8.12.3 Impact Assessment

The groundwater study for the Project (Technical Appendix 12) has reviewed the potential impacts on groundwater levels, groundwater quality and GDEs. Discussion of the potential impacts and their likelihood are provided below for the mining and rehabilitation phases of the Project.

Existing impacts from current facilities are not discussed herein, including known groundwater quality impacts in the vicinity of the TSF. It is noted that the Project will utilise an increase in the height of the tailings embankment that is already approved and regulated, and it is not assessed separately in this EES. The existing TSF is considered outside of the scope of this groundwater assessment with any existing groundwater impacts discussed in Section 4.8.1.

Alternative disposal options for tailings that were considered as part of this Project are included in Section 5.4.

Groundwater levels and quality

The potential impacts of the proposed open pit mining for the Project relate to the water table under Big Hill returning to pre-dewatering levels during mining or after mining is completed and the potential for this rebounded water table to interact with materials which could have an adverse effect on groundwater quality. If the proposed open cut pits intersect the water table, it may result in one or both of the following:

- Poorer groundwater quality from either interaction with exposed rock or contributions from the pit’s surface water.

\textsuperscript{15} BOM atlas.
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- Lowering of the water table, with the potential effects of reduced discharge to local creek(s), reduced bore viability and potential stress to GDEs. This potential impact would only be an issue in the event that the recovering water table intersected the base of the mining pits prior to backfilling of the pits and created a preferential pathway and sump for groundwater flows.

The base of North and South Pit are proposed to be 225 and 200 metre AHD respectively. The water level in the underground workings is currently estimated to be in the order of -1,050 metre AHD (SGM, July 2013) with a visual observation for the rate of water rise underground being less than 10 metre per month. At this observed rate of water table recovery without dewatering in the underground mine, it is highly unlikely that groundwater levels will recover to pre-dewatering elevations during the five years life of the Project. In the event that the water table continued to recover at the observed rate of less than 10 metre per month (which is unlikely as the rate would be expected to slow over time), the water table would still be in the vicinity of 400 metres below the base of the South pit on the completion of mining activity. As such, the North and South Pits will not have any groundwater inflows into them prior to backfilling and rehabilitation.

The regional groundwater level will, however, eventually recover to its pre-dewatered levels. The likely levels that could be expected beneath Big Hill are in the order of 180-200 metre AHD. As the base of South Pit will be approximately 200 metre AHD, it is expected that the water table will recover to just above the base of the rehabilitated South Pit. The base of North pit is 225 metre AHD and is unlikely to be intersected by the recovery of groundwater levels.

The waste rock backfill in the pits is expected to have a higher permeability than the surrounding bedrock and if groundwater rises above the base of South Pit, the groundwater will infiltrate the waste rock and start to interact with the material. However, as outlined earlier, testing of the geochemical characterisation of the waste rock material suggests that the majority of material is non-reactive and unlikely to leach salts (salinity) or metals. As there is a small proportion of waste rock that may be potentially metal soluble, it is proposed that this material be segregated and placed at an elevation higher than 225 metre AHD to avoid any potential for contact with a recovered water table.

Therefore, as groundwater levels recover to pre-dewatering elevations, the local groundwater quality will not be impacted by contact with the waste rock material that is used to backfill the pits.

**Rainfall infiltration**

During mining, any surface water run-off will be collected were possible and used for dust suppression purposes.

During and post rehabilitation (backfilling and revegetation) of the North and South Pit, rainfall has the potential to infiltrate the waste rock material and enter the groundwater system. The potential groundwater quality impact is elevated salts and metals from rainfall infiltration interacting with the waste rock.

As outlined above, testing has shown that the majority of waste rock does not appear to leach salts or metals and thus any rainfall infiltration through this material is unlikely to be impacted.

The rate of infiltration through the rehabilitated surface is also considered to be significantly less than the existing situation for the following reasons:

- the engineered profile has been designed to reduce infiltration – minimal depressions
- enhanced vegetation cover will increase evapotranspiration
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- the removal of voids from historic mining which are currently open to the surface or near surface.

Even in the event that the quality of infiltrated rainfall was adversely affected by leaching from the backfilled waste rock and this water entered the water table, a combination of the small volumes, dilution and the neutralising potential of surrounding materials would mean the impact would not be significant and would not be discernible in the regional groundwater.

**Groundwater dependant ecosystems**

The nearest potential GDE (Jerrywell Creek) lies approximately one kilometre to the east of Big Hill.

The potential impact of the Project on groundwater levels and quality is considered to be negligible given the remote possibility that the water table will be intersected by the North and South Pit during mining and the low potential for leaching from the waste rock after backfilling. As such, there is little likelihood for the Jerrywell Creek GDE to be impacted by a change in groundwater contribution or quality from the Project.

Furthermore, it is noted that Jerrywell Creek is considered to be up hydraulic gradient of the regional flow direction, which is north and west. Thus, even in the event that there were changes in groundwater quality resulting from the Project, the flows of any adversely affected groundwater would be away from Jerrywell Creek.

8.12.4 Management and Mitigation Measures

The strategy for water management in relation to managing potential impacts to groundwater includes:

- Collection, channelling and temporary containment of surface runoff from disturbed areas (including mining pre-strip areas, waste rock emplacement and haul roads). This is discussed further in Section 8.11.

- Capture and containment of groundwater inflows and/ or surface water inflows to the open pits on-site (refer to Section 8.11).

- Design and construct the waste rock emplacement profile to restrict the deep infiltration of groundwater by compaction.

Specific management and mitigation measures that will be conducted to achieve the objectives listed above are described below for the two main phases of the Project.

**Mining phase**

Groundwater monitoring will be conducted around the perimeter of the mine void (if practicable) to assess groundwater levels and trends and determine the rate of groundwater recharge (rebound) following the cessation of mine dewatering (as part of EMP).

As a minimum, groundwater monitoring will include:

- monitoring of water levels in the underground mine works (if safe to do so) for as long as practicable

- if a perched groundwater system is identified, a preliminary hydrogeological investigation will be undertaken to assess the nature and extent of the perched system and determine its importance to the regional groundwater flow regime
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- if groundwater monitoring indicates the potential for groundwater accumulation within the bottom of either pit, partial backfilling or dewatering from the underground mine operations will be assessed and actions taken so that dry rehabilitation can be undertaken and maintained.

- all mine waters (i.e. rainfall runoff or isolated groundwater accumulation zones) will be contained (e.g. pumped from the pit to on-site storages) and used for dust suppression and process water.

A mine waste rock validation program will be conducted as mining proceeds to ensure that potentially acid forming materials are identified prior to removal from the pit and backfilling as part of rehabilitation works. Such that:

- where potentially acid forming materials are identified, such materials will be placed and encapsulated in waste rock emplacement areas within compacted zones of non-acid forming waste rock in order to isolate such material from rainfall and to restrict the ingress of rainfall infiltration and oxygen.

- if potentially acid forming materials are identified and exposed in the floor of the South Pit final void, such material will be sealed off with a compacted layer of non-acid forming mine waste rock to achieve a similar outcome with respect to rainfall protection and oxygen restriction.

Rehabilitation phase

During rehabilitation, the following mitigation measures will be implemented to minimise adverse impacts. The site will:

- ensure compliance with appropriate guidelines, legislation and approvals prior to discharge of any surface waters (collected at the mine) into natural waterways that may be connected to groundwater (GDEs).

- restrict deep infiltration of rainfall or groundwater inflow by adequate compaction of the backfilled waste rock during rehabilitation.

- revegetate the rehabilitated pits to increase local evapotranspiration, along with the implementation of engineered surface water controls (e.g. final design profile of backfilled rock) to reduce the potential for deep infiltration of rainfall.

Analysis of groundwater quality post-rehabilitation is not considered practicable due to the groundwater depth and the low potential for the Project to impact on regional water quality.

8.12.5 Conclusion

The following conclusions are made in relation to the groundwater implications of the Project:

- Groundwater beneath the Project area and the immediate surrounds is not utilised and the nearest GDE in the vicinity is approximately one kilometre to the east of the Project.

- There is a significant cone of depression created by historic and current underground dewatering activities with the water table currently estimated to be at -1,050 metre AHD.

- Based on current observed rates of groundwater recovery when dewatering of the underground mine is not occurring, groundwater is highly unlikely to rebound and be intersected during mining of the open cut pits. As such, there is no potential for the pits to act as a groundwater sump and reduce the flows of groundwater into the regional system.
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- As the groundwater levels recover to pre-mining levels, it is unlikely that groundwater will come into contact with the waste rock used to backfill North Pit but in the deeper South Pit, there is potential that recovered groundwater levels will intersect backfilled waste rock.
- The majority of waste rock used for backfill is not leachable for metals and is unlikely to materially affect groundwater quality from either rainfall infiltration or interaction with the water table.

In summary, it is considered that the Project will not result in any adverse impacts to groundwater.
8.13 Waste Rock Management
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8.13 Waste Rock Management

8.13.1 Introduction

This section of the EES describes and assesses the potential waste rock management impacts of the Project on the surrounding environment; identifies measures to manage and mitigate potential adverse impacts and assesses overall impacts of waste rock management following implementation of the proposed management and mitigation measures.

The generation and management of other wastes from processing and mining activities is addressed in the EMP (refer to Chapter 11).

This assessment is based primarily on information provided in:

- Mining One Pty Ltd (2014), *Big Hill Enhanced Development Project: Geotechnical Investigation*, prepared for CGC.

This report is included in Technical Appendix 9 to this EES.

### Relevant sections of EES Scoping Requirements

This section of the EES covers the following components of the EES Scoping Requirements insofar as they relate to waste rock management:

#### 4.5 Health and Social Impacts

**Evaluation Objective**

To protect the health, safety and wellbeing of residents and the social fabric of the community in the area in the context of project hazards.

**4.5.1 Public Health and Safety**

**Key issues**

- Public safety hazards during mine construction, operation, rehabilitation and post-closure, including in relation to the presence of deep pits in close proximity to existing residential areas and the geotechnical stability of the mine and rehabilitated landform.

**Priorities for characterising the existing environment**

- Describe the physical and chemical characteristics of overburden, ore and waste rock to be removed during mine development and operations, following mechanical extraction, including specific aspects relevant to human health.

**Design and mitigation measures**

- Describe and evaluate potential and proposed design and mitigation measures that could:
  - ensure public safety during mine development, operation and rehabilitation, that is prior to the completion of the restoration and rehabilitation of Big Hill.

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16 Assessment should be completed to a level commensurate with the detailed hazard and risk assessment required for the Work Plan under MRSD Act.
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**Assessment of likely effects**
- Assess potential safety hazards to the public arising from the project.

**Approach to manage performance**
- Describe and evaluate any proposed measures to mitigate or manage public safety hazards.

**Key issues emerging from EES studies and community consultation:**

There were no key issues related to waste rock arising from the community during the preparation of EES studies or community consultation process.

**Summary of findings**

- An extensive geochemical sampling program has been undertaken on the waste rock material that is to be managed as part this Project.

- The highly weathered nature of the geology within which the pits are located and the neutralising capacity of its mineralogy mean the vast majority of waste rock material can be classified as non-acid generating (NAG). The testing also shows there is minimal risk of leaching saline or elevated metal run-off or seepage water.

- A small number of potentially acid forming (PAF) samples taken from below the base of South Pit were identified by the waste rock characterisation program. Potential PAF material will be detected through a waste rock validation program, segregated appropriately and managed to ensure any leaching is contained.

- Where PAF material is identified or detected on the pit floor, it will be sealed off or encapsulated in waste rock emplacement areas within compacted zones of non-acid forming waste rock (cells) in order to isolate it from rainfall and restrict the ingress of oxygen.

**8.13.2 Existing Conditions**

**8.13.2.1 Soils**

The landscape of Stawell is characterised by small undulating hills and rises of bedrock that have a highly variable weathering profile and a thin veneer of soil, typically of limited extent.

Soil profiles in the Stawell region are naturally enriched in some heavy metals (e.g. arsenic), however, their bioavailability (extent to which they can be adsorbed onto or absorbed into a living organism) is considered low. Also, the low rainfall and significant vegetative cover in the Stawell region provide environmental conditions where soil arsenic is unlikely to be hazardous to biota (Noble, 2005).

The bioavailability of arsenic in the soils local to the mine is similar to that in regional soils and in general, the concentrations of bioavailable arsenic and other metals in the soils of Stawell are considered to pose minimal human health risk (Noble et al., 2010).

The Big Hill area consists of a low hill with extensive oxidation of the underlying rock generally extending down to around 90 metres below surface, with little or no sulphides (Mining One, 2013).
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The local surface soils as granular loams with low to moderate organic carbon content (1 to 4 per cent), with a mean pH of 4.6 indicating that the soils are naturally moderately to strongly acidic. Within the Big Hill area, topsoils consist of a thin layer of brown to pale brown, sandy to clay topsoil, overlying variable subsoil materials including layers of sandy loams, sandy gravels, clay, clayey gravels and rock or old workings.

The depth of topsoil across the Project area ranges from 0.01 to 0.35 metres, although it is mostly 0.01 to 0.05 metres depth. It is likely that the topsoil thickness on Big Hill reflects historic mining activities and may differ substantially from the original soils.

8.13.2.2 Geology

SGM is situated in a major northwest-trending structural corridor along the western margin of the Lachlan Fold Belt. The gold ore bodies from which SGM mine are generally associated with the Magdala Dome, comprising a doubly plunging one kilometre wide unit of basalt enveloped by sulphide and iron enriched sedimentary rocks (termed ‘volcanogenics’) that host the majority of the ore-grade mineralization.

The Big Hill and underlying Magdala deposits occur in metamorphised volcanogenic sediments. Big Hill is the up dip extension of the Magdala system which has been historically mined from underground. Big Hill geology and mineralisation can be broken into four main domains Mariner’s, Allen’s, Iron Duke and Magdala Flank. All except Mariner’s and Allen’s are separated by faults (Resources Strategies, 1999).

From a material characterisation perspective the geology and mineralogy of the Big Hill area indicates that:

- extensive weathering has occurred to a depth of some 60 to 90 metres below the present surface of Big Hill
- the majority of the pre-existing sulphide mineralisation above these levels has been partly or completely oxidised
- elevated sulphide and metal concentrations are likely to be restricted to deeper sections of and below the floor of, both open pits and within inter-waste zones (i.e. waste rock within delineated ‘ore zones’).

8.13.2.3 Waste Rock Generated from Mining

Mining of the North and South Pits is estimated to produce approximately 8.3 million tonnes of waste rock material that will be either:

- temporarily stored at the TWRS, until being used to backfill the pits; or
- directly utilised as backfill to the North Pit.

The management of waste rock will be required for the duration of mining and backfilling.

The following provides an overview of the geochemical properties of the waste rock to be generated from the Project. The physical (geotechnical) properties of the waste rock and how this influenced the design of the TWRS is provided in Section 8.9.
The geochemical properties influence the storage and handling of the waste rock within the TWRS (as detailed below) and the backfilling, landform construction (slopes) and re-vegetation of the pits (as detailed in the Chapter 10).

**Overview**

The previous Big Hill EES conducted an extensive assessment (Resources Strategies, 1999) on the waste rock material that is to be managed as part this Project, which included:

- review of the geological framework of the Big Hill area
- sampling of selected drill holes by SGM to obtain representative ore and waste rock
- an assessment of the geochemical abundance of elements in the materials relative to the average earth crustal abundance
- an evaluation of the acid producing potential
- an assessment of elemental solubility in mine waste rock.

Geochemical characterisation was undertaken in 1998-1999 on 50 drill samples which were collected from the same area and rock material which is proposed for this Project. This is supported by more recent (2013) sampling by SGM.

The standard analytical suite for the 1998-1999 samples was the following

- total sulphur content (concentration of sulphur in the rock)
- paste pH and electrical conductivity (EC) (the pH and EC of water that is mixed with crushed rock in the laboratory)
- shake solubility (concentration of a range of dissolved species in water after the water has been mixed with waste rock for 24 hours in the laboratory)
- multi-element analysis (the concentration of a range of elements within the rock)
- net acid generation (NAG) (a laboratory test to measure the acid generated from the rock, minus the acid neutralised by the rock)
- acid base accounting (ABA) (a series of calculations and laboratory tests to estimate how much acid the rock can both generate and neutralise) including:
  - maximum potential acidity (MPA) (a calculated estimate of acid generating potential using the sulphur concentration of the rock)
  - acid neutralising capacity (ANC) (laboratory test to measure how much acid the rock can neutralise)
  - net acid producing potential (NAPP) (acid generation minus acid neutralisation; similar to NAG but using MPA and ANC rather than a laboratory test).

The results of these analyses are presented in Resources Strategies (1999), and summarised in the following sections.
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**pH and salinity**

The results showed that all samples (except those within a single fault zone) were neutral to slightly acidic. This confirms that the majority of source material for waste rock is weathered / oxidised and the potential for acid and metalliferous drainage (AMD) is low. Samples taken from within the fault zone (which occurs below the proposed base of South Pit) recorded more acidic paste pH results ranging from 2.6 to 3.5. This means it has increased potential for AMD generation.

The electrical conductivity results indicate the vast majority of samples tested were slightly to moderately saline, indicating that the leaching of waste rock is unlikely to generate a saline runoff above background conditions.

**Sulphur**

The presence of sulphur in the waste rock indicates a potential for the generation of acid.

The total sulphur content of the material tested was generally very low with the majority of the samples containing less than 0.05 per cent total sulphur and 88 per cent of the samples containing less than 0.16 per cent. This is indicative of pervasive weathering through much of the material to be mined and is visibly evident in all drilling (refer to core photos in Technical Appendix 9).

Five out of 50 samples recorded higher total sulphur values between 0.57 and 7.21 per cent (with four of these taken from the fault zone below the base of South Pit). These samples are taken from a location below the pit base and therefore material that is not proposed be mined. However, this result suggests that there is some potential for small pockets of such material which may be encountered towards the base of South Pit and potentially the North Pit.

One sample was volcanic inter-waste rock material taken from within North Pit ore zone and recorded a total sulphur content of 0.39 per cent, which is still considered to be low.

**Acid base accounting and net acid generation**

These assessments determine the acid forming potential of the waste rock and ore samples. Testing involves a static laboratory test designed to evaluate the balance between acid generation (i.e. oxidation of sulphide minerals) and acid neutralising processes.

The test work was performed on 15 of the 50 samples selected on the basis of total sulphur content. Due to the generally low total sulphur contents, maximum potential acidity (MPA) for the selected samples was relatively low. The exceptions came from the five samples containing higher levels of sulphur as described above.

The net acid producing potential (NAPP\(^{17}\)) results showed that 10 of the 15 samples (66 per cent) tested had either negative or very low positive NAPP's. All of these samples were classified as non-acid forming due to their very low total sulphur content (i.e. less than 0.11 per cent) and negligible NAG results.

The NAG test results confirmed that only the samples taken from the fault zone below the base of South Pit and the one inter-waste sample were potentially acid forming (i.e. final NAG pH less than 4).

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\(^{17}\) Net acid producing potential - NAPP is a theoretical calculation used to provide an indication of the materials potential to acidify and produce acidic drainage.
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**Geochemical multi-element analysis**

Multi-element scans (or assays) were carried out to identify the presence of any elements (or metals) in the rock at concentrations that may have a potential environmental impact. Multi-element assays were performed on all 50 samples during the 1998-1999 program.

The analysis indicated that the majority of waste rock samples tested contained elevated silver, arsenic, selenium and to a lesser extent antimony and bismuth concentrations.

A potential environmental impact can only occur if the enriched element can be released into the environment at concentrations which are of environmental concern and be transported to a sensitive receptor. To assess the potential impacts, the results of the geochemical multi-element analysis were considered in the following assessments:

- Air quality (Section 8.7)
- Surface water (Section 8.11)
- Groundwater (Section 8.12).

**Shake solubility results (static tests)**

Shake solubility test work was completed to assess the solubility of the elevated metals under leaching conditions. The testing was conducted on 15 of the 50 (30 per cent) samples (including ore and waste rock samples).

The results for the selected samples showed two distinct groups in terms of elemental solubility under the experimental leaching conditions.

- **Group 1** - four samples taken from the fault zone beneath the proposed pits. These samples recorded elevated levels in one or more of the following: electrical conductivity, aluminium, cadmium, cobalt, chromium, copper, iron, manganese, nickel, zinc and arsenic. Some of these samples exceeded ANZECC (2000) guidelines for livestock with respect to: aluminium, cadmium, cobalt, copper and nickel.

- **Group 2** - 10 out of the remaining 11 samples tested recorded soluble metal concentrations below detection limits for the majority of the parameters tested and electrical conductivities below ANZECC (2000) guidelines. A sample from the inter-waste zone contained elevated levels for arsenic.

**Geotechnical**

To supplement the data collected from the previous EES, a geotechnical program of works, consisting of 28 fully cored geotechnical (HQ triple tube) holes (approximately 1,570 metre) was carried out in 2013. Drill holes were targeted to intersect all proposed pit walls and provide samples of each lithology in a number of orientations so that material characteristics and structural information could be obtained (Figure 8-79).

A summary of the geotechnical characteristics of the waste rock, and the management and mitigation measures necessary to temporarily store waste rock is provided in Section 8.9. Details of the geotechnical investigation program and assessment are presented in Technical Appendix 9.
Figure 8-79  Location of geotechnical holes in the 2013 drilling program (Mining One, 2014)

In summary, the results confirm the observations from Mt Micke, that the design slope and stability factors are achievable for the waste rock materials to be stored at the TWRS.

It is noted that the testing conducted does indicate that some material from both the North and South Pits are dispersive in nature and potentially could lead to erosion issues if unmanaged. For this reason a detailed surface water management plan is proposed to ensure any run-off and/or erosional issues are managed and which follows best practice in regards the placement and storage of waste rock material.

**Additional waste rock for backfilling**

It is anticipated that approximately 1 million tonnes of additional waste rock material to that generated from mining of North and South Pits is needed to achieve the reinstated proposed final surface profile. Waste rock from various waste rock stockpiles (including Mt Micke) located across the remainder of the site will be used for this purpose.
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The current volume of waste rock at Mt Micke is greater than two million tonnes, with a portion of this stockpile planned for processing.

8.13.3 Impact Assessment

**Geochemical**

The majority of waste rock tested shows it to be non-acid forming (NAF), and exhibiting relatively benign characteristics due to the low to very low total sulphur content (Resources Strategies, 1999).

A small number of potentially acid forming (PAF) samples (taken from below the base of South Pit) were identified by the waste rock characterisation program. These samples also reported significantly enriched levels of some metals and, in some instances a degree of metal solubility was evident. This material is probably restricted to small quantities near the floor of the South Pit and close to, or within, the ore zone. The limited solubility of metals in the majority of waste rock is thought to be due to the oxidised nature of mine waste rock which has resulted in the formation of stabilised oxide-metal compounds.

**Geotechnical**

The stability analysis results show that the TWRS is not expected to experience large-scale stability issues and that the location of the TWRS is unlikely to affect the water storage dam. Additionally the FOS of greater than 1.5 is appropriate for the relatively short term storage of waste rock (refer to Section 8.9).

8.13.4 Management and Mitigation Measures

8.13.4.1 Geochemical

**Waste rock validation program**

As a result of the assessment of waste rock properties it is recommended that additional testing and identification of mine waste rock be undertaken as mining proceeds (i.e. through a mine waste rock validation program) to assist in identifying any potentially acid forming materials prior to them being removed from the pit.

The validation program would include a combination of visual mineralogical assessment, paste pH and EC tests, shake solubility analysis and NAG tests. This program would trial assessment methodologies with the aim of formulating an appropriate assessment technique which provides representative and rapid results.

**Temporary storage of waste rock materials at the TWRS**

Some waste rock generated from the excavation of the North and South Pits may require specific management within the TWRS (e.g. depending on its geochemical properties, pH, and potential for acid formation). The TWRS area is sufficient to enable separate stockpiling of different types of waste rock. Management methodology for waste rock is controlled by the Waste Rock Management Plan.
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Where PAF material is identified it is recommended that it be placed in an area of the TWRS (in the former Davis Pit overburden dump area rather than on GWMWater land) where any leachable water is able to be segregated and contained.

**Backfilling and encapsulation of potential acid forming material**
Where PAF material is identified it is recommended that it be placed and encapsulated in waste rock emplacement areas within compacted zones of non-acid forming waste rock (cells) in order to isolate it from rainfall and restrict the ingress of oxygen. Such a cell would be at least 10 metres below surface and above the recovered regional groundwater level (approximately 225 meters AHD).

If PAF materials are exposed in the pit floor of South Pit, they will be sealed off with a compacted layer of non-acid forming mine waste rock to achieve a similar outcome with respect to rainfall protection and oxygen restriction.

**Surface water quality monitoring program**
Notwithstanding the above, a water quality monitoring program (surface water only) for the waste rock emplacement will be included as a component of the overall monitoring plan and should include the following elements: silver, arsenic, bismuth, antimony, selenium and zinc. The monitoring program will be undertaken over the life of open cut mining to validate the waste rock management strategy. All runoff from active waste rock storage areas will be contained and re-used on-site.

8.13.5 Conclusion
There is a high degree of confidence in the ability to manage waste rock appropriately given the significant geochemical and geotechnical testing completed on the geology that will be the source of waste rock generated for this Project. There is also a large body of evidence generated from the experience obtained during mining of Davis and Wonga Pit and the waste rock stockpiles created which has left no observable impacts to date in regards to AMD and neutral metalliferous drainage (NMD).

In regards to the geochemical aspects of the waste rock the key impacts considered relate to potential generation of acid, saline and/or metalliferous run-off or seepage to groundwater. Risks relating to the geotechnical stability of the TWRS are assessed in Section 8.9.

The highly weathered nature of the waste rock and the neutralising capacity of its mineralogy mean it can be classified as non-acid generating (NAG). The testing also shows there is minimal risk of leaching saline or elevated metal run-off or seepage water. The minor volumes of rock where there is some potential for acid and/or saline can be found with the validation program segregated appropriately and managed to ensure any leaching is contained. There will be a Waste Rock Management Plan as a part of the Work Plan Variation, which will include this validation program.

To provide additional protection for the water storage dam, a bund will be maintained at the toe of the TWRS to provide an additional barrier for material that may rollout during dumping or may wash down during heavy rainfall.

Other potential risks from waste rock include dust generation and stormwater run-off. Mitigation measures are proposed to address these potential impacts in Sections 8.7 and 8.11 respectively.
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8.14 Traffic and Transportation

8.14.1 Introduction

This section of the EES describes and assesses the potential traffic impacts of the Project on the existing road network and provides appropriate mitigation measures where required, to ensure that impacts are within acceptable levels.

This assessment is based primarily on information provided in:

- URS Australia Pty Ltd (November 2013), Big Hill Enhanced Development Project: Traffic impact assessment, prepared for CGC.

This report is included in Technical Appendix 13 to this EES.

Relevant sections of EES Scoping Requirements

This section of the EES addresses in part the following requirements of the EES Scoping Requirements:

‘4.9 Environmental Management Framework

Draft Evaluation Objective

To provide a transparent framework with clear accountabilities for managing environmental effects and hazards associated with construction, operation, decommissioning and rehabilitation phases of the project, in order to achieve acceptable environmental outcomes.

Design and mitigation measures

- Provide a proposed framework for managing the risks of adverse environmental effects, including:
  - objectives and measures or procedures for managing environmental performance with respect to:
    - traffic

Key issues emerging from EES studies and community consultation:

There were no key issues related to traffic and transportation impacts arising during the preparation of EES studies or the community consultation process.

Summary of findings

- approximately 80-100 staff will be required for the Project, compared with current staff numbers of 145 as at March 2013, resulting in a reduction in background traffic
- during the mining stage of the Project, all movements of mined and stockpiled materials will be contained within the site with no use of external roads
- waste rock movement between Mt Micke and the South Pit will occur during Quarters 19 and 20 of the rehabilitation stage of the Project and is the only traffic movement on public roads
- the peak waste rock movement between Mt Micke and the South Pit occurs during Quarter 20 at 484,824 tonnes of material which equates to 4,848 haul truck movements or a maximum of 150 movements (i.e. 75 in each direction) per day
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- a new haul road intersection across Albion Road will be constructed to improve visibility and public safety
- additional traffic volume impacts on the performance of the road network (during Quarters 19 and 20) when external roads are used is minimal
- there is no impact on existing school bus routes and there will be minimal impact on public transport routes associated with the mobilisation and demobilisation of equipment to and from the site
- all intersections assessed fell well within capacity limits (degree of saturation below 80 per cent)
- the impact of the Project on the performance of intersections is not significant and most intersections do not require any mitigation measures.

8.14.2 Existing Conditions

Existing road network

The regional road network around Stawell consists of a network of highways that provide connections to Hamilton and Portland to the southwest, Horsham to the northwest, Bendigo to the northeast and Ballarat to the southeast.

The Project area is surrounded (and traversed) by a network of local roads which are managed by the NGSC. A description of the relevant local roads and their location with respect to the Project area is provided below in Table 8-81. A road network layout is provided in Figure 8-80.

Table 8-81 Local road network surrounding the Project area

<table>
<thead>
<tr>
<th>Road</th>
<th>Condition</th>
<th>Location in context with the Project area</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reefs Road</td>
<td>Sealed two-lane two-way road</td>
<td>Runs through site</td>
<td>Gravel / dirt shoulders and no line markings</td>
</tr>
<tr>
<td>Leviathan Road</td>
<td>Sealed two-lane two-way road</td>
<td>East</td>
<td>Gravel / dirt shoulders and no line markings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Truck access gate to processing plant on the southern end, between Reefs Road and Albion Road.</td>
</tr>
<tr>
<td>Albion Road/Bulgana Road</td>
<td>Sealed two-lane two-way road</td>
<td>South</td>
<td>Gravel / dirt shoulders and no line markings</td>
</tr>
<tr>
<td>Crowlands Road</td>
<td>Sealed two-lane two-way road</td>
<td>North</td>
<td>Gravel / dirt shoulders and line markings</td>
</tr>
<tr>
<td>Jubilee Road</td>
<td>Unsealed two-lane two-way road</td>
<td>Southeast</td>
<td>Sufficient width to accommodate two-way heavy vehicles movements</td>
</tr>
<tr>
<td>Big Hill Road</td>
<td>Sealed two-lane two-way road</td>
<td>Runs through site</td>
<td>Gravel / dirt shoulders and no line markings</td>
</tr>
<tr>
<td>Scenic Road</td>
<td>Sealed two-lane two-way road</td>
<td>Runs through site</td>
<td>Gravel / dirt shoulders and no line markings</td>
</tr>
<tr>
<td>Main Street</td>
<td>Sealed two-lane two-way road</td>
<td>Northwest</td>
<td>On street parking in some locations</td>
</tr>
<tr>
<td>Fisher Street</td>
<td>Sealed two-lane two-way road</td>
<td>West</td>
<td>On street parking</td>
</tr>
</tbody>
</table>
Figure 8-80  Project in context of local road network
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Transport infrastructure within the existing SGM site

The processing plant and Mt Micke are divided by the intersection of Albion Road, Leviathan Road, Bulgana Road and Jubilee Road. (Refer to Figure 8-80). The processing plant has a direct access gate onto Leviathan Road approximately 200 metres north of Albion Road.

Mt Micke has a direct access gate onto Jubilee Road approximately 50 metres south of Bulgana Road. Jubilee Road turns into an access track further south of the Mt Micke access gate until its intersection with Lavett Road.

To manage the current traffic movements of mining trucks on the public road network between Mt Micke and the processing plant, temporary fixed traffic signals have been erected to separate mining truck movements from general traffic movements. These arrangements incorporate temporary traffic signals along all four approaches to the Albion Road / Leviathan Road / Bulgana Road / Jubilee Road intersection and provide a clear and unimpeded section of road between Mt Micke and the processing plant (including the intersection) to prohibit any interaction between mining trucks and general traffic.

Public transport, school buses and haulage

Surrounding the Project area are designated routes for public transport, school buses and haulage.

School buses use Albion Road, Fisher Street and Crowlands Road from 7.00am - 8.30am and 2:30pm - 4:30pm, depending on the proximity and starting time of local schools.

A number of long-distance regional bus services operate throughout northwest Victoria and seven of these routes provide services to Stawell. These public transport services occur at a low frequency; at or below one service per day. Table 8-82 provides a summary of public transport services.

Table 8-82 Summary of existing public transport services surrounding the Project area

<table>
<thead>
<tr>
<th>Operator</th>
<th>Mode</th>
<th>Route name</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Southern Rail</td>
<td>Train</td>
<td>The Overland</td>
<td>Three days each week</td>
</tr>
<tr>
<td>Firefly Express Coaches</td>
<td>Bus</td>
<td>Melbourne to Adelaide</td>
<td>Every day</td>
</tr>
<tr>
<td>Greyhound Australia</td>
<td>Bus</td>
<td>Adelaide to Melbourne</td>
<td>Every day</td>
</tr>
<tr>
<td>Sandlant Buses</td>
<td>Bus</td>
<td>Stawell to Ararat and Ballarat</td>
<td>Monday to Friday</td>
</tr>
<tr>
<td>Sandlant Buses</td>
<td>Bus</td>
<td>Stawell to Halls Gap</td>
<td>School days</td>
</tr>
<tr>
<td>Swan Hill Bus Lines Pty Ltd</td>
<td>Bus</td>
<td>St Arnaud to Ararat and Stawell</td>
<td>Tuesday &amp; Friday only</td>
</tr>
<tr>
<td>V Line</td>
<td>Bus</td>
<td>Ballarat to Horsham, Nhill and Ouyen</td>
<td>Every day</td>
</tr>
<tr>
<td>V Line</td>
<td>Bus</td>
<td>Stawell to Halls Gap (Grampians)</td>
<td>Every day</td>
</tr>
</tbody>
</table>

Designated B-double and higher mass limit truck routes in the vicinity of the Project area have been identified from VicRoads data and are summarised on Figure 8-81.
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Figure 8-81  B-double and higher mass limit truck routes surrounding the Project area
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Existing local road accident data

A review of the VicRoads CrashStats database has revealed that no casualty accidents have been recorded for the five year period from July 2006 to June 2011 along the sections of road shown in Figure 8-82.

Figure 8-82  VicRoads CrashStats survey area
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**Existing traffic volumes**

Existing traffic volumes around the Project area were assessed in order to determine the potential change in traffic volume as a result of the Project.

**Midblock traffic volumes**

Midblock traffic volumes represent the number of vehicles counted mid-way along a block between two intersections to give a total for each direction. The NGSC conducted midblock tubular counts along Leviathan Road, Reefs Road, Albion Road and Landsborough Road between Monday 18 March 2013 and Tuesday 26 March 2013. This method uses pneumatic road tube counters, which are units that have rubber tubes that are placed across the travel lanes and use the pressure changes to record the number of axle movements.

Table 8-83 includes the midblock volumes from the traffic count and provides an assessment of these outputs in terms of the level of service (LOS). LOS is an index of the operational performance of traffic on a given traffic lane, carriageway, road or intersection, based on service measures such as speed, travel time, delay and degree of saturation during a given flow period. Intersection traffic service levels are defined as LOS A to F as follows:

- **LOS A** – free-flow conditions with a high degree of freedom for motorists to select speed and manoeuvre within traffic flow
- **LOS B** - stable flow conditions, reasonable freedom to select speed and manoeuvre within traffic flow
- **LOS C** - stable flow conditions, restricted freedom to select speed and manoeuvre within traffic flow
- **LOS D** - approaching unstable flow conditions, severely restricted to select speed and manoeuvre within traffic flow
- **LOS E** - close to capacity, with limited freedom to select speed and manoeuvre within traffic flow.
- **LOS F** – unsatisfactory performance as demand exceeds capacity and additional capacity is required.

<table>
<thead>
<tr>
<th>Description</th>
<th>Leviathan Road 100 m north of Albion Road</th>
<th>Leviathan Road 100 m south of Landsborough Road</th>
<th>Albion Road 100 m west of Leviathan Road</th>
<th>Reefs Road 300 m west of SGM entrance</th>
<th>Landsborough Road 100 m west of Leviathan Road</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average daily volume (two-way)</strong></td>
<td>211</td>
<td>107</td>
<td>248</td>
<td>311</td>
<td>731</td>
</tr>
<tr>
<td><strong>AM peak hour volume (two-way)</strong></td>
<td>22</td>
<td>16</td>
<td>34</td>
<td>22</td>
<td>80</td>
</tr>
<tr>
<td><strong>PM peak hour volume (two-way)</strong></td>
<td>25</td>
<td>23</td>
<td>41</td>
<td>30</td>
<td>81</td>
</tr>
<tr>
<td><strong>Heavy vehicle proportion</strong></td>
<td>5.1%</td>
<td>15%</td>
<td>7.3%</td>
<td>11%</td>
<td>7.9%</td>
</tr>
<tr>
<td><strong>Midblock level of service</strong></td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>
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Overall, the existing peak hour traffic volumes in the area are very low and the proportion of heavy vehicles ranges from 5.1 per cent to 15 per cent.

All road sections assessed within the vicinity of the Project area were assessed as operating at a level of service A which means that the existing traffic volumes are very low allowing motorists a high degree of freedom to select speed and manoeuvre within traffic flow. Traffic volumes could increase considerably and still fall well within acceptable levels of service.

Intersection traffic volumes

Using the midblock traffic volumes supplied by NGSC and the number of current employees at the mine, background traffic has been estimated at relevant intersections. Vehicle movements related to current mine activities have been removed to give an estimate of non-mine related background traffic and to enable assessment of the Project impacts when compared with expected traffic levels in 2014 if the mine closes and the Project does not proceed. Background traffic volumes are shown in Figure 8-83, Figure 8-84, Figure 8-85 and Figure 8-86. These figures show peak hour traffic movements, with heavy vehicle (anything larger than a car) proportions shown next to the total traffic volumes as a percentage.
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* Percentages represent heavy vehicles as a proportion of total traffic volumes.
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The current traffic volumes detailed in the above figures do not result in congestion within the road network or at any of the intersections surrounding the Project site.

The degree of saturation (DoS) is a measure of congestion levels experienced by road users at intersections. For example, a DoS of 1.0 represents a fully saturated intersection or movement, in which congestion levels are high resulting in queuing and delays, while a DoS of 0.80 represents an acceptable level of stable traffic flow, but with restrictions on desired speed and manoeuvrability.

The existing performances of the following intersections were assessed:

- Reefs Road / Mine Access (unsignalised T-intersection)
- Reefs Road / Leviathan Road (unsignalised T-intersection)
- Leviathan Road / Albion Road / Jubilee Road / Bulgana Road (unsignalised 4 way intersection)
- Leviathan Road / Landsborough Road / Crowlands Road (unsignalised 4 way intersection).

Results show that the all assessed intersections are underutilised in current conditions. Table 8-84 details the current conditions at each of the assessed intersections.

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Critical movement</th>
<th>DoS</th>
<th>Average delay (seconds)</th>
<th>Queue length (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reefs Road / mine access</td>
<td>Reefs Road; east &amp; west approach</td>
<td>0.01</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Reefs Road / Leviathan Road</td>
<td>Leviathan Road; south approach</td>
<td>0.01</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Leviathan Road / Albion Road / Jubilee Road</td>
<td>Leviathan Road; north approach</td>
<td>0.01</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Leviathan Road / Landsborough Road / Crowlands Road</td>
<td>Crowlands Road; east &amp; west approach</td>
<td>0.02</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

8.14.3 Impact Assessment

The Project will involve closure of the western end of Reefs Road (with access to the mine and processing plant from the eastern side), Scenic Road and Big Hill Road. Big Hill Road will be reinstated at the conclusion of the Project and upgraded to meet VicRoads and NGSC standards. Potential impacts of the Project on traffic include:

- impacts of mining vehicles on residential amenity
- impacts of mining traffic on road and intersection congestion
- impact of mining traffic on road safety
- impacts of mining traffic on public transport and freight routes.

These impacts are discussed in more detail in subsequent sections.
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**Project traffic assumptions**

Estimated traffic volumes expected during the Project compared to the estimated background traffic in the event that the Project does not proceed are based on a number of assumptions applied to 2013 traffic data provided by NGSC.

This assessment assumes:

- up to 100 staff will be required for the Project, compared with 145 as at March 2013
- all employees will enter the mine site via Reefs Road (off Leviathan Rd)
- up to nine 100 tonne trucks (Caterpillar 777F or similar equipment) will be required to transport ore and waste rock between the pits, the TWRS, the processing plant and Mt Micke
- during the mining stage of the Project all material movements will be contained within the site with no use of public roads
- during the rehabilitation stage (Year 5), waste rock will be transported from Mt Micke to the South Pit which requires haul trucks to cross a public road (Albion Road)
- the peak waste rock movement between Mt Micke and the South Pit occurs during Quarter 20 and equates to 4,848 haul truck movements or a maximum of 150 movements (i.e. 75 in each direction) per day based on a 12 hour working day.

Traffic volumes and patterns associated with employees and construction vehicles have been estimated over the operating phases of the Project based on the worst case scenario. This includes 100 car movements to and from the Project area and 150 heavy vehicle movements per day. This scenario is unlikely to occur during the Project, as peak car movements to the Project area are scheduled to occur during Year 2, while heavy vehicle movements on public roads are only scheduled for Year 5 of the Project.

The impact assessment also assumes haul trucks will move between the processing plant and Mt Micke via the new haul road / Albion Road intersection (see Section 8.14.4), which will be created to minimise haul truck traffic on public roads.

**Impacts of mining vehicles on residential amenity**

SGM intends to retain local employment for the Project meaning employee access patterns for the current mining operation are unlikely to change in any material way during the above ground mining activity. The major light vehicle routes to the site in the vicinity of the Project are shown in Figure 8-87.
The Project will employ up to 100 employees, fewer than the number of employees currently travelling to site (145 employees as of March 2013). As such, the impact on residential areas resulting from employee access to the site for the Project will be lower than for the current mining operations which are minimal, particularly as light vehicle approaches do not adjoin residential areas.

Excavation activities will require between two and nine Caterpillar 777F trucks to haul waste material to and from the processing plant. However, all waste rock generated during the operation will either be stored at the TWRS or directly backfilled into the North Pit meaning all mining equipment movements will be contained within the main Project area and not on public roads.

The movement of waste rock from Mt Micke to the South Pit (Figure 8-92) will peak in Year 5 at 4,848 individual haul truck movements; or an estimated maximum of 150 movements per day (i.e. 75 in each direction). This is the only movement that requires haul trucks to cross public roads (Albion Road) (Figure 8-92); however none of these movements are close to residential areas and will not have any impact in this regard.
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Mobilisation and demobilisation of up to 29 vehicles (including excavators, haul trucks and bulldozers) to the Project area will be required at the beginning and conclusion of the Project, however their arrivals are assumed to be staggered over a number of weeks and have minimal impact on surrounding areas.

Detailed assessments of potential noise and dust impacts associated with internal traffic movements resulting from the Project are provided in Sections 8.5 and Section 8.7 respectively. Management and mitigation measures have been identified and will be implemented to minimise impacts.

Impacts of mining traffic on road and intersection congestion

Assuming three haul truck movements per hour between Mt Micke and the processing plant and 100 light vehicle traffic to and from the Project area per day, future traffic volumes have been determined for the impacted intersections. These volumes are shown in, Figure 8-88, Figure 8-89, Figure 8-90 and Figure 8-91.

These figures show peak hour traffic movements for Year 5, the only year that heavy vehicles associated with mining cross public roads, with heavy vehicle (anything larger than a car including delivery trucks and vans) proportions shown next to the total traffic volumes as a percentage. Therefore, while haul trucks are only expected at the haul road / Albion Road intersection (see the description of the new haul road / Albion Road intersection in Section 8.14.4), heavy vehicle types associated with the Project are likely in other locations.
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Figure 8-88 Leviathan Road / Reefs Road – future total peak hour traffic volumes, Year 5*

Figure 8-89 Crowlands Road / Leviathan Road / Oliver Road – future total peak hour traffic volumes, Year 5*

Figure 8-90 Reefs Road / Mine Access Road – future total peak hour traffic volumes, Year 5*

Figure 8-91 Albion Road / Leviathan Road – future total peak hour traffic volumes, Year 5*

* Percentages represent heavy vehicles as a proportion of total traffic volumes.

Year 5 traffic volumes and patterns assume 100 car movements to and from the Project area and 150 heavy vehicle movements per day. This scenario is highly conservative and unlikely to occur during the Project, as peak car movements to the Project area are scheduled to occur during Year 2, while heavy vehicle movements on public roads are only scheduled for Year 5 of the Project.
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The predicted traffic volumes detailed in the above figures are not expected to result in congestion within the road network surrounding the Project area.

As outlined earlier, the degree of saturation (DoS) is a measure of congestion levels experienced by road users at intersections.

Similar to the DoS assessment conducted for the existing traffic volumes, the performance of the following intersections were assessed in terms of the likely impact of the Project on the DoS:

- Reefs Road / Mine Access (unsignalised T-intersection)
- Reefs Road / Leviathan Road (unsignalised T-intersection)
- Leviathan Road / Albion Road / Jubilee Road / Bulgana Road (unsignalised four-way intersection)
- Leviathan Road / Landsborough Road / Crowlands Road (unsignalised four-way intersection).

The results shown in Table 8-85 indicate that the highest volume mining related traffic that could be expected during the Project (Year 5) is not likely to have a significant impact on intersection performance when compared with the scenario where the Project does not proceed. The intersections remain well within capacity limits with a maximum DoS ranging between 0.01 and 0.04 and average delays increasing from between 0.8 seconds and 15 seconds.

The fire watch building and communications tower is proposed to be relocated to the existing SGM stores area and accessed from Albion Road (refer to Chapter 6 for details). An existing off-road vehicle track will be upgraded to provide vehicle access to the existing stores area. Access to the stores area from Albion Road will be very limited with a maximum of five movements per day, therefore a traffic assessment of the access road was not deemed necessary.

The stores area and access road will need to be considered further in a road-use management plan to determine whether any intersection upgrades are required.
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### Table 8-85 Intersection performance comparison between no Project and Year 5 of the Project

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Critical movement</th>
<th>DoS</th>
<th>Average delay (seconds)</th>
<th>Queue length (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No Project*</td>
<td>Year 5**</td>
<td>Incremental impact</td>
</tr>
<tr>
<td>Reefs Road / mine access</td>
<td>Reefs Road; east &amp; west approach</td>
<td>0.01</td>
<td>0.01</td>
<td>0</td>
</tr>
<tr>
<td>Reefs Road / Leviathan Road</td>
<td>Leviathan Road; south approach</td>
<td>0.01</td>
<td>0.01</td>
<td>0</td>
</tr>
<tr>
<td>Leviathan Road / Albion Road / Jubilee Road</td>
<td>Leviathan Road; north approach</td>
<td>0.01</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Leviathan Road / Landsborough Road / Crowlands Road</td>
<td>Crowlands Road; east &amp; west approach</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
</tr>
</tbody>
</table>

* 'No Project' data excludes existing (i.e. 2013) mine traffic so represents traffic volumes that are lower than actual current volumes.

** Year 5 traffic volumes and patterns assume 100 car movements to and from the Project area and 150 heavy vehicle movements per day. This scenario is highly conservative and unlikely to occur during the Project, as peak car movements to the Project area are scheduled to occur during Year 2, while heavy vehicle movements on public roads are only scheduled for Year 5 of the Project.
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Impact of mining traffic on road safety

The movement of waste rock between Mt Micke and the South Pit is the only time mine trucks will access the public road network (Figure 8-92). The total distance of this movement in one direction is currently approximately 270 metres (Figure 8-92). Mine trucks take a significant amount of time to complete movements on the public road network and motorists on the public road network experience an all red time at the existing mine traffic lights of 50 seconds. From the traffic lights, motorists cannot see the oncoming mine trucks and have been observed continuing on through the red signal.

![Figure 8-92](image.png)

**Figure 8-92** Current vehicle movements between the processing plant and Mt Micke

While the VicRoads CrashStats data presented earlier in this section indicate that there have been no casualty accidents on the roads surrounding the mine site, and the proposed mining operation could continue to use the current access routes, a new haul road / Albion Road intersection is proposed to remove any risk of issues at the current traffic lights. This is discussed in more detail in Section 8.14.5.
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Entrance gates for the site currently exist on Leviathan Road for truck access and Reefs Road for staff access and parking. The configuration of these access points currently take into account the volume and swept path of vehicles that access and egress the site. Onsite parking, circulation and vehicle separation will all be within the site and do not need to be upgraded from current arrangements.

The mobilisation and demobilisation of mobile equipment to site and transport of waste rock from Mt Micke to the South Pit includes over dimensional (OD) vehicles. An approved OD permit from VicRoads must be obtained prior to any OD vehicles using the public road network.

Impacts of mining traffic on public transport and freight routes

A number of long-distance regional bus services operate throughout north-west Victoria and seven of these routes provide services to Stawell. These public transport services occur at a low frequency; at or below one service per day.

The mobilisation and demobilisation of up to 29 mining vehicles may interact with these routes, however this impact is likely to be minimal due to the low frequency of services and the low number of mining vehicles required. Day-to-day project vehicles will not interact with public transport and freight routes. On this basis, public transport services will not be significantly impacted based on the proposed vehicle movements generated by the Project.

School bus route operators and local school principals were consulted contacted as part of this study and confirmed that the Project would not impact on existing bus routes.

8.14.4 Management and Mitigation Measures

This section outlines the recommended mitigation measures for impacts on the existing road network.

New haul road / Albion Road intersection

To reduce the safety risk posed by mine trucks at the Albion Road / Jubilee Road / Bulgara Road / Leviathan Road intersection (Figure 8-92); it is proposed to install a new intersection including temporary traffic signals and the construction of a new haul road as shown in Figure 8-93. Details of this intersection arrangement, including the use of traffic signals are to be confirmed with NGSC should the Project receive approval.

The benefit of this arrangement is that mine trucks will only cross Albion Road (Jubilee Road will be closed to public traffic during Year 5) rather than travel on public roads. This arrangement will also allow motorists a clear view of mine truck movements.
In order to further improve the safety of public traffic, it is proposed that Jubilee Road (from the Mt Micke access gate through to Albion Road) and Bulgana Road (access from Leviathan Road) may be closed to public traffic during periods when mine trucks require access to Mt Micke (i.e. Year 5). The closure of Bulgana Road will remove any interaction between haulage trucks and public traffic and reduce the risk of collision between haulage trucks and public traffic. Should the Project proceed, this closure would be considered in consultation with NGSC and Hillside Paintball (which is currently accessed via Jubilee Road and Albion Road).
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Public road closures and associated bypass works

Road closures will be designed and constructed to *Austroads Guide to Roads Design* and *VicRoads Supplement to Austroads Guide to Roads Design*. As part of the Project, SGM is proposing to close the following road sections and is responsible for all associated costs:

- Big Hill Road – whole length
- Reefs Road – between Big Hill Road and mine access gate
- Scenic Road – whole length.

As part of road closure, SGM will communicate and consult with all relevant stakeholders (NGSC and community) to ensure works meet required standards and are consistent with both State and Council planning.

The signage to direct visitors and trucks to the mine plant will be reviewed and updated as required (e.g. Big Hill road closure will require access to Reefs road from Leviathan road for employees and visitors). Trucks will continue to enter the site via Leviathan road.

Mt Micke Traffic Management Plan

A Traffic Management Plan will be developed to manage material movements between Mt Micke and the South Pit and will include:

- operating hours
- vehicle operating speed limit restrictions
- signage
- temporary traffic signal configuration
- road inspection program
- road rehabilitation
- use of unlicensed vehicles on public roads.

Site access intersections

The existing mine access entrances will be used to access the Project area. A new haulage vehicle access at Albion Road will also be constructed. The fire watch building and communications tower will be relocated to the current SGM stores area and accessed from Albion Road and will require an access track from Albion Road.

As these works affect the existing road network and are entirely attributed to the impact of the Project, SGM will be responsible for all associated costs with upgrading these access point intersections. A traffic sign plan for the haul road / Albion Road Intersection is included in Appendix B of the Traffic Impact Assessment (Technical Appendix 13).

NGSC has funding to undertake works on the Albion/Leviathan intersection to make it B-double compliant. These works will be completed following completion of mining and rehabilitation works to prevent any damage that may be caused by mine trucks.
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Development of a road maintenance program
As part of any road management works, SGM will:
- conduct a baseline inspections with a council representative prior to commencing any works
- complete a visual assessment of road integrity at all impacted road sections at a frequency that is agreed with NGSC
- repair road sections impacted by works at the end of the project, to the satisfaction of NGSC.

Capacity upgrades for over dimensional vehicles
Mitigation measures recommended to manage OD vehicles impacts on the road network include:
- planning of required freight movements to utilise non OD vehicles where possible
- planning freight movements to utilise OD vehicles which do not exceed the existing available envelope dimensions
- following required planning, permit applications and escort requirements as specified by VicRoads.
Implementation of these mitigation measures will be refined as the details of specific freight requirements of the Project are finalised.

8.14.5 Conclusion
The Project will generate minor changes to traffic volumes on the existing road network surrounding the Project area. The overall number of employees for the Project (and hence employee traffic) is lower than that associated with the underground mining operations and the vast majority of traffic generated by the Project occurs only within the mine boundaries. Year 5 of the Project is the only year that mining vehicles (haul trucks) cross public roads and measures have been proposed to significantly reduce any risks associated with this.

As such, potential amenity impacts caused by mine traffic on residential streets will be minimal.

The impact of mining traffic on the performance of the road network has been assessed and is considered to be minimal. The impact of the Project on the performance of intersections is not significant and most do not require mitigation. All intersections assessed fell well within capacity limits (DoS below 80 per cent).

Mining traffic is not expected to impact on public transport and freight routes and does not require mitigation.

Overall, it is contended that the Project traffic impacts are well within acceptable limits from social, road safety and road capacity viewpoints.
8.15
Visual and Landscape
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8.15 Visual

8.15.1 Introduction
This section of the EES describes and assesses the potential visual and landscape impacts resulting from the Project as Big Hill is progressively mined, backfilled and rehabilitated. It identifies measures to manage and mitigate potential adverse impacts and assesses the overall impacts on visual amenity following implementation of the proposed management and mitigation measures.

This assessment is based primarily on information provided in:

This report is included in Technical Appendix 15 to this EES.

**Relevant sections of EES Scoping Requirements**
This section of the EES covers the following components of the EES Scoping Requirements insofar as they relate to landscape and visual impact:

**Draft Evaluation Objective**
To minimise adverse effects on landscape, visual amenity and recreational values associated with Big Hill and environs.

**Key issues**
- Changes to the visual amenity and character of Stawell township as Big Hill is progressively removed, mined and backfilled and rehabilitated.
- Short-term and potentially permanent effects on the landscape values and associated recreational values of Big Hill, including if reinstatement of topography post-mining is not successful.

**Priorities for characterising the existing environment**
- Characterise the visual character and associated landscape, amenity and recreational values of Big Hill.
- Describe recreational values and use of Big Hill.
- Identify the viewshed to and from Big Hill, including from adjoining residential areas, public lookouts, and key vantage points within the township.

**Design and mitigation measures**
- Outline and evaluate potential and proposed mine design and staging options that could mitigate effects on landscape and visual amenity during mining, from adjoining residential areas, public lookouts, and other vantage points within the township.
- Describe and evaluate potential and proposed measures to restore and rehabilitate the landscape, visual amenity and recreational values of Big Hill after mining.

**Assessment of likely effects**
- Assess the effects of the project and relevant alternatives on:
  - landscape and visual amenity values of Big Hill, with respect to both general views from within the Stawell township and environs as well as the immediate residential surrounds, having regard to both visual changes and viewer perceptions; and
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— recreational opportunities (including for tourists) of loss of access to Big Hill during mining and rehabilitation, in the context of the current extent of use and the availability of alternative recreational opportunities.

Approach to manage performance

- Describe and evaluate any proposed additional measures to mitigate or manage effects on landscape, visual amenity and recreational values, including in relation to:
  - the configuration and staging of works; and
  - reinstatement and rehabilitation activities, including back-filling of mine voids and restoration of Big Hill’s topography to achieve a stable profile and sustainable after-use (with representative cross-sections and a concept plan for after use).

Key issues emerging from EES studies and community consultation

The key issues that emerged from the community in the course of the EES investigations and as a result of the ongoing community engagement and communications program are:

- concern about reduced amenity for nearby residents for the duration of the Project
- short-medium term loss of views to Big Hill within the township during mining and prior to rehabilitation of Big Hill may result in a decline in the aesthetic appeal of Stawell, and for some residents, a reduced sense of place and connection to Stawell
- short-medium term loss of Big Hill as a vantage point for views across the region, and particularly, views of the Grampians until Big Hill is reinstated to original topography
- rehabilitation of the Project area to an acceptable level of visual amenity is an important Project outcome for the Stawell community.

Summary of findings

- Big Hill is prominent both physically and culturally given its proximity to the Stawell township, history, the range of memorial structures on its peak and the views it affords.
- There will be a short-medium term impact on visual amenity as a result of the Project.
- The overall visual impact of the Project is substantially mitigated by the fact that the mining operation involves the excavation of pits in the side of the hill which maintain the ridgeline of Big Hill to a large degree. As a result, the visual impact of the Project from most viewpoints around Stawell is more of disturbed surfaces than removal of the hill profile and ridgeline.
- The overall visual impact of the Project is further reduced by the progressive rehabilitation of the pits as mining progresses with the North Pit fully mined in Year 2 and reinstated to original topography up to three years ahead of the Project finish.
- The rehabilitated Big Hill has the potential to be a visual improvement compared to Big Hill in its current condition and to become an enhanced community asset.
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8.15.2 Existing Conditions

8.15.2.1 Landscape Setting

The Stawell township is located in the northern foothills of the Great Dividing Range, adjacent to the Wimmera / Mallee northern plains of Victoria. Stawell is located near to the southern boundary of the Northern Plains catchment. Rivers such as the Wimmera flow north and generally empty into lakes and wetlands just short of the Murray River.

The Grampians Range is located to the southwest of Stawell. This range is the south western terminus of the Great Dividing Range, which follows Australia’s eastern seaboard, beginning in North Queensland. These elevated hills and ramparts attract substantial rainfall and drain through the Western District of Victoria via the Glenelg, Hopkins and Merri Rivers (among others) to the Southern Ocean.

Big Hill is a ridgeline which rises approximately 40–50 metres above the Stawell township. The town sits at its base and extends south and west towards Pleasant Creek (the site of the original settlement). Big Hill is both physically and culturally prominent given its proximity to the town, its history and the range of structures on its peak. The communications tower located at its summit can be seen from great distances.

8.15.2.2 Statutory Planning Context

A review of local and state planning policies relating to visual amenity impacts has been undertaken and is summarised below.

The most important policy relating to landscape in the Northern Grampians Planning Scheme is:

Clause 12.04-2 Landscapes

The objective of this clause is:

‘To protect landscapes and significant open spaces that contribute to character, identity and sustainable environments.’

Strategies relevant to the Project are as follows:

- ‘Recognise the natural landscape for its aesthetic value and as a fully functioning system.

- Ensure natural key features are protected and enhanced.’

While the Project will have a short-medium term impacts for ‘open spaces that contribute to character [and] identity’, in the longer term the Project will improve public safety through the removal of old mining voids and provide a safe, stable and sustainable landform which will be an ongoing community asset.

The relevant section of the Municipal Strategic Statement (MSS) relating to visual landscape in the Northern Grampians Planning Scheme is:
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Clause 21.09 – Industry

The relevant objective of this clause is:

‘to promote and facilitate mining and extractive industry in the Shire in a responsible manner’

which is to be achieved by encouraging

‘mining and extractive industry activities provided that the proposals adequately address environmental, amenity and rehabilitation issues to ensure the long term impacts of mining and extractive industry on the surrounding environment and community are minimised.’

The Project is consistent with this clause in that it facilitates mining activities while seeking to return a net benefit to the Stawell community in the long term in terms of visual amenity and recreational value through rehabilitation.

8.15.2.3 Landscape Character Determinants

Landscape character is determined by a combination of geology, physiography and land use.

Geology

The geological features of Stawell and the surrounding area are detailed in Chapter 4, Section 4-6.

Physiography

Big Hill is a highly modified landscape due to 19th century mining activity which has resulted in inconsistent tree cover including a range of planted exotic species and self-sown native trees. Replanting of the hill commenced with the Pioneer Memorial Plantation in 1939 and was to continue up the slope of the hill. However, the lack of topsoil and large areas of exposed rock prevented this from occurring. A number of disparate structures are also located on Big Hill. These include water tanks, ventilation shafts, towers and historic memorials and a network of walking paths, which are in a poor state of repair. Some historic mining voids are fenced by cyclone fencing to ensure public safety.

The physiography of Stawell and its backdrop of mountains and hills south, east and west and the vast flat lowlands of the north is apparent from Big Hill (Figure 8-94 and Figure 8-95).

Land use

Agricultural activity is ubiquitous in the region surrounding Stawell, interspersed by National (Grampians National Park) and State Parks, vineyards, wineries (particularly surrounding Great Western), a complex rural road network and the Melbourne-Adelaide rail corridor. A thriving tourism industry has grown around the wineries and dramatic district landscape - especially the Grampians and isolated geological features such as Mount Arapiles.

Historically, gold mining has been a transformative industry in Stawell as evidenced by the extensive physical evidence of both alluvial and deep shaft activity dating from the 1850s. The entire Stawell township area, including Big Hill, is a highly modified landscape by tunnels, trenches, former open cuts and associated infrastructure.
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Within the urban area of Stawell, the following land uses with attendant landscape types can be identified:

- residential
- rural living (low density rural residential)
- industrial (to the south and located generally in the Highway / Railway area)
- commercial (focused on the Main Street activity centre with its retail / restaurant focus as well as administrative).

The land use surrounding the Project area is described in further detail in Chapter 4.

Urban character

The regional and local landscape describes the visual landscape setting, from which the following general observations are made:

- The views of Big Hill from the township lie mainly to the south and west, and most of these views have an urban foreground and middle ground (i.e. with streets, building infrastructure).
- Open landscape is located to the north of Big Hill. Beyond this is agricultural and conservation land (Deep Lead conservation area), as well as the Stawell Golf Club. Immediately east of Big Hill itself is mining infrastructure (including dams, processing equipment, a shed and stockpiles).

In summary, Stawell’s urban character is defined by:

- Undulating and varied topography.
- Striking views to the mountains south, east and west.
- An irregular but pleasant street system giving rise to some surprising views.
- A sense of history resulting from numerous heritage relics and ruins.
- Current mining operations (works area and processing plant) located east of Big Hill.
- Attractive Victorian era town centre, including the town hall, post office and a number of churches.
- Suburban areas, located to the south of the Melbourne-Adelaide railway line northwest of Campbell-Needham and Byrne Street. To the east there is also a suburban enclave surrounding the trotting track and showground. Most of these precincts are residential and date back to the mid-20th century.
- The Western Highway forms a southern border to Stawell; beyond this the landscape is flat and dominated by open Eucalypt woodland.
- An elevated heritage area in contrast to a lower precinct stretching from the railway south to the Western Highway. The elevated part of town enjoys open vistas and sense of space. The lower is contained spatially with only limited views.
- Box Ironbark Forest surrounding the township and infiltrating some areas, such as the Little Rickard and Moonlight Street area.

Landscape value

Based on community consultation and the social impact assessment conducted as part of this EES, it is evident that Big Hill is valued by the Stawell community primarily for its historic landscape, as a recreation area and for its panoramic views of the township and the Grampians but is also acknowledged as being degraded, and by some, an eyesore.
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Heritage
An historic heritage study of the Project area has been undertaken which has recognised the Big Hill area as a ‘heritage landscape’ of local significance and recommended its inclusion in the NGSC local heritage overlay. The western end of Big Hill was assessed but deemed not appropriate for inclusion on the Victorian Heritage Register. The cultural heritage and historic heritage values are discussed in further detail in Sections 8.3 and 8.4 respectively.

Recreation
Big Hill is valued as a recreational area by the local community for informal activities such as walking. This is discussed in detail in Section 8.15.

Summit views
The views from the summit of Big Hill are highly valued locally. The view from Big Hill to the west provides an excellent view of the township and the Grampians beyond. These panoramas are also important because they constitute a measure of how visually ubiquitous Big Hill is within the township environments and beyond.

8.15.2.4 Key Community Values
Community values relating to the visual and landscape impacts have been identified through a range of consultation activities undertaken as part of the Project. It is important to understand community perceptions about the visual and landscape features of Big Hill that is highly valued so that potential impacts can be managed through mitigation measures for the Project.

Resident interviews
At the outset of the Project, almost 100 residents who live in the surrounding streets of Big Hill participated in a consultation interview. The purpose of the interview was to understand their perceptions of Big Hill and identify key concerns and potential benefits they believe would result from the Project. A number of the responses provide useful insight into the visual impact assessment.

When residents were asked to express their current perceptions of Big Hill, the majority of respondents identified Big Hill as a viewing and recreational area, and others perceived it to be a local attraction that has historical values. However, over half of the respondents identified that Big Hill requires improvements and a similar number believe it is an ‘eyesore’.

Visual impacts were not readily identified by those residents interviewed as a key concern of the Project with only a small number identifying visual impacts as a potential negative. Likewise, visual improvements were identified by only a small proportion of respondents as a potential benefit of the Project to them personally or to the broader community.

Should the Project proceed, the key outcomes sought by nearby residents are rehabilitation and an enhanced recreation area at Big Hill. Retaining the lookout and viewing opportunities from Big Hill was identified by a small proportion of nearby residents as a good project outcome.

Overall, the key community value identified through the resident interviews undertaken, is the importance of delivering a rehabilitation plan for Big Hill that would offer an improved visual amenity from its current condition (refer to Chapter 7).
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**Stakeholder workshop**

A stakeholder workshop was held with local businesses and community organisations to identify aspects of the current site that the community like, what they believe works well now, aspects they do not like and what could be improved at Big Hill.

Overwhelmingly, stakeholders identified the viewing area to the Grampians as the key positive of the current situation at Big Hill. Interestingly, Big Hill was also identified as an ‘eyesore’ or as ‘ugly’ in appearance as the most commonly identified negative of the current situation.

The key themes relating to the visual impact assessment that emerged from this consultation included:

- tourism and attractions
- amenity and recreation
- visual improvement
- rehabilitation.

In relation to visual improvements, stakeholders identified that the priority outcomes for Big Hill should be a stunning outlook, landscaping of the entire hill, retaining the existing hill height and ensuring that the new Big Hill is a spectacular visual aspect from any point within the Stawell township.

The stakeholder workshop, which engaged a broader set of community stakeholders than residents in the immediate vicinity of Big Hill, has indicated that the broader community view of Big Hill is not dissimilar to those living nearby and that there appears to be some commonality of view about outcomes for the hill.

### 8.15.2.5 Existing visual setting of Big Hill in the local context

Figure 8-97 through to Figure 8-112 below provide a range of visual perspectives of Big Hill from selected viewing points around Stawell. Figure 8-96 provides detail on where each of the viewing points is located and provides a comprehensive perspective of the way in which Big Hill is seen from around Stawell, and is the basis for assessment of visual impact in the following section of this chapter.

The existing conditions photographs show that from most vantage points in and around Stawell township, views of Big Hill are framed by the urban environment with houses, commercial premises and utilities generally visible in the foreground. Big Hill is not of an elevation or scale where it dominates the local landscape setting, but rather, is integrated with the urban form and open space around it. As discussed in the impact assessment section of this chapter, the open pit mining approach, from many viewing points, will not result in loss of the Big Hill ridgeline as the pits cut into the hillside rather than removing the hill top completely. The visual impression of the hill from many vantage points would be one of scattered vegetation interspersed with cleared and disturbed surfaces.

From many perspectives, Big Hill is not dominant and is often only identifiable by the prominent communications tower or Pioneer Memorial Rotunda.

The following section of this chapter assesses the visual impact of the Project from a number of the viewing points depicted in Figure 8-97 through to Figure 8-112.
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Figure 8-94  Panorama from Big Hill summit (east to southeast)

Figure 8-94 begins with a northeast image of the summit and pans eastwards. The GWMWater reservoir is visible in the middle-ground and the almost flat northern plains of the Wimmera are visible in the background.

Figure 8-95  Panorama from Big Hill summit (southwest to west)

Figure 8-95 pans from southwest to west. The urban area of Stawell township is in view with the Great Dividing Range as a backdrop.
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Figure 8-96  Visual impact assessment - photograph location map
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Figure 8-97  Photo 1: Regional view from Crowlands Road (looking southwest)
Taken from Crowlands Road looking southwest toward Stawell. It is only from this point that Big Hill becomes visible and then is only recognisable by the communications tower, tree line and minor infrastructure buildings.

Figure 8-98  Photo 2: Local view from Crowlands Road (looking west)
Taken from Crowlands Road looking west toward Stawell. Big Hill itself is not visible due to obstruction by a dense line of vegetation and its location is only identified by the communications tower. The shape of the hill is not apparent.

Figure 8-99  Photo 3: Immediate view from Navarre Road (looking southwest)
Taken from Navarre Road looking southwest towards Stawell. The view towards Big Hill is obstructed by the dam wall with only a glimpse of the communications tower to identify the location of the site. The dam wall obstructs the view towards the hill.

Figure 8-100  Photo 4: Immediate view from Short Street (looking south)
Taken from Short Street looking south towards the hill. The view towards the site is cluttered with building infrastructures and only in the background are there glimpses of the Pioneer Memorial Rotunda, communications tower and water tank.
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Figure 8-101 Photo 5: Immediate view from Moonlight Street (looking southeast)

Taken from Moonlight Street looking southeast towards the hill. The framing of the urban landscape directs a vista towards the hill however building infrastructures obstructs the view and detract the eye from the site. The view is cluttered by the water tank, mining infrastructure and communications tower making the hill unappealing to the eye. The hill has a multitude of structures and does not dominate within this view. Urban landscape detracts from the view of the hill and the hill is insignificant and blends into the background.

Figure 8-102 Photo 6: Immediate view from Main Street (looking southeast)

Taken from Main Street looking southeast towards the hill. The elevation allows a brief glance of the Pioneer Memorial Rotunda roof and the top of the communications tower. This view is dominated by earth and power lines.

Figure 8-103 Photo 7: Immediate view from Layzell Street (looking east)

Taken from Layzell Street looking east towards the hill. The landform of the hill is identifiable however the hill is not visually exciting or iconic and integrates with the urban landscape of Stawell. Pioneer Memorial Rotunda is visible but obstructed by the local urban elements. Urban elements of lamp posts and building structures dominate this view making the hill blend into the background.

Figure 8-104 Photo 8: Immediate view from Byrne Street (looking east)

Taken on Byrne Street looking east towards the hill. No visible view of the Big Hill is evident since it is mostly obstructed by the built environment. The protrusion of the communications tower is the only way to identify the site location. A range of urban elements of dense vegetation and structures obstruct views of the site.
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Figure 8-105 Photo 9: Immediate view from Kinsella Street (looking northeast)

Taken on Kinsella Street looking northeast towards the hill. Big Hill and the Pioneer Memorial Rotunda is not a dominant part of the landscape and blends in with the existing built environment. The hill is visually poor and is not recognisable as a significant site as it is cluttered by power posts and because of sparse vegetation. Urban elements dominate the view making the hill blend into the background.

Figure 8-106 Photo 10: Immediate view from Patrick Street (looking northeast)

Taken on Patrick Street looking northeast towards the hill. The view of the hill is obstructed by vegetation and building structure and is not evident where only the telecommunications tower determines the site location.

Figure 8-107 Photo 11: Immediate view from a side street close to Evan Street (looking northeast)

Taken from a side street close to Evan Street looking northeast towards the hill. The hill is only identifiable through the tree line but is visually cluttered by telecommunications tower and mining infrastructures.

Figure 8-108 Photo 12: Immediate view from Evan Street (looking northeast)

Taken from Evan Street looking northeast towards the site. The view is largely obstructed by building structures. It is visually crowded with the elements of the telecommunications tower and miscellaneous mining infrastructure.
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**Figure 8-109 Photo 13: Local view from Gray Street (looking north)**

Taken from Gray Street looking north through a wire fence towards the hill. The shape of the hill is evident however it is not recognisable as the iconic Big Hill and only glimpses of the communications tower and miscellaneous structures are seen. This view towards the hill is unattractive and largely obstructed.

**Figure 8-110 Photo 14: Local view from the intersection of Conway and Holt Street (looking north)**

Taken from the intersection of Conway and Holt Street looking north towards the hill. Big Hill is visible showing the communications tower and structures without much obstruction. It does not present as an iconic Big Hill point, but rather blends into the Stawell townscape.

**Figure 8-111 Photo 15: Local view from an intersection of Holt and Fisher Street (looking northwest)**

Taken from an intersection of Holt and Fisher Street looking northwest towards the hill. A clear view of the hill is evident and is seen as a part of the urban landscape of Stawell without much historical recognition. Big Hill is cluttered by the communications tower and miscellaneous structures. Local urban environment blends in with the hill in the background disguising the site.

**Figure 8-112 Photo 16: Local view from Wimmera Street (looking towards Baylis Street)**

Taken from Wimmera Street looking towards Baylis Street towards the hill. It is framed because of the urban environment that creates a vista leading the eye towards the site. This view is direct and appealing to the local context. There is minimal obstruction towards the hill with the Pioneer Memorial Rotunda recognisable.
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8.15.3 Impact Assessment

This assessment examines the potential impacts of the Project on the existing landscape and views to Big Hill and the surrounding area. Three elements of the Project were considered as part of the visual impact assessment, namely:

- the short – medium term impact of the pits cut into the side of Big Hill during mining activities and while progressive rehabilitation takes place
- the permanent relocation of the communications tower and fire watch building from the top of Big Hill to a slightly lower elevation along the ridge extending from the southeast of Big Hill
- the location of the TWRS northeast of the Big Hill ridge adjacent to Crowlands Road.

The visual impact of the Project was modelled at various stages, including Year 2 (when mining in the North Pit has been completed and mining has commenced in the South Pit) and following the completion of the rehabilitation phase.

The assessment of the rehabilitated landform assumes:

- the rehabilitation and revegetation of Big Hill will be completed progressively
- the Pioneer Memorial Rotunda will be reinstated in its current position
- approximately 10 years of vegetation growth on the rehabilitated landscape.

An end use Master Plan will be developed by the future land manager of the Project area and will include the detailed design of memorial relocation, pedestrian / recreation trails, vehicle carriageways, parking and community facilities (refer to Chapter 10).

8.15.3.1 Photography and Modelling

As part of the impact assessment, a series of photos was taken from locations around Stawell that provide immediate views (typically less than 0.5 kilometre from the Project area), local views (typically 0.5 kilometre to one kilometre) and regional views (less than one kilometre) of the Project area.

Photos have been taken at a standard eye height of 1,650 millimetres using an 80 millimetre (or zoom lens) as this more closely approximates the distance the eye sees the view, although not the range, of the human eye. Additionally, 30 millimetre photos of each view were also taken and are included in Technical Appendix 15.

A 3D base model was constructed in digital terrain models which were modelled in Vectorworks 2013 using geometry, materials and lighting effects to provide an image that replicates the actual conditions of the Project area. All care and effort has been made to represent the landscapes scale and vegetation.
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8.15.3.2 Assessment Criteria

The visual impact assessment assessed the potential impact of the Project in terms of scale, extent and value.

- **Scale** assesses the impact of the change to the existing view, and is rated as:
  - low: imperceptible visible change
  - low to moderate: minor visible change
  - moderate: definite visible change has occurred
  - moderate to high: the visible change is highly noticeable
  - high: the visible change dominates the view.

- **Extent** assesses how many people will be affected by the change to the view, and is rated as:
  - low: few people affected as the viewpoint is a low use area (low numbers of people passing by), the access is poor, or well screened by vegetation
  - moderate: access to the view is good although it is only a passing view
  - high: highly exposed and always in full view.

- **Value** assesses how those affected by the change perceive the change. It relates to its importance as a visual landmark to the town of Stawell.

8.15.3.3 Modelling and Assessment

The potential impact to the visual landscape was modelled for a selection of photographs (viewing points) that were considered representative of regional, local and immediate views of Big Hill (refer to Figure 8-96 for locations of the photos). A selection of montages is included below showing the existing conditions, Year 2 of the mining activity and after rehabilitation. Year 2 was considered to be ‘worst case’ as the mining of North Pit (which is the most visible) is nearing its maximum depth and mining has also commenced in the South Pit. A brief description and rating of the assessed level of impact associated with Year 2 of mining is included with each montage.

In considering the level of impact associated with each viewing point, it is important to remember that the impact is not permanent and that the entire Big Hill will be rehabilitated within five years. As such, the impact rating assigned to each viewing point is for a point in time and the impact after the Project is complete reverts to conditions that will be similar to existing conditions, or even improved.
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**Big Hill**

**Regional view**

Figure 8-113, Figure 8-114 and Figure 8-115 were taken from Seaby Street looking north towards the city centre near the intersection with Smith Street (refer to Figure 8-96, Photo 17).

<table>
<thead>
<tr>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low:</td>
<td>The change to the view (from a hill to an open pit face) is noticeable, but not significant due to the distance and other urban infrastructure in the mid and foreground.</td>
<td>High: This is a highly trafficked main road, hence the mining would be visible to a substantial number of people using the road.</td>
</tr>
<tr>
<td>High:</td>
<td>Big Hill is highly regarded by the Stawell community, based on feedback from community consultation.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 8-113 Existing regional view of Big Hill from Seaby Street (looking northeast)  
Figure 8-114 Year 2 regional view of Big Hill from Seaby Street (looking northeast)  
Figure 8-115 Post rehabilitation regional view of Big Hill from Seaby Street (looking northeast)
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Local view

Figure 8-116, Figure 8-117 and Figure 8-118 were taken from Wimmera Street looking northeast towards Big Hill (refer to Figure 8-96, Photo 16).

<table>
<thead>
<tr>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moderate</strong></td>
<td>While the view will change (from a hill to an open pit face), the vegetation in the mid ground and the distance tends to mitigate the impact.</td>
<td><strong>Moderate</strong> - <strong>High</strong>: The view is from a public and regularly used location. <strong>High</strong>: Big Hill is highly regarded by the Stawell community, based on feedback from community consultation.</td>
</tr>
</tbody>
</table>

Scale

Extent

Value
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Immediate view

Figure 8-119, Figure 8-120 and Figure 8-121 were taken on Kinsella Street looking northeast towards Big Hill (refer to Figure 8-96, Photo 9).

<table>
<thead>
<tr>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>The view will be significantly altered by the Project with removal of infrastructure such as the Pioneer Memorial Rotunda, vegetation removal and exposure to the open pit.</td>
<td>The view will be significantly altered by the Project with removal of infrastructure such as the Pioneer Memorial Rotunda, vegetation removal and exposure to the open pit. Big Hill is highly regarded by the Stawell community, based on feedback from community consultation.</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>All streets immediately to the south and west of the mine will be exposed to this view. However, these streets are residential and not high traffic areas.</td>
<td>All streets immediately to the south and west of the mine will be exposed to this view. However, these streets are residential and not high traffic areas. Big Hill is highly regarded by the Stawell community, based on feedback from community consultation.</td>
</tr>
</tbody>
</table>
8 Environmental Impact Assessment

Immediate view

Figure 8-122, Figure 8-123, and Figure 8-124 were taken from Moonlight Street looking southeast towards Big Hill (refer to Figure 8-96, Photo 5).

<table>
<thead>
<tr>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>High:</td>
<td>The view has completely changed as this is one of the few areas where the entire hill and ridgeline has been temporarily removed from view.</td>
<td>Moderate: The view has changed from existing conditions in that the communications tower is no longer evident and vegetation cover appears somewhat different. However, the ridgeline is re-established and the change from existing conditions is not significant.</td>
</tr>
<tr>
<td>Moderate:</td>
<td>The visual change is visible to all local residents and passer-by. It is prominent due to its adjacent location. The vista formed by the street network and buildings further exacerbates the visual change.</td>
<td>Moderate:</td>
</tr>
</tbody>
</table>
Immediate view

Figure 8-125, Figure 8-126, and Figure 8-127 were taken from Layzell Street looking east towards Big Hill (refer to Figure 8-96, Photo 7).

<table>
<thead>
<tr>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>The view has completely changed with mining. The current view of a vegetated hill side with the rotunda is now of an open mine face.</td>
<td><strong>High</strong>: The visual change is visible to all local residents and passer-by. It is prominent due to its immediate location and can be clearly seen from any point within the general intersection. <strong>High</strong>: Big Hill is highly regarded by the Stawell community based on feedback from community consultation.</td>
</tr>
</tbody>
</table>
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**Communications tower and fire watch building**

**Regional view**

Figure 8-128 and Figure 8-129 were taken from Patrick Street, looking north (refer to Figure 8-96, refer Photo 5T).

<table>
<thead>
<tr>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>High: The tower will be clearly and highly visible.</td>
<td>High: This is a high traffic area with schools on the north side of the street and a trotting track to the south.</td>
<td>Low: The communications tower and fire watch building are already a fixture on Big Hill and visible from many vantage points around the town.</td>
</tr>
</tbody>
</table>
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Tower regional view

Figure 8-130 and Figure 8-131 were taken from Napier Street looking east towards the site proposed for the relocation of the telecommunication and fire watch towers (refer to Figure 8-96, Photo 8T).

<table>
<thead>
<tr>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>The tower will be clearly and highly visible.</td>
<td>Low: The communications tower and fire watch building are already a fixture on Big Hill and visible from many vantage points around the town.</td>
</tr>
<tr>
<td>Low to Moderate</td>
<td>To get this view the immediate foreground needs to be uninterrupted beyond three meters. A large tree/trees or double story house would hide the tower.</td>
<td></td>
</tr>
</tbody>
</table>
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Local view

Figure 8-132 and Figure 8-133 were taken from O’Regan Street, looking north (refer to Figure 8-96, Photo 4T).

![Figure 8-132 Existing local view from O’Regan Street (looking north) of the site proposed for relocation of the communications tower and fire watch building](image1)

![Figure 8-133 Post relocation local view from O’Regan Street (looking north) of the relocated communications tower](image2)

<table>
<thead>
<tr>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>The communications tower will be seen but will be screened to some extent by the eucalypt woodland.</td>
<td>Low-Moderate: Traffic on this road is considered to be low.</td>
</tr>
<tr>
<td>Low-Moderate</td>
<td>Traffic on this road is considered to be low.</td>
<td>Low: The communications tower are already a fixture on Big Hill and visible from many vantage points around the town.</td>
</tr>
</tbody>
</table>
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Temporary Waste Rock Stockpile

Immediate View

Figure 8-134 and Figure 8-135 and were taken from Crowlands Road (refer to Figure 8-96, Photo 2T and Photo 1)

Figure 8-134 Existing local view from Crowlands Road (looking south) towards the proposed Temporary waste rock stockpile

Figure 8-135 Existing local view from Crowlands Road (looking southwest) towards the proposed Temporary waste rock stockpile
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Immediate View

Taken from Crowlands Road, looking south (refer to Figure 8-96, Photo 2T).

Scale | Extent | Value
--- | --- | ---
**Moderate:** The TWRS is not visible from Leviathan Rd due to the existing vegetation. From Crowlands the TWRS will be visible amongst the roadside Eucalypts which will mitigate the impact. | **Low:** Crowlands is a rural road and traffic is considered low. | **High:** The current view is of an open paddock surrounded by trees. Most people would consider a stockpile of waste rock to be an inferior view. It is however, only for a relatively brief period, after which point it will be returned to a paddock.
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8.15.3.4 Assessment of Impacts

Table 8-86 through to Table 8-88 provide a summary of the assessed level of impact associated with the mining of Big Hill, relocation of the communications tower and fire watch building and the TWRS from the nine viewing points considered representative of regional, local and immediate views of the Project site. The tables indicate that overall, two of the nine viewing points have been assessed as having high visual impacts for scale (change to existing view), extent (how many people affected) and value (how those affected perceive the change). In both instances, the viewing points are from within the township and are close to the North Pit.

**Big Hill**

The visual impact of the Project is the greatest at locations closest to Big Hill as there is less distance and mid or foreground infrastructure or vegetation to mitigate the impact. As shown in Table 8-87 below and in the previous photographs, the highest impacts in all three categories of scale, extent and value are from Kinsella Street (Photo 9) and Layzell Street (Photo 7).

The visual impact in Moonlight Street (High, Moderate, Moderate) (Photo 5) is very evident during the mining phase of the Project as the Big Hill ridgeline disappears from view for a period of time, particularly in Year 2. Arguably, residents in this area will experience the greatest level of temporary visual ‘change’ as a result of the project. However, the extent of change is moderated by the fact that during mining, residents in this area do not have a constant view of the mined pit face. Once mining in the North Pit has taken place and rehabilitation completed, the view of Big Hill from Moonlight Street will be fully restored.

The other three locations where visual impact ratings were high for one or more of scale, extent and value are views from Layzell Street (High, High, High) (Photo 7), Kinsella Street (High, High, High) (Photo 9) and Wimmera Street (Medium, Medium-High, High) (Photo 16). In each of these cases, the visual impact is different from that in Moonlight Street in that the Big Hill ridgeline remains intact in the view shed but the open face of the North Pit is visible. Again, the proposed rehabilitation activities to occur beyond Year 2 return the views of Big Hill from Layzell, Kinsella and Wimmera Streets.

Seaby Street (Low, High, High) (Photo 17) is the only other location where at least two of the visual assessment criteria are rated as high impact, but in this case, the regional or more distant nature of the view reduces the scale impact to low. In this case, the scale of change in Big Hill is low (difficult to discern) due to the distance and urban development in the foreground but the extent is high as Seaby Street is a highly trafficked area so visible to many people.

In summary, the visual impact of the Project in the immediate area will be discernible from various distances away from Big Hill but only two of the representative viewing locations are rated as high impact. However, this must be balanced against the hills current landscape which has had some form of mining on it for nearly 150 years; the original vegetation has been removed and, particularly on the northern slope, attempts at revegetation have been hampered by the previous mining activities.

From a professional landscape architects viewpoint Big Hill is best described as extremely compromised and at worst, severely degraded. These comments have also come through in the community consultation, where some respondents described it as ugly which has repercussions on the value rating.
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An equally important consideration to the potential visual impacts of the Project is what Big Hill represents to the local community and the potential impact of its temporary alteration due to mining. Community consultation has shown that Big Hill has iconic status and it is where people go to get an oblique aerial view of Stawell and the surrounding area.

Overall, there will be an extensive temporary visual change to Big Hill (which is already in a degraded state from a landscape perspective) and local residents and visitors will be without its elevated viewing point for a relatively short period. However, there is the potential to increase Big Hill’s value to the community beyond what presently exists through rehabilitation activities and the potential for community input into future uses and facilities through a master plan process.

Table 8-86  Summary of visual impacts associated with mining activities at Big Hill

<table>
<thead>
<tr>
<th>Big Hill view</th>
<th>Photo number</th>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional view of Big Hill from Seaby Street (looking northeast)</td>
<td>17</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Regional view of Big Hill from Wimmera Street (looking northeast)</td>
<td>16</td>
<td>Moderate</td>
<td>Moderate – High</td>
<td>High</td>
</tr>
<tr>
<td>Immediate view of Big Hill from Kinsella Street (looking northeast)</td>
<td>9</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Immediate view of Big Hill from Moonlight Street (looking southeast)</td>
<td>5</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Immediate view of Big Hill from Layzell Street (looking east)</td>
<td>7</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

Communications Tower

The relocated communications tower and fire watch building will have less impact on the landscape due to its size, relative transparency of the structure and the established presence of a tower and a fire watch building already on the hill. As can be seen from the photo montages of Patrick Street (Photo 5T), Napier (Photo 8) and O'Regan Street (4T), the tower structure is a simple, open framed, steel tower.

The regional view from Patrick Street looking north (Photo 5T) has the highest visual impact. The scale impact has been ranked as high as the tower will be clearly visible and the extent impact also rated as high due to the area being heavily trafficked and proximal to schools and the local trotting track. The value however is low as there is an established presence of a tower in the area and a degree of familiarisation with this element on the skyline.

The ratings for the communications tower and fire watch building are summarised in Table 8-87 below.
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### Table 8-87 Summary of visual impacts associated with relocation of the communications tower and fire watch building

<table>
<thead>
<tr>
<th>Tower view</th>
<th>Photo number</th>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local view from Patrick Street (looking north)</td>
<td>5T</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Local view from Napier Street (looking east)</td>
<td>8</td>
<td>High</td>
<td>Low – Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Local view from O’Regan Street (looking north)</td>
<td>4T</td>
<td>Moderate</td>
<td>Low – Moderate</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Temporary Waste Rock Stockpile (TWRS)**

The TWRS will be located on land previously used for the Davis Pit overburden dump (unreserved Crown land) as well as on cleared pasture land currently owned by GWMWater. The 25 hectare footprint of the TWRS is located southeast of Reefs Road and immediately south of GWMWater water storage reservoirs 6 and 7.

As the waste rock stored at the TWRS is to be used for rehabilitation of the mined pits, any visual impact associated with the facility will be temporary and the area would be returned to existing conditions within five years of Project commencement. Figure 8-134 and Figure 8-135 above provide views of the TWRS area from Crowlands Road which is the location from which the facility will be most visible during its use.

The TWRS is a temporary landscape feature which will start at an approximate ground level of 250 metres AHD, peak at around 300 – 305 metres AHD in Year 3 - Year 4 of the Project and return progressively to natural ground levels around Year 5 as the stockpile is used to rehabilitate the mined pits. The TWRS will be clearly visible from the eastern end of Crowlands Road but will be screened from areas to the north of the site by the GWMWater water storage reservoir embankment and the fact that the land slopes away from Big Hill. Views from Leviathan Road to the east of the TWRS are screened by vegetation. The TWRS will not be visible from the township to the west of the Project area as the ridgeline of Big Hill effectively screens the area. At its peak height of around 305 metres AHD, the top of the TWRS may be visible from more distant points around Stawell for a short duration but this will not represent an unacceptable visual impact due to the distance and temporary nature of the stockpile.

As shown in the impact analysis, at its ultimate height it is a small hill which can only be seen from Crowlands Road; and even here it is between roadside vegetation. For these reasons, at its ultimate height, the TWRS has moderate scale impact. Crowlands Road is a rural road with low traffic volumes and no surrounding residential buildings. Few people will see it, so the extent rating is low. As noted in the impact analysis, most people would regard a hill of waste rock as an inferior view to an open paddock, which therefore results in a high visual impact value.

Based on the low exposure of the view and its temporary nature, the visual impact is likely to be considered as within acceptable limits.

The ratings for the TWRS are summarised in Table 8-88.
8 Environmental Impact Assessment

Table 8-88  Summary of visual impacts associated with the temporary waste rock stockpile

<table>
<thead>
<tr>
<th>Temporary waste rock stockpile view</th>
<th>Photo number</th>
<th>Scale</th>
<th>Extent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local view from Crowlands Road (looking south)</td>
<td>2T</td>
<td>Moderate</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

8.15.3.5  Aerial Representation of Visual Changes associated with the Project

The figures below provide a graphic representation of the visual changes associated with the Project from the existing conditions, through to the period with the most visual impact (when the North Pit is fully excavated and mining has commenced in the South Pit), to the phase where the North Pit has been backfilled and mining progresses in the South Pit, and then full reinstatement of Big Hill. It should be noted that this is a graphic interpretation only but it does provide a perspective on the visual changes experienced over the five year project duration. The final revegetation of Big Hill shown in Figure 8-142 may vary depending on the outcomes of the proposed Master Plan for the area which will be developed with stakeholder and community involvement.
Figure 8-138 Oblique aerial view of Big Hill (existing condition)

This oblique aerial view shows the existing condition of Big Hill. The approximate extent of the works area is shown in the red dashed line. As can be seen, vegetation is spotty though consistent in the northern area and denser in the southwest. Already cleared areas are also clearly evident.

Figure 8-139 Oblique aerial view of Big Hill (during Year 2 of the Project)

This same view as the preceding existing example, shows the ‘Worse Case’ in Year 2 when the mine will have the most visual impact. The North Pit is still a large hole with the exposed face to the town and South Pit excavation has commenced.
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Figure 8-140 Oblique aerial view of Big Hill (during Year 4 of the Project)
During Year 4 the North Pit has been filled and profiled to approximate the previous form. South Pit is being filled from the stockpile which is now reduced in height.

Figure 8-141 Oblique aerial view of Big Hill (during Year 5 of the Project)
Year 5 the previous bare earth of the new Big Hill is now covered with emerging plants and stabilising grasses as is the South Pit area.
Figure 8-142 Oblique aerial view of Big Hill (post rehabilitation)

An artist’s impression of the fully mitigated Big Hill at 20+ years. Tree cover is denser and far more extensive than the existing.

Note: End land use and amenity design is to be determined in consultation with the land manager, NGSC and community consultation.
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8.15.4 Management and Mitigation Measures

The Project involves the open cut mining of two pits along the Big Hill ridge line, followed by backfilling of the pits to achieve a stable landform and similar topography. In effect, the rehabilitation will complete the restoration and revegetation of Big Hill that was initiated in 1938 after alluvial gold mining ceased.

Any major visual impact (i.e. the mining of the North Pit), will be of a temporary nature (a total of five years to complete mining and rehabilitation activities). The mitigation will seek to achieve the restoration and long term improvement of Big Hill. Steps have been taken in the design of the Project to minimise visual and landscape impacts arising from the proposed mining and rehabilitation activities. The following sections highlight the management and mitigation measures that have been adopted for the Project.

Reduced project duration

As described in Chapter 5, the Project will include approximately four years of mining with a further year to complete backfilling and rehabilitation. The project duration has been reduced from the eight years proposed in the 1998-1999 proposal, which will reduce the duration of visual amenity impacts on the community by up to four years.

Progressive mining and rehabilitation

The Project description (Chapter 6) describes progressive backfilling and rehabilitation to be undertaken during the Project. This approach addresses the issue of long term visual amenity by backfilling and rehabilitating both pits to their current topographic height and to a similar topographic profile thus removing any long term visual impacts. In Year 2 mining will be completed in the North Pit and will commence in the South Pit. Vegetation will be established following backfilling of the North Pit to create a stable landform and prevent erosion. Progressive rehabilitation (whilst South Pit mining is underway) will reduce the period of visual impact of the Project on the North Pit by up to three years.

Additional management and mitigation measures

The planting of trees in the foreground of key view points towards Big Hill was considered as it would minimise the scale of visual impact. However, due to the relatively short timeframe of the Project, this was considered to be ineffective as there would not be sufficient time for these to become established before the Project was completed.

End use Master Plan

An end use Master Plan is proposed to reinstate Big Hill as a community and regional asset (refer to Chapter 10). This will be undertaken in consultation with the land owner, future land manager and the Stawell community. It will consider vegetation, relocation of heritage monuments and sites, recreational uses, tourist attractions etc.
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Items which would be included in this are:

- identification of the future land manager
- repositioning of memorials including the Pioneer Memorial Rotunda, which may require reinstatement at a higher elevation so it is visible above the canopy line
- cleared areas for access roads, vehicle parking and marshalling areas
- recreational trails, tracks and paths
- management and bushfire (emergency) access tracks
- historic interpretation signage, etc.

8.15.5 Conclusion

Big Hill has been a highly changing landscape over the past 150 years. The historic sketches and photography included in the landscape visual impact assessment (Technical Appendix 15) demonstrate the ongoing and dramatic changes to the hill over time with obvious visual impacts for the Stawell township. This Project represents the continuation of the evolution of the Stawell landscape as a result of mining activity.

There will be a short- to medium-term visual impact associated with the mining of Big Hill and this will affect both local and immediate views of the hill at various times during the five year mining and rehabilitation program. Importantly however, the overall visual impact of the Project is substantially minimised by the fact that the mining operation involves the excavation of pits maintaining the ridgeline of Big Hill largely intact. As a result, the visual impact of the Project from most viewpoints around Stawell is more of disturbed surfaces than removal of the hill profile and ridgeline. From the impact assessment, there are two immediate locations (views) where the scale, extent and value impact of the Project are rated as high due to the change in view and the highly trafficked nature of the areas. There are two other locations where the visual impact is rated as high on two of the three assessment criteria (scale, extent, value), namely a view through the township to Big Hill and a location where the relocated communications tower will be highly visible. Overall however, from a range of other viewpoints around the town, the impacts were not assessed as being significant.

Unlike the 1999 proposal to mine Big Hill where the intention was to leave the South Pit as a void, the impact of this Project is of limited duration as all mining and landform reinstatement to original topography will be completed within approximately five years. Importantly, mining in the North Pit will be completed in Year 2 with placement of waste rock and restoration to original topography occurring up to three years ahead of full project completion. This clearly reduces the overall scale of visual impact.

The proposed relocation of the communication tower and fire watch building will have a lesser, but permanent impact on the visual landscape as they will remain in their new locations. In terms of visibility, the relocated towers have less overall impact than in their current location at the summit of Big Hill although will be highly visible from several locations.
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It is recognised that the visual relationship between Big Hill and the Stawell community is multi-faceted and important. The community consultation and social impact assessments conducted as part of this EES indicate a common theme that, while Big Hill is an integral part of the landscape and community, it is also seen by some as degraded in terms of visual amenity, weeds and rubbish, and posing safety risks associated with past mining. The reinstatement of Big Hill to original topography and the objective to develop a rehabilitation and end-use Master Plan with community input provides an opportunity to create a rehabilitated Big Hill in an improved condition to current and with a range of enhanced community facilities and assets.

The visual modelling undertaken as part of this EES show that while the Project will result in short- to medium-term impacts of varying degrees depending on the vantage point, the rehabilitation of the Project area will result in the improved visual amenity of Big Hill in the long term.
8.16
Health
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8.16 Health

8.16.1 Introduction
This section of the EES describes and assesses the potential health impacts of the Project; identifies measures to manage and mitigate potential adverse impacts and assesses overall impacts on health following implementation of the proposed management and mitigation measures.

This assessment is based primarily on information provided in:
- URS Australia Pty Ltd (2014), *Big Hill Enhanced Development Project: Health Impact Assessment*, prepared for CGC; and

These reports are included in Technical Appendix 16 to this EES.

### Relevant sections of EES Scoping Requirements

This section of the EES covers the following components of the EES Scoping Requirements insofar as they relate to health:

### ‘4.5 Health and Social Impacts

#### Evaluation Objective
To protect the health, safety and wellbeing of residents and the social fabric of the community in the area in the context of project hazards.

#### 4.5.1 Public Health and Safety

#### Key issues
- Potential for nearby residents and other sensitive receptors to be exposed to hazardous dust levels during open-cut mining construction, operation and rehabilitation.

#### Priorities for characterising the existing environment
- Describe the physical and chemical characteristics of overburden, ore and waste rock to be removed during mine development and operations, following mechanical extraction, including specific aspects relevant to human health.
- Assess background levels of airborne particulates (dust) in the vicinity of Big Hill during potential weather conditions at different times of the year, with due regard to data requirements under the PEM for background air quality monitoring, or alternative data sets to the satisfaction of the Environment Protection Authority (EPA).

#### Design and mitigation measures
- Describe and evaluate potential and proposed design and mitigation measures that could:
  - avoid or minimise the exposure of people to hazardous levels of airborne particulate matter; and
  - ensure public safety during mine development, operation and rehabilitation, that is prior to the completion of the restoration and rehabilitation of Big Hill.
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Assessment of likely effects

- Predict likely atmospheric concentrations of particulate matter and other relevant Class 1, 2 or 3 indicators in surrounding areas during mine construction, operation and rehabilitation. Modelling of the dispersal of relevant emissions is to be provided for varying weather conditions, including evaluation of predicted levels relative to criteria specified in the PEM or design criteria in Schedule A of SEPP (Air Quality Management). Satisfactory evidence of quality assurance of predictive studies is to be provided.

Approach to manage performance

- Outline proposed measures to ensure that the public is not exposed to levels of airborne particulate matter exceeding PEM or SEPP criteria, including measures to monitor and control exposure to such hazards.

Key issues emerging from EES studies and community consultation:

Community concerns arising from the ongoing community engagement and communications program that relate to potential health impacts of the Project are:

- community concern exists about:
  - long-term health impacts as a result of reduced air quality
  - the mitigation measures that will be put in place to minimise health impacts of the Project
  - risk to the health of students at nearby schools as a result of reduced air quality.

- some residents indicated that the potential impacts of the Project are a source of increased stress and anxiety.

Targeted consultation was also undertaken for the purpose of the health impact assessment (HIA) to address health related issues. Representatives from the following organisations and groups were interviewed:

- Northern Grampians Shire Council (NGSC) – Environmental Health Staff
- Victorian Environment Protection Authority
- Department of Health – Grampians Region
- Local health professionals, medical practitioners, pharmacists, maternal and child health nurses.

The targeted consultation outcomes as they relate to health are summarised below:

- elevated noise
- dust and air quality, with respect to:
  - potential health impacts associated with particulate matter inhalation
  - the effectiveness of dust suppression
  - whether stopping work would be sufficient to reduce dust from exposed surfaces on windy days
  - water availability for dust suppression during drought or summer months
  - potential health impacts associated with the use of chemical dust suppressants
  - potential health impacts from heavy metals contaminating the drinking water in the town supply or rainwater tanks.
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- blasting and vibration, with respect to:
  - frequency of blasting
  - whether there will be a specific time of the day that blasting occurs to reduce the 'fright' factor.
- other:
  - information availability to reduce stress and anxiety
  - final Big Hill landform and end use.

Summary of findings

- The community health perception in the Northern Grampians Shire (NGS) region is similar to state wide with 44 per cent reporting very good health and 66 per cent reporting low stress.
- The NGS ranks poorly for incidence of ill health with males ranking 73rd and females rating 75th out of the 78 municipalities in Victoria for morbidity.
- NGS has a slightly higher proportion of smokers, more obese females, and more alcohol consumption at risky or high risk levels in males, compared to the Victorian population. However physical activity levels and diet are similar to the total Victorian population.
- NGS has a higher mortality rate than the Victorian population (7.0 per 1,000 compared to 5.7 per 1,000 in 2011); however this difference is not statistically significant.
- Respirable crystalline silica (RCS) and asbestos were not detected and therefore there is no potential health impact from these substances as a result of the Project.
- Modelling showed arsenic and combustion sources in air are below assessment criteria and are therefore not considered to pose a health risk to the Stawell community during the Project.
- The potential health impacts associated with noise, blasting, socio-economic and mental health impacts from stress and anxiety associated with the Project are considered to be low or very low.
- Based on air quality modelling, PM$_{10}$ and PM$_{2.5}$ emissions during the Project are expected to increase at nearby receptors. The associated risk rating for the assessment of particulate matter was ‘low’, indicating that PM emissions will require mitigation. Mitigation will be undertaken by reducing activity on-site (including stopping work where necessary) to ensure compliance with PEM limits.

8.16.2 Existing Conditions

8.16.2.1 Health Determinants
The health of individuals and communities is influenced by several factors, such as the social, economic and physical environment, as well as individual characteristics and behaviours. These health determinants can have a positive or negative impact on health and are not always under the direct control of the individual concerned.
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The *Australian National Health Performance Framework* (AIHW 2009) provides a number of measurable indicators, or health determinants, to guide the assessment of the health status of the population. These health determinants are summarised in Table 8-89, with the measures adapted from *Your Health: The Chief Health Officer’s Report 2010* (DOH 2010b). Table 8-89 shows that environmental factors are among a number of determinants which influence the health of the community.

Table 8-89 Potential health determinants of the community

<table>
<thead>
<tr>
<th>Health determinants</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health behaviours:</td>
<td>• fruit and vegetable consumption</td>
</tr>
<tr>
<td>Attitudes, beliefs,</td>
<td>• physical activity level</td>
</tr>
<tr>
<td>knowledge,</td>
<td>• smoking status</td>
</tr>
<tr>
<td>behaviours</td>
<td>• long-term risk of harm from alcohol</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
</tr>
<tr>
<td></td>
<td>• blood pressure checks</td>
</tr>
<tr>
<td></td>
<td>• cholesterol checks</td>
</tr>
<tr>
<td></td>
<td>• cancer screening participation</td>
</tr>
<tr>
<td></td>
<td>• immunisation of children.</td>
</tr>
<tr>
<td>Biomedical factors:</td>
<td>• body weight status</td>
</tr>
<tr>
<td>Genetic-related</td>
<td>• newborn screening</td>
</tr>
<tr>
<td>susceptibility to</td>
<td>• cancer or chronic illness incidence.</td>
</tr>
<tr>
<td>disease</td>
<td></td>
</tr>
<tr>
<td>Community and</td>
<td>• income</td>
</tr>
<tr>
<td>socioeconomic</td>
<td>• population</td>
</tr>
<tr>
<td>factors: Social</td>
<td>• volunteering</td>
</tr>
<tr>
<td>capital, support</td>
<td></td>
</tr>
<tr>
<td>services and factors such as housing,</td>
<td></td>
</tr>
<tr>
<td>education,</td>
<td></td>
</tr>
<tr>
<td>employment and</td>
<td></td>
</tr>
<tr>
<td>income.</td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>• air quality</td>
</tr>
<tr>
<td>factors: Physical,</td>
<td>• water quality</td>
</tr>
<tr>
<td>chemical and</td>
<td>• soil quality</td>
</tr>
<tr>
<td>biological factors</td>
<td></td>
</tr>
</tbody>
</table>

8.16.2.2 Baseline Health Data

Aggregated health data for the Grampians region (which encompasses 11 local government authorities (LGA), including the NGSC) is available from the Victorian Department of Health (DOH) and has been used to establish the baseline health information for the area relative to the rest of Victoria. Other sources of baseline health information have been utilised, where relevant. These sources include the Australian Bureau of Statistics (ABS), Department of Health (DOH) and NGSC.

Community health perception

The Victorian Population Health Survey conducted in 2010 (DOH 2010) showed the “self-reported health” in the Grampians region is similar to that for the whole of Victoria, with 43.6 per cent of males and 44.6 per cent of females reporting excellent or very good health. Similarly, 65.8 per cent of males and females reported experiencing low levels of psychological distress, showing no difference in psychological distress levels between the Grampians region and Victoria state-wide.
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This indicates that, although the local population has generally poorer health than the State averages (see baseline health data below), the local population to do not recognise this as a concern. However, this factor is unlikely to influence actual health outcomes that may be associated with the Project.

**Mortality and morbidity**

Mortality and morbidity rates are common indicators of the health of a community. Mortality is defined as the number of people who died within a population, while morbidity is the incidence of ill health.

Mortality rates for NGS and Victoria as a whole are available from ABS (2013a), with age standardised mortality rates for 2007 to 2011 summarised in Table 8-90. Age standardised rates are rates that have been adjusted across the populations considered, to ensure that differing age profiles (such as the aging population in NGS) do not skew the data. The data indicate that NGS has a higher mortality rate per annum than the state wide average.

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Grampians Shire</td>
<td>7.0</td>
<td>7.1</td>
<td>6.8</td>
<td>6.9</td>
<td>7.0</td>
</tr>
<tr>
<td>Victoria (State)</td>
<td>6.0</td>
<td>6.0</td>
<td>5.9</td>
<td>5.8</td>
<td>5.7</td>
</tr>
</tbody>
</table>

Avoidable mortality (AM) is a simple and practical population-based method of counting untimely and unnecessary deaths from diseases for which effective public health and medical interventions are available. Five years of AM data (2002-2006) have been aggregated by the Victorian Health Information Surveillance System (VHISS) which allows analyses of population trends, and reduces year-to-year variability and the width of confidence intervals for areas with small populations (DOH 2012). The data are summarised in Figure 8-143 below, for NGS and Victoria. The trend data indicate that for all avoidable mortality measures summarised by DOH, NGS has a higher rate than that of the whole state. However, overall trends are similar, with Ischaemic Heart Disease (IHD) and lung cancer the two main causes of avoidable mortality across Victoria and NGS.
Avoidable Mortality for 2011

The total standardised rate for AM in Victoria for 2002-2006 was 104 per 100,000, compared to an AM rate for NGS for 2002-2006 of 115 per 100,000. This indicates that approximately 15 per cent of deaths in NGS can be attributed to ‘avoidable’ causes such as heart disease and cancer.

Morbidity rates for males and females in the NGS indicate relatively poor comparative health status, with males rating 73rd and females rating 75th of the 78 municipalities in Victoria (NGSC 2005). The NGSC reports lower life expectancies than the Victorian average, and particularly high levels of morbidity associated with cancer, diabetes, mental health, cardiovascular disease, asthma, injuries and suicide.

**Asthma**

Asthma is a chronic inflammatory condition of the airways associated with episodes of wheezing, breathlessness and chest tightness. Asthma can be exacerbated by air emissions and is therefore an important consideration when assessing the potential health impacts of the Project.

Asthma is a significant health problem within Australia, with high prevalence rates relative to those reported internationally (AIHW 2011). This can often be related to generally drier, dustier ambient conditions, with agricultural products (e.g., grain dusts, animal dander, high pollen counts) contributing in rural areas. However, NGS has a slightly lower asthma prevalence rate of 18.31 per cent, compared to the Victorian state wide rate of 21.25 per cent.
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Asthma related mortality rates are an important health measure, as epidemiological data indicate that asthma mortality rates increase with increased levels of air pollution. During 2011, the asthma mortality rate in Victoria was 1.7 per 100,000 people, with a higher rate amongst females (2.2 per 100,000) than males (1.1 per 100,000) (ABS 2013b).

Recent asthma related mortality rates for the NGS are not available, as they are ‘too small to publish’ (Grampians Pyrenees Primary Care Partnership 2012). However, historic data from 1997 to 2004 are available from the Victorian Health Information Surveillance System (VHISS) (DOH 2012), with the 1999-2003 standardised data presented in Table 8-91 below.

Asthma related health outcomes can also be assessed by a measure of Ambulatory Care Sensitive Conditions (ACSC). This relates to any medical care scenario which did not result in an overnight hospital stay (e.g. a visit to the local general practitioner or medical centre). The standardised admission rates for asthma ACSC incidence in NGS and Victoria for 2010-2011 is summarised in Table 8-91.

**Table 8-91 Health measures for asthma in Northern Grampians Shire and Victoria**

<table>
<thead>
<tr>
<th></th>
<th>Prevalence of asthma²</th>
<th>ACSC standardised admission rates² 2010 - 2011</th>
<th>Hospital admissions rate ratio for asthma² 2009-2010</th>
<th>Avoidable mortality rate from asthma²,³,e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Grampians Shire</td>
<td>18.31</td>
<td>1.77</td>
<td>0.94</td>
<td>2.79</td>
</tr>
<tr>
<td>Rural Victoria</td>
<td>23.0</td>
<td>1.81</td>
<td>NA</td>
<td>1.41</td>
</tr>
<tr>
<td>Victoria</td>
<td>21.25</td>
<td>1.80</td>
<td>1.0</td>
<td>1.21</td>
</tr>
</tbody>
</table>

a Average annual rate per 100 population, 2008 data (DOH 2012)
b Age standardised to Victorian population 2006, rate per 1,000 person (Grampians Pyrenees Primary Care Partnership 2012)
c 2009-2010 data, rate per 1,000 person (Grampians Pyrenees Primary Care Partnership 2012)
d Annual average rate per 100,000 population
e Data from 1999-2003 (the most recent complete data available for Northern Grampians) (DOH 2012)

Again, this indicates that the NGS has lower prevalence of asthma and ambulance and hospital admission rates compared to the Victorian state wide rates. However, the avoidable mortality rate from asthma is higher. The available published baseline health data does not indicate why the mortality rate form asthma is higher in NGS, while the prevalence and admission rates are lower. It is possible that these results are impacted by patients seeking treatment elsewhere (i.e. asthmatics seeking regular treatment in Horsham or Melbourne), and hence not being captured in NGS prevalence data. Alternatively, due to the relatively low population in the NGS region, a slight increase in asthma mortality of one or two individuals over the period of which these statistics were gathered could result in a noticeably higher asthma mortality rate.

**Lifestyle determinants of health**

Personal behaviour and lifestyle choices, such as physical activity, nutrition, tobacco smoking and alcohol consumption, are factors influencing the health of individuals.
Physical activity and nutrition

Physical activity and a healthy diet are both important factors in the overall health and well-being of an individual. Poor levels of physical activity and nutrition are both major contributors to lifestyle related health problems, such as diabetes, obesity, cardio-vascular diseases and cancer (WHO 2010).

With 54.7 per cent of males and 60.5 per cent of females meeting the Department of Health and Aged Care physical activity guidelines, the physical activity level reported for the NGS region was similar to the level reported for Victoria overall (DOH 2010).

Similarly, 5.7 per cent of males and 10 per cent of females met the National Health and Medical Research Council dietary guidelines for vegetable consumption in the NGS region (self-reported), which is the same level reported for Victoria overall. In 2010, 34.5 per cent of males and 43.9 per cent of females in the NGS region reported they met the dietary guidelines recommending two serves of fruit daily, which is slightly lower than the fruit consumption reported for Victoria overall (DOH 2010).

Overweight and obesity

Being overweight and obese increases the risk of mortality and morbidity caused by conditions such as cardiovascular disease, type 2 diabetes and certain cancers. In 2010, 42.5 per cent of males and 21.2 per cent of females were reported as being overweight in the NGS region, which is similar to all Victorians. However, females in the Grampians region were more likely to be obese (21.2 per cent) compared to all Victorian females (15.2 per cent) (DOH 2010). This proportion of the population is in addition to the overweight portion, resulting in a total of 42.4 per cent of women being overweight or obese in NGS.

Smoking

Smoking is a major contributing factor to poor health, and several types of cancer and cardiovascular diseases are among the many illnesses correlated with smoking. In 2010, a higher proportion of females (22.3 per cent) and males (24.9 per cent) in the NGS region were reported to be current smokers compared to all Victorian females (15.8 per cent) and males (17.8 per cent).

Alcohol consumption

Excessive alcohol consumption not only has a direct negative impact on an individual’s health, but is also a major contributor to some negative social impacts. Alcohol related health effects include cardiovascular problems, certain cancers and liver cirrhosis. The direct health effects of alcohol consumption are often exacerbated by other risk factors, such as smoking and dietary factors, or can be the underlying cause of other health issues such as mental illness (NHMRC 2009).

In 2010, males in the NGS region were more likely to consume alcohol at risky or high risk levels (8.6 per cent) compared to all Victorian males (3.3 per cent). Females in the Grampians region were less likely to abstain from alcohol (14.7 per cent) compared to 22.6 per cent of Victorian females state wide (DOH 2010).
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Mental health

Mental health is an important indicator of wellbeing, and can be assessed through a range of measures. Mental and behavioural problems within NGS, based on self-assessment data provided in the National Health Survey 2007-2008, were higher than the state average (Grampians Pyrenees Primary Care Partnership 2012). Males and females in NGS reported rates of mental and behavioural problems of 11.8 per cent and 12.6 per cent, respectively; these are similar to general regional Victorian rates (11.0 per cent and 12.2 per cent for males and females respectively) and significantly higher than Victoria statewide rates of 9.9 per cent and 11.6 per cent. Self-assessment of mood problems within the same study indicated rates of 6.9 per cent and 9.0 per cent in NGS males and females, compared with Victoria wide rates of 6.0 per cent and 8.3 per cent. NGS rates for levels of psychological distress, hospital treatment for self-inflicted injuries and utilisation of mental health services are significantly higher than Victoria wide trends (Grampians Pyrenees Primary Care Partnership 2012).

8.16.2.3 Socioeconomic Factors

The socioeconomic profile of the Stawell community is detailed in Section 8.18.2.12.

In summary, the key demographic issues associated with Stawell in relation to health are as follows:

- The population of Stawell has declined and aged in recent years
- A number of indicators of socio-economic status, such as income, education and employment show Stawell's population have a somewhat lower level of socio-economic advantage than Regional Victoria as a whole. This is reflected in Socio-economic indexes for areas (SEIFA) scores for the township.

8.16.2.4 Environmental Factors

Existing environmental factors associated with the Project area as they relate to health outcomes are described below.

Air quality

The existing air quality conditions are described in detail in Section 8.7.

Background concentrations for various airborne parameters at Stawell are currently unavailable for a full year period, and the Air Quality Impact Assessment (AQIA) has therefore sourced data from other similar townships (e.g. Bendigo for particulate matter (PM), NO₂, CO and Geelong for SO₂). Collection of air quality data from two local monitoring stations established by SGM is ongoing and the data collected to date suggests that the background levels of air quality parameters at Stawell are similar to the Bendigo proxy data used in the AQIA. As such, it could be expected that the AQIA in this EES based on Bendigo data is representative of the actual situation in Stawell.

Particulate matter (PM₁₀ and PM₂.₅)

As previously outlined, the ambient air monitoring program implemented by SGM in Stawell in May 2013, and data collected to date, indicates that Stawell background concentrations of PM₁₀ and PM₂.₅ are similar (or lower) than those reported in Bendigo. Therefore, use of the Bendigo data for background PM₁₀ levels is considered conservative for the assessment of total PM₁₀ and PM₂.₅ in Stawell during the Project, as estimated total levels will likely be overestimated.
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The available data regarding existing PM$_{10}$ and PM$_{2.5}$ concentrations are summarised in Table 8-92. These values are compared against published criteria ("National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) (NEPC 1998)"), to provide context for the existing air quality conditions which have been assumed for Stawell.

Table 8-92  Background air quality particulate concentrations and assessment criteria

<table>
<thead>
<tr>
<th>Background concentration (µg/m$^3$)</th>
<th>Averaging period</th>
<th>Assessment criteria (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{10}$ 17.8</td>
<td>Annual average (70$^{th}$ percentile value)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Maximum 24 hr 55.7</td>
<td>50 (AAQ NEPM) 60* (PEM: Mining)</td>
</tr>
<tr>
<td>PM$_{2.5}$ 6.1$^a$</td>
<td>Annual average (70$^{th}$ percentile value)</td>
<td>8 (AAQ NEPM)</td>
</tr>
<tr>
<td></td>
<td>Maximum 24 hr 18.9$^a$</td>
<td>25 (AAQ NEPM) 36* (PEM: Mining)</td>
</tr>
</tbody>
</table>

$^a$ Derived from a factor of 0.34 applied to measured PM$_{10}$ data, based on site specific data collected at Stawell, refer to Technical Appendix 7 (AQIA (URS 2014a))

* PEM values from Protocol for Environmental Management: Mining and Extractive Industries. They are taken from intervention levels in the SEPP (AQM), which are 20 per cent above ambient air quality objectives in the SEPP (AAQ) and AAQ NEPM, and are used to assess local / neighbourhood air monitoring data. They apply to all sources of pollutants in a defined area, not to an individual source. If these levels are exceeded, they should trigger action to improve local air quality.

In summary, the background data indicate that there can be days in the region where background levels of respirable dust are at concentrations exceeding the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) 1998 (e.g. for Bendigo there was one exceedance in 2004). Sources of exceedance can include dust storms, bushfires and burning off activities. As part of the management and mitigation strategies proposed for the Project, it is intended to use real time monitoring to assess potential impacts and daily background conditions and modify operations, or under worst case conditions, cease mining operations entirely to enable compliance with regulatory limits.

Combustion

Background levels of NO$_x$ and CO have been assessed using the available Bendigo air monitoring data, while background SO$_2$ data have been adopted from Geelong air monitoring stations, as data were not available from Bendigo. Available sources of regional background levels of PAH are limited and therefore available data from Traralgon has been adopted. The background levels are low and no issues were identified.

Respirable Crystalline Silica (RCS)

RCS (as PM$_{2.5}$) was reported above the laboratory limit of detection on one occasion only at the 7 Fisher St Ambient Air Quality Monitoring Station (AAQMS). This level was adopted as the ambient background concentration (0.75 µg/m$^3$) in the AQIA.

The mean percentage silica dioxide content (69.2 per cent) was calculated from the available ore and waste rock sampling results. This value was conservatively assumed to represent RCS within the ore body.
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Noise
In general, the noise environment in Stawell is characterised by a number of ambient noise sources including local and highway traffic; noise from local industries and commercial sites; noise from schools and community activity; and wildlife noise (insects and birds).

Historically, dwellings within close proximity to existing SGM activities have been exposed to noise levels of up to 50 decibels (dB) $L_{Aeq}$ (hourly average) from the mine during the day time.

Few complaints have been received by the mine in relation to noise in recent years (16 noise complaints between 2000-13) with the majority of complaints relating to evening or night time activity.

Ambient noise monitoring was conducted at selected residential locations around the Project area to determine baseline ambient noise conditions. During this time, underground mining and the processing plant were operational continuously. Ambient noise levels during the day time ranged from 42-61 dB $L_{Aeq}$ (hourly average). Ambient noise levels recorded are consistent with a ‘typical’ suburban area with higher noise levels observed along main roads and intersections. Target noise levels for the area are 50 dB in locations previously exposed to mining noise under the current SGM Environmental Management Plan and 46 dB in other areas as specified in the regulatory guidelines *Noise from Industry in Regional Victoria* (2011).

Blasting
Blasting has been used throughout the course of underground and open cut mining operations at SGM for over 30 years. There have been historical complaints associated with underground blasting, particularly when blasting has been in shallow areas.

When blasting occurs it takes place at set times. SGM has an SMS notification service which provides advance notification of blasts to residents who wish to be alerted.

It is expected that some blasting will be required for the Project in the lower 15 metres of the North Pit and the lower 30 metres of the South Pit (which is about 8 per cent of the pit volume).

8.16.2.5 Summary of baseline information for the Health Report
In summary, people within the NGS perceive their own health to be quite good, with low levels of psychological distress reported. However, statistics show that when compared to the Victorian state average, the NGS reports lower life expectancy, and particularly high levels of morbidity associated with cancer, diabetes, mental health, cardiovascular disease, asthma, injuries and suicide.

With regards to Stawell, the population is aging and has a somewhat lower level of socio-economic advantage (in terms of income, education and employment) than Regional Victoria. With respect to background environmental factors in the Stawell area with the potential to impact on human health, studies undertaken as part of this EES indicate that the key variables of airborne particulate matter and noise are generally compliant with regulatory limits with some exceedances at residences under certain conditions (refer to Sections 8.5.3 and 8.7.3). The data collected as part of the abovementioned studies have been used to inform the human health impact assessment and are discussed in more detail below.
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8.16.3 Impact Assessment

Based on the legislative requirements (described in Chapter 3) as they relate to health, environmental health determinants, the Project scope, and the outcomes of preliminary consultation undertaken at the commencement of the Project approvals process, the following factors have been identified as potential health impacts which require assessment:

- air quality emissions:
  - Particulate matter – PM$_{10}$, PM$_{2.5}$, dust deposition
  - Arsenic and RCS
  - Combustion sources – NO$_2$, CO, SO$_2$, PAH
  - Naturally occurring compounds, if present: asbestos and radionuclides
- noise
- blasting
- drinking water quality – due to the potential for dust deposition into domestic tank waters and adjacent reservoir
- socio-economic impacts
- mental health impacts: stress and anxiety.

8.16.3.1 Health Impact Assessment Methodology

Health impact has been assessed using the following methodology:

- Issue Identification – Data regarding a Project related factor (such as noise) or a compound of potential concern (COPC) is collected and evaluated to determine if the factor / compound is present or likely to be present at levels which are above health screening levels or other recommended guidelines. In this step, the need for a quantitative or qualitative assessment is determined.

- Quantitative Assessment – This process is used (as required) to assess potential impacts, whereby the identified factor / COPC is at levels requiring a more detailed assessment of potential health impacts. This process utilises established methods and published health data (e.g. WHO air quality guidance). The outcome is then assessed in conjunction with a qualitative process to rank the potential impact.

- Qualitative Assessment – This process considers the likelihood and consequence of the impact occurring, to develop a risk rating for each identified impact.

Consequence x Likelihood = Risk

Risks are categorised according to a risk matrix ranking system.

The quantitative and qualitative assessment methodology used for this assessment is discussed in further detail below.
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Quantitative risk assessment
In this Health Report, quantitative methods are generally applied to the assessment of biomedical and environmental factors (as summarised in Table 8-93).

For the purposes of this Health Impact Assessment (HIA), biomedical factors (e.g. genetic susceptibility or high blood pressure) are generally not considered applicable to the Project. For the assessment of relevant environmental factors, such as airborne particulate matter (PM), the methodologies outlined in the guidance provided in Environmental Health Risk Assessment (enHealth 2012) and the Amended National Environment Protection (Assessment of Site Contamination) Measure (Amended ASC NEPM) (NEPC 2013) have been applied. This process is generally divided into the following tasks.

- Exposure Assessment - This stage identifies the potential receptors that may be exposed to the identified impacts, such as local residents, or sensitive receptors such as children attending child care or primary school or inhabitants of aged care facilities. In addition, potential exposure concentrations or levels are also identified.

- Hazard Assessment - For the COPC identified, published epidemiological and toxicological data are reviewed to enable quantification of the potential health outcomes associated with the estimated exposures.

- Risk Characterisation - Following the identification of exposure concentrations and intakes for the relevant receptors, and an assessment of the potential health outcomes associated with the hazards identified, risks can be characterised. For the purposes of this HIA, the risk characterisation step has been completed in line with the qualitative risk assessment methodology outlined below, whereby a risk outcome is defined based on the consequence and likelihood of the health outcome occurring.

Qualitative risk assessment
As no Victoria specific guidance is available, the potential consequences, likelihood, risk levels and management criteria summarised in the tables below (Table 8-93 to Table 8-96) have been adapted from the Western Australian Health Risk Assessment (Scoping) Guidelines (WA DoH 2010) and its associated source documents. This document has been applied as it is the most detailed Australian guidance available. The risk tables within the WA guidance were similar, yet varied slightly, to the consequences, likelihood and risk levels utilised in the Hazard and Risk Report (URS 2013d). Therefore the WA DoH guidance has been adapted to provide consistency with the risk matrix applied across other aspects of the Project risk assessment (Chapter 9).

The possible consequences, or potential adverse impacts on the health of the Stawell community, are presented in Table 8-93. This table indicates what the defined acute and chronic health outcome may be for a given issue and the associated consequence category (e.g. hospitalisation of 5-10 per cent of the population that may be directly impacted by a project would be classed as a ‘Major’ consequence).

While this table of consequences details the potential adverse health impact categories, the Project may also result in positive impacts that enhance community health and services.
## 8 Environmental Impact Assessment

### Table 8-93 Health impact assessment - categories for potential health consequences

<table>
<thead>
<tr>
<th>Category</th>
<th>Acute health consequence (per impact)</th>
<th>Chronic health consequence (per project lifecycle)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme (1)</td>
<td>- more than one fatality OR&lt;br&gt;- more than five permanent disabilities OR&lt;br&gt;- non-permanent injuries requiring hospitalisation for more than 5 to 10 per cent of the Stawell population OR&lt;br&gt;- acute health effect requiring hospitalisation for more than 5 to 10 per cent of the Stawell population&lt;br&gt;- more than $10,000,000 of health cost per hazard.</td>
<td>Chronic health effect requiring medical treatment for more than 10 to 15 per cent of the Stawell population</td>
</tr>
<tr>
<td>Major (2)</td>
<td>- one fatality OR&lt;br&gt;- two to five permanent disabilities OR&lt;br&gt;- non-permanent injuries requiring hospitalisation for more than 2 to 5 per cent of the Stawell population OR&lt;br&gt;- acute health effect requiring hospitalisation for more than 2 to 5 per cent of the Stawell population&lt;br&gt;- between $5,000,000 and $10,000,000 of health cost due to hazard.</td>
<td>Chronic health effect requiring medical treatment for more than 5 to 10 per cent of the Stawell population</td>
</tr>
<tr>
<td>Moderate (3)</td>
<td>- no fatality AND&lt;br&gt;- one permanent disability OR&lt;br&gt;- non-permanent injuries requiring hospitalisation for 1 to 2 per cent of the Stawell population OR&lt;br&gt;- acute health effect requiring hospitalisation for 1 to 2 per cent of the Stawell population AND&lt;br&gt;- no evacuation&lt;br&gt;- between $500,000 and $5,000,000 of health cost due to hazard.</td>
<td>Chronic health effect requiring medical treatment for more than 1 to 5 per cent of the Stawell population</td>
</tr>
<tr>
<td>Minor (4)</td>
<td>- no fatality AND&lt;br&gt;- no permanent disability AND&lt;br&gt;- no non-permanent injuries requiring hospitalisation AND&lt;br&gt;- no acute health effect requiring hospitalisation AND&lt;br&gt;- no evacuation&lt;br&gt;- between $100,000 and $500,000 of health cost due to hazard.</td>
<td>Chronic health effect requiring medical treatment for more than 0 to 1 per cent of the Stawell population</td>
</tr>
<tr>
<td>Negligible (5)</td>
<td>- no fatality AND&lt;br&gt;- no permanent disability AND&lt;br&gt;- no non-permanent injuries requiring hospitalisation AND&lt;br&gt;- no acute health effect requiring hospitalisation AND&lt;br&gt;- no evacuation&lt;br&gt;- less than $100,000 of health cost due to hazard.</td>
<td>No chronic health effect requiring medical treatment</td>
</tr>
</tbody>
</table>
8 Environmental Impact Assessment

Likelihood is the probability or frequency of the consequence occurring and takes into consideration the probability and frequency of:

- the health hazard occurring
- the population being exposed to the health hazard.

The likelihood of these consequences occurring over the duration of Project lifecycle is assessed using the following range of probabilities (taken from WA DoH 2010) as presented in Table 8-94.

**Table 8-94 Health impact assessment - likelihood matrix**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Likelihood descriptor</th>
<th>Likelihood18</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Almost certain</td>
<td>1 in 10</td>
</tr>
<tr>
<td>2</td>
<td>Likely to occur</td>
<td>1 in 100</td>
</tr>
<tr>
<td>3</td>
<td>Possible</td>
<td>1 in 1,000</td>
</tr>
<tr>
<td>4</td>
<td>Unlikely</td>
<td>1 in 10,000</td>
</tr>
<tr>
<td>5</td>
<td>Rare</td>
<td>1 in 100,000 or more</td>
</tr>
</tbody>
</table>

When comparing the combination of the likelihood and consequence ratings to the risk analysis matrix, it provides an indication of the magnitude or significance of the impact (i.e. the risk definition) as presented in Table 8-95 below (taken from WA DoH 2010).

**Table 8-95 Health impact assessment - risk level matrix**

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>1 Negligible</th>
<th>2 Minor</th>
<th>3 Moderate</th>
<th>4 Major</th>
<th>5 Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost certain</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Extreme</td>
<td>Extreme</td>
</tr>
<tr>
<td>Likely to occur</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Extreme</td>
</tr>
<tr>
<td>Possible</td>
<td>Very Low</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>Extreme</td>
</tr>
<tr>
<td>Unlikely</td>
<td>Very Low</td>
<td>Very Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Rare</td>
<td>Very Low</td>
<td>Very Low</td>
<td>Very Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
</tbody>
</table>

The subsequent management criteria for each determined level of risk are presented in Table 8-96.

---

18 Likelihood numbers taken from the source document referenced in the WA DoH HIA scoping guidance for likelihood categories (WA DoH 2009)
8 Environmental Impact Assessment

Table 8-96  Health impact assessment - risk management criteria

<table>
<thead>
<tr>
<th>Risk rating</th>
<th>Management criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme</td>
<td>Potentially unacceptable; modification of proposal required</td>
</tr>
<tr>
<td>High</td>
<td>Major management required</td>
</tr>
<tr>
<td>Medium</td>
<td>Management required</td>
</tr>
<tr>
<td>Low</td>
<td>Some management required and addressed with routine controls</td>
</tr>
<tr>
<td>Very Low</td>
<td>No management required</td>
</tr>
</tbody>
</table>

8.16.3.2  Air Quality

A detailed assessment of air quality is included in Section 8.7 and should be referenced for full details of air quality related issues and the assessment methodology.

Relevant legislation

There are a number of relevant protocols and guidelines for assessing air quality impacts in Australia and Victoria. These include the following key documents:

- *National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) 1998* – establishes the national framework for assessing PM
- *State Environment Protection Policy (SEPP) (Ambient Air Quality) 1999* and the *SEPP (Air Quality Management) 2001* – these establish the Victorian framework for managing air quality emissions
- *Protocol for Environmental Management (PEM), Mining and Extractive Industries 2007* – developed under the SEPP (AAQ) to guide the assessment of impacts specifically related to conducting environmental investigations of existing and future mines.

These protocols and guidelines for air quality assessment include requirements for assessment of relevant compounds such as particulate matter, respirable crystalline silica, emissions from combustion sources, asbestos, and naturally occurring radioactive material.

Air quality impact assessment (AQIA)

As part of the AQIA for the proposed mining operation at the Stawell gold mine, two years were initially modelled for the assessment of exposure concentrations during operations:

- Year 2 – excavation of overburden and ore is expected to be at peak levels, with activities occurring in both the North and South pits
- Year 5 – material movement will be greatest. The South Pit is being backfilled and rehabilitated using waste rock transported from the TWRS and a suitable alternative.

Following the completion of the Year 2 and Year 5 modelling, additional assessment of Year 1 was also conducted and is provided within the AQIA. As the modelled concentrations within Year 1 do not exceed the concentrations modelled in Years 2 and 5, the HIA has relied upon the Year 2 and Year 5 data for the assessment of potential health impacts, as these are the more conservative scenarios.
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The AQIA report has assessed the potential air quality impacts at 128 sensitive receptor locations. This includes 112 sensitive receptors such as residential premises, schools and community facilities (R1-R116) as well as 16 locations on the GWMWater water storage reservoirs (D1-D16). There is no direct human exposure to dust on the reservoirs, the potential health impact being the deposition of airborne contaminants into drinking water supplies. The air quality modelling assumed a number of best practice dust management controls that are included within the Project design such as watering, chemical dust suppressants, reduced dumping heights and equipment filters.

**Particulate matter**

Particulate matter (PM) can be a significant contributor to air pollution, with common sources including vehicle exhaust, smoke from fires, emissions from industrial facilities, and windblown dust from exposed soil or earthworks. PM is generally assessed in three forms:

- PM$_{10}$ – Particulate matter less than or equal to 10 micrometres in diameter; this fraction of PM is respirable and will enter the upper respiratory tract
- PM$_{2.5}$ – Particulate matter less than or equal to 2.5 micrometres in diameter; this fraction of PM is respirable and will enter the lower respiratory tract
- TSP – total suspended particulates; this includes respirable and non-respirable particles, and can result in nuisance deposition or visual amenity issues.

**Issue identification**

Inhalation of PM can result in a number of negative health outcomes, with health effects dependant on exposure duration and exposure concentration.

Studies indicate that chronic health impacts associated with long term exposures (e.g. annual average increases) include increased mortality from cardiopulmonary disease, development of chronic respiratory disease, and decreased lung function (WHO 2005). Acute health impacts associated with an increase in short term PM exposure (e.g. peak 24 hour increases) include increased mortality and hospitalisation from cardiopulmonary diseases, increased respiratory symptoms and decreased lung function (WHO 2005).

There is a linear relationship between PM exposure and identified health indictors, which means that health impacts may potentially occur from any increase in exposure (DEH 2004). As a result, this assessment considers the potential health impacts associated with the increase in exposure above background levels, as well as exposures above assessment criteria. This is conservative, as it includes PM exposures for all days of operations, not just those days that are above the assessment criteria.

**Quantitative assessment**

Available guidance indicates that the assessment of health impacts associated with PM exposure can be focused on measures of PM$_{10}$. This is due to the majority of epidemiological and measurement data being collected for PM$_{10}$, with these data also representative of exposure to finer PM$_{2.5}$ materials (i.e. the PM$_{2.5}$ fraction would also be included in measured PM$_{10}$ concentrations and would be correlated with the measured health outcomes). However, more recent international reviews (USEPA 2009; 2012; WHO 2013b) have focused on assessing the health impacts of PM$_{2.5}$, as it is generally the most significant fraction of PM that is association with negative health effects.
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With regards to the PM that will be sourced from Project operations, the composition of the PM will vary from that found in urban centres, where the majority of PM epidemiological research is conducted. Being from a mining source, the PM in Stawell will likely be coarser than PM from a combustion source, with potentially less harmful components (USEPA 2012). Site specific data have been collected to confirm this, with approximately a third of the PM$_{10}$ fraction comprised of PM$_{2.5}$.

This assessment has considered chronic (based on potential annual average) and acute (based on potential peak 24 hour) exposures.

A number of key receptors were selected (which would be representative of other similar receptor types) as shown in Table 8-97.

Table 8-97  Sensitive receptors assessed within the health impact assessment

<table>
<thead>
<tr>
<th>AQIA receptor ID</th>
<th>Type</th>
<th>Location</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Residences</td>
<td>Immediate Area$^{19}$</td>
<td>Provides an averaged assessment across the most impacted population</td>
</tr>
<tr>
<td>R12</td>
<td>Residence</td>
<td>Hawthorn St</td>
<td>Maximum modelled increase in annual average PM$_{10}$ concentrations at a residence</td>
</tr>
<tr>
<td>R7</td>
<td>Residence</td>
<td>Fisher St</td>
<td>Maximum modelled increase in 24 hour average PM$_{10}$ concentrations, excluding background. at a residence</td>
</tr>
<tr>
<td>R50</td>
<td>School</td>
<td>Patrick St</td>
<td>St Patricks Primary School – closest school to Project area</td>
</tr>
<tr>
<td>R61</td>
<td>Aged care facility</td>
<td>Patrick St</td>
<td>Eventide Homes – closest aged care facility to Project area</td>
</tr>
</tbody>
</table>

The maximum PM$_{10}$ and PM$_{2.5}$ exposure concentrations modelled (from both Year 2 and Year 5) are summarised in Table 8-98 and Table 8-99 and have been used in a conservative assessment of potential PM exposures for the modelled year.

Table 8-98 Maximum modelled particulate matter exposure (PM$_{10}$) concentrations at sensitive receptors during the Project

<table>
<thead>
<tr>
<th>AQIA ID</th>
<th>Receptor Type</th>
<th>Background PM$_{10}$ ($\mu g/m^3$)</th>
<th>Site contribution modelled PM$_{10}$ ($\mu g/m^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Annual Average</td>
<td>Max 24 hr (without background)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max 24 hr</td>
<td>Annual average (without background)</td>
</tr>
<tr>
<td>R12</td>
<td>Residence</td>
<td>17.8</td>
<td>1.9</td>
</tr>
<tr>
<td>R7</td>
<td>Residence</td>
<td>17.8</td>
<td>2.0</td>
</tr>
<tr>
<td>R50</td>
<td>School</td>
<td>17.8</td>
<td>0.4</td>
</tr>
<tr>
<td>R61</td>
<td>Aged care facility</td>
<td>17.8</td>
<td>0.4</td>
</tr>
</tbody>
</table>

*Maximum 24 hour (including background) concentration may be from a different day to the day where the maximum 24 hour (without background) concentration was modelled.*

$^{19}$ The Immediate Area, has been defined in Section 8.15.2 as the area within approximately 200 metres of the Project boundary. It also includes the unpopulated region to the north and east of the Project area to align with the Australian Bureau of Statistics (ABS) boundaries (ABS SA1: 2139213 & 2139224)
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Table 8-99  Maximum modelled particulate matter exposure (PM$_{2.5}$) concentrations at sensitive receptors during the Project

<table>
<thead>
<tr>
<th>AQIA ID</th>
<th>Receptor</th>
<th>Background PM$_{2.5}$ (µg/m$^3$)</th>
<th>Site contribution modelled PM$_{2.5}$ (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Annual average Max 24 hr</td>
<td>Annual average (without background) Max 24 hr (without background)</td>
</tr>
<tr>
<td>R12</td>
<td>Residence</td>
<td>6.1  18.9</td>
<td>0.7  12.6</td>
</tr>
<tr>
<td>R7</td>
<td>Residence</td>
<td>6.1  18.9</td>
<td>0.7  13.3</td>
</tr>
<tr>
<td>R50</td>
<td>School</td>
<td>6.1  18.9</td>
<td>0.2  1.3</td>
</tr>
<tr>
<td>R61</td>
<td>Aged care</td>
<td>6.1  18.9</td>
<td>0.1  1.8</td>
</tr>
</tbody>
</table>

a  Maximum 24 hour (including background) concentration may be from a different day to the day where the maximum 24 hour (without background) concentration was modelled.

The total number of exceedances of the assessment criteria during Year 5 (which represents the worst case modelled results) are summarised in Table 8-100. Adjacent residences have been compared against the PEM, while the nearest school and aged care facility have also been compared against the NEPM criteria, as required under the PEM.

Table 8-100  Summary of number of days predicted to exceed assessment criteria during Year 5

<table>
<thead>
<tr>
<th>AQIA ID</th>
<th>Receptor</th>
<th>Number of days in Year 5 with modelled exceedences of the assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PEM PM$_{2.5}$ – 36 µg/m$^3$</td>
</tr>
<tr>
<td>R12</td>
<td>Residence</td>
<td>0</td>
</tr>
<tr>
<td>R7</td>
<td>Residence</td>
<td>0</td>
</tr>
<tr>
<td>R50</td>
<td>School</td>
<td>0</td>
</tr>
<tr>
<td>R61</td>
<td>Aged care facility</td>
<td>0</td>
</tr>
</tbody>
</table>

Assessment of potential non-residential impacts

The increase of PM$_{10}$ above background at the nearest school and aged care facility will be significantly lower than at the adjacent residential properties, with an annual average increase of less than one microgram per cubic metre (µg/m$^3$) and a maximum 24 hour increase of approximately 5 µg/m$^3$. Modelled PM$_{2.5}$ increases at these receptors were less than 0.2 µg/m$^3$ and less than 2 µg/m$^3$, for annual average and 24 hour increases, respectively.

The maximum 24-hour averages at these receptors therefore comply with the assessment criteria in the PEM (60 µg/m$^3$). Some exceedances of the NEPM (50 µg/m$^3$) were predicted, however, the total number of exceedances of the NEPM at the receptors further afield (i.e. the school and aged care facility), are below the five exceedances permissible per year under the AAQ NEPM guidelines, and are related to the elevated background on that day.
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In summary, impacts at the nearest non-residential sensitive receptors are below the assessment criteria adopted from both the PEM and NEPM and potential impacts are considered acceptable.

Assessment of potential residential impacts

Potential health impacts at residential receptors were considered for:

- potential ‘worst case’ scenarios, based on maximum modelled concentrations at the most impacted residences
- averaged exposure concentration across the ‘Immediate Area’ (within 200 metres of Project boundary) to provide an average assessment of potential exposures across the most impacted population.

The averaged concentrations for the Immediate Area have been derived from the contour maps created to represent predicted total emissions across the wider area. The available contour maps from the AQIA were reviewed, with annual average PM$_{2.5}$ and maximum 24 hour PM$_{10}$ contour maps shown in Figure 8-144 and Figure 8-145, respectively.
Figure 8-144  Predicted annual average particulate matter (PM$_{2.5}$) concentration contours (0.34 ratio applied) – during Year 2 (site contribution plus background)
Figure 8-145 Predicted maximum 24 hour average particulate matter (PM$_{10}$) concentration contours –Year 5 (site contribution only)
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The values derived from the contour plots shown in Figure 8-144 and Figure 8-145 (across the Immediate Area), are summarised in Table 8-101. PM$_{2.5}$ concentrations have been calculated by applying the site specific ration of 0.34 to the estimated PM$_{10}$ concentrations. This ratio value is based on site specific sampling of PM$_{10}$ and PM$_{2.5}$, and the derivation of this ratio is discussed in detail in the AQIA. While a generic ratio of 0.5 is applied in some guidance documents, the coarser components of PM at the site (due to the crustal nature of the source) are evident based on site specific sampling.

**Table 8-101** Average modelled particulate matter exposure concentrations across Immediate Area

<table>
<thead>
<tr>
<th>PM Class</th>
<th>Modelled PM (µg/m$^3$) without background</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual average</td>
</tr>
<tr>
<td>PM$_{10}$</td>
<td>2.0</td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>0.68</td>
</tr>
</tbody>
</table>

For this assessment, the selection of relevant relative risk values has relied upon information available from WHO (2005; 2013b) and USEPA (2009; 2012) reviews. The guidance recommends that an assessment consider both acute exposures (i.e. 24 hour impacts) and chronic exposures (i.e. annual increases), as health impacts are associated with both types of exposure.

The values selected for application in the HIA are summarised in Table 8-102.

**Table 8-102** Summary of published relative risk estimates for a 10 µg/m$^3$ increase in particulate matter (PM$_{10}$)

<table>
<thead>
<tr>
<th>Source</th>
<th>Relative risk (Unitless) (95 per cent confidence interval)</th>
<th>Health outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM$_{10}$ measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHO (2005)</td>
<td>1.006 (1.004-1.008)</td>
<td>Daily all-cause mortality</td>
</tr>
<tr>
<td></td>
<td>1.013 (1.005-1.020)</td>
<td>Daily respiratory mortality</td>
</tr>
<tr>
<td>Pope et al (2002)</td>
<td>1.04 (1.01-1.08)</td>
<td>Long term all-cause mortality</td>
</tr>
<tr>
<td>[In WHO (2005)]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PM$_{2.5}$ measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[In USEPA (2012)]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grineski et al (2011) [In USEPA 2012]</td>
<td>1.02 (0.96-1.09)</td>
<td>Daily – asthma hospital admissions</td>
</tr>
</tbody>
</table>
Risk has been quantified by applying the relative risk values above (Table 8-102) to the baseline health rates and the modelled increases in exposure (Table 8-103 and Table 8-104). Increased mortality, per population of 100,000, is calculated by:

$$\text{Additional mortality/morbidity} = ((\text{Base incidence rate} \times \% \text{ increase}) - \text{base incidence}) \times PM $$

The outcomes of the particulate matter risk calculations using the NGS population data is summarised in Table 8-103 and Table 8-104. These calculations are based on the maximum modelled concentrations at the most impacted residences (Table 8-98 and Table 8-99), and assume a population of up to 50 people may be impacted by these maximum concentrations.

**Table 8-103  Estimated increase in mortality risk based on maximum increase in modelled particulate matter concentrations at most impacted receptors**

<table>
<thead>
<tr>
<th>Health outcome</th>
<th>Baseline incidence rate (per 100,000)</th>
<th>Relative risk per 10 µg/m³ increase</th>
<th>PM₁₀ increase (µg/m³)</th>
<th>Increased risk per 100,000</th>
<th>Increased risk at most impacted residences (per 50 people)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM₁₀</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual mortality</td>
<td>700</td>
<td>1.04</td>
<td>2.0</td>
<td>5.6</td>
<td>0.0028</td>
</tr>
<tr>
<td>Daily mortality</td>
<td>1.92</td>
<td>1.006</td>
<td>58.8</td>
<td>0.068</td>
<td>0.000034</td>
</tr>
<tr>
<td>Daily respiratory mortality a</td>
<td>0.25</td>
<td>1.013</td>
<td>58.8</td>
<td>0.019</td>
<td>0.0000096</td>
</tr>
<tr>
<td><strong>PM₂.₅</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual all-cause mortality</td>
<td>700</td>
<td>1.048</td>
<td>0.7</td>
<td>2.4</td>
<td>0.0012</td>
</tr>
<tr>
<td>Daily all-cause mortality</td>
<td>1.92</td>
<td>1.078</td>
<td>13.3</td>
<td>0.20</td>
<td>0.00010</td>
</tr>
</tbody>
</table>

a Calculated from annual mortality rates for asthma, lung cancer, IHD, COPD (90.4 per 100,000 per year in NGS, equating to 0.25 per day).
b Assumed population of 50 to quantify most impacted receptors. This conservatively assumes that up to 50 individuals will be potentially exposed to the maximum concentrations modelled at adjacent residences.

**Table 8-104  Estimated increase in morbidity risks based on maximum increase in modelled particulate matter concentrations at most impacted receptors**

<table>
<thead>
<tr>
<th>Health outcome</th>
<th>Baseline incidence rate (per 100,000)</th>
<th>Relative risk per 10 µg/m³ increase</th>
<th>PM₁₀ increase (µg/m³)</th>
<th>Increased risk per 100,000</th>
<th>Increased risk at most impacted residences (per 50 people)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM₁₀</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily asthma hospital admissions</td>
<td>0.26</td>
<td>1.058</td>
<td>58.8</td>
<td>0.089</td>
<td>0.000044</td>
</tr>
<tr>
<td><strong>PM₂.₅</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual asthma hospital admissions</td>
<td>94</td>
<td>1.093</td>
<td>0.7</td>
<td>0.61</td>
<td>0.00031</td>
</tr>
<tr>
<td>Daily asthma hospital admissions</td>
<td>0.26</td>
<td>1.02</td>
<td>13.3</td>
<td>0.0069</td>
<td>0.0000035</td>
</tr>
</tbody>
</table>

a Assumed population of 50 to quantify most impacted receptors. This conservatively assumes that up to 50 individuals will be potentially exposed to the maximum concentrations modelled at adjacent residences.
Given that these maximum modelled concentrations in Table 8-103 and Table 8-104 are representative of a small number of assumed ‘worst case’ locations, an assessment of risk is also presented based on the average modelled concentrations for receptors within the Immediate Area of the site (Table 8-101).

Table 8-105 Estimated increase in mortality risk based on maximum increase in modelled particulate matter concentrations estimated in Immediate Area (based on a population of 561 in the Immediate Area)

<table>
<thead>
<tr>
<th>Health outcome</th>
<th>Baseline incidence rate (per 100,000)</th>
<th>Relative risk per 10 µg/m³ increase</th>
<th>PM increase (µg/m³)</th>
<th>Increased risk per 100,000</th>
<th>Increased risk in Immediate Area (per 561)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM_{10}</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual mortality</td>
<td>700</td>
<td>1.04</td>
<td>2.0</td>
<td>5.6</td>
<td>0.031</td>
</tr>
<tr>
<td>Daily mortality</td>
<td>1.92</td>
<td>1.006</td>
<td>15</td>
<td>0.017</td>
<td>0.000096</td>
</tr>
<tr>
<td>Daily respiratory mortality a</td>
<td>0.25</td>
<td>1.013</td>
<td>15</td>
<td>0.0049</td>
<td>0.000028</td>
</tr>
<tr>
<td><strong>PM_{2.5}</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual all-cause mortality</td>
<td>700</td>
<td>1.048</td>
<td>0.68</td>
<td>2.3</td>
<td>0.013</td>
</tr>
<tr>
<td>Daily all-cause mortality</td>
<td>1.92</td>
<td>1.078</td>
<td>5.1</td>
<td>0.076</td>
<td>0.00043</td>
</tr>
<tr>
<td>a Calculated from annual mortality rates for asthma, lung cancer, IHD, COPD (90.4 per 100,000 per year in Northern Grampians).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8-106 Estimated increase in morbidity risk based on maximum increase in modelled particulate matter concentrations estimated in Immediate Area (based on a population of 561 in the Immediate Area)

<table>
<thead>
<tr>
<th>Health outcome</th>
<th>Baseline incidence rate (per 100,000)</th>
<th>Relative risk per 10 µg/m³ increase</th>
<th>PM increase (µg/m³)</th>
<th>Increased risk per 100,000</th>
<th>Increased risk in Immediate Area (per 561)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM_{10}</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily asthma hospital admissions</td>
<td>0.26</td>
<td>1.058</td>
<td>15</td>
<td>0.023</td>
<td>0.00013</td>
</tr>
<tr>
<td><strong>PM_{2.5}</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual asthma hospital admissions</td>
<td>94</td>
<td>1.093</td>
<td>0.68</td>
<td>0.59</td>
<td>0.0033</td>
</tr>
<tr>
<td>Daily asthma hospital admissions</td>
<td>0.26</td>
<td>1.02</td>
<td>5.1</td>
<td>0.0027</td>
<td>0.000015</td>
</tr>
</tbody>
</table>
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The increased risks calculated in Table 8-103 to Table 8-106 above are based on either a daily or an annual rate of increase. The annual values can then be multiplied out to calculate risk levels for the duration of the Project. These would be conservative risk estimates, as it is based on the assumption that maximum impacts occur through all five years of operations. Only the annual averages have been multiplied out to calculate total Project risks, as the daily risks are highly variable, depending on daily variability in PM concentrations. The annual averages appropriately capture and average out that variability. The risk values for the total project duration, based on the calculations provided in Table 8-103 to Table 8-106 are presented below.

Table 8-107 Estimated increase in risk based on maximum increase in modelled particulate matter for project duration (five years)

<table>
<thead>
<tr>
<th>Health outcome</th>
<th>Increased risk in Immediate Area (per 561 people)</th>
<th>Increased risk at most impacted residences (per 50 people)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{10}$ – Annual all-cause mortality</td>
<td>0.031 Per annum 0.16 Project duration (5 years)</td>
<td>0.0028 Per annum 0.014 Project duration (5 years)</td>
</tr>
<tr>
<td>PM$_{2.5}$ – Annual all-cause mortality</td>
<td>0.013 Per annum 0.065 Project duration (5 years)</td>
<td>0.0012 Per annum 0.0060 Project duration (5 years)</td>
</tr>
<tr>
<td>PM$_{2.5}$ – Annual asthma hospital admissions</td>
<td>0.0033 Per annum 0.017 Project duration (5 years)</td>
<td>0.00031 Per annum 0.0016 Project duration (5 years)</td>
</tr>
</tbody>
</table>

Qualitative assessment

The calculated risk rates associated with exposure to the modelled PM$_{10}$ and PM$_{2.5}$ concentrations during the Project have been assessed within the context of the qualitative risk matrices (described in Section 8.16.3.1).

The modelled PM concentrations associated with the Project are expected to result in an increase in PM exposure at nearby receptors, as indicated by the contour maps of the potential emissions presented in Figure 8-144 and Figure 8-145. These figures indicate that a population of 561 people within the Immediate Area would see an annual average increase of PM$_{10}$ of approximately 2.0 µg/m$^3$, and an annual average increase of PM$_{2.5}$ of approximately 0.68 µg/m$^3$. These estimated PM concentrations were assessed as potentially resulting in an increase in mortality and morbidity effects in the Immediate Area. The consequences of the calculated increased rates have been assessed through the qualitative risk matrices provided in this HIA (refer Technical Appendix 16).

Based on the potential health consequences outlined in Table 8-93 consequences are considered ‘Moderate’.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>Possible</td>
<td>Low</td>
</tr>
</tbody>
</table>
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Respirable crystalline silica (RCS)
An assessment of respirable crystalline silica (RCS) in air is required for sites where crystalline silica is present within the material being disturbed (such as in a mining operation). In particular, RCS as PM\textsubscript{2.5} is of interest due to the potential for irritative effects on the lower respiratory tract, resulting in silicosis.

Issue identification
Ambient air samples of RCS as PM\textsubscript{2.5} were collected during preliminary PM sampling conducted at Big Hill. In addition, overburden, ore and waste rock samples were collected for silica dioxide (SiO\textsubscript{2}) analysis, from a number of locations within the area to be mined. These samples are considered representative of materials to be disturbed during the Project.

Qualitative assessment
Concentrations of RCS in PM\textsubscript{2.5} were predicted in the AQIA report, by estimating the mean silica concentration in waste, ore and overburden samples. This value was applied to the annual mean PM\textsubscript{2.5} modelled results at each sensitive receptor to yield a cumulative annual mean RCS (as PM\textsubscript{2.5}) ground level concentration.

The calculated maximum annual average ground level concentration of RCS in PM\textsubscript{2.5} was 2.1 µg/m\textsuperscript{3}, which is below the PEM assessment criteria of 3 µg/m\textsuperscript{3}. This estimated value assumes that all silica dioxide present within the ore body and waste rock samples would be present as RCS (as PM\textsubscript{2.5}), which is a conservative assumption.

As the estimated maximum concentration of RCS in PM\textsubscript{2.5} is below the PEM criteria, the potential impacts associated with RCS inhalation are limited, with a risk matrix consequence of ‘Negligible’.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>Unlikely</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

Risk management will not be required.

Combustion sources
Combustion sources, such as vehicle exhaust, can result in emissions of a number of compounds that require further assessment under the PEM. Emissions from combustion sources that were assessed within the AQIA and HIA include:
- nitrogen oxides (NO\textsubscript{x})
- carbon monoxide (CO)
- polycyclic aromatic hydrocarbons (PAHs)
- sulphur dioxide (SO\textsubscript{2}).

Issue identification
Combustion emissions may potentially impact on respiratory health if exposure to elevated levels occurs, and they therefore require assessment in the HIA. Such assessment is also required under the Protocol for Environmental Management (PEM): Mining and Extractive Industries.
Background levels of PAHs are assumed to be low, with background data sourced from Traralgon. Background levels of NO\textsubscript{x} and CO have been assessed using the available Bendigo air monitoring data; while background SO\textsubscript{2} data has been adopted from Geelong air monitoring stations (refer to the Air Quality chapter for more details on use of these data sets).

**Qualitative assessment**

An assessment of the combustion emission levels that may be present during the Project, based on the outcomes of the AQIA, is included below.

The AQIA modelled potential maximum concentrations of NO\textsubscript{x}, CO, PAHs and SO\textsubscript{2} at key receptors located in proximity to the Project area. The maximum concentrations modelled at any receptor for these compounds are summarised in Table 8-108, with a comparison against relevant assessment criteria.

<table>
<thead>
<tr>
<th>Chemical modelled</th>
<th>Maximum off-site concentration</th>
<th>Assessment criteria (ppm)</th>
<th>Source of assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO\textsubscript{x}</td>
<td>0.09 ppm</td>
<td>0.14 ppm (1-hour average)</td>
<td>PEM</td>
</tr>
<tr>
<td>CO</td>
<td>1.35 mg/m\textsuperscript{3}</td>
<td>33.2 mg/m\textsuperscript{3} (= 29 ppm) (1-hour average)</td>
<td>PEM</td>
</tr>
<tr>
<td>PAH (Total)</td>
<td>0.36 ng/m\textsuperscript{3}</td>
<td>0.3 ng/m\textsuperscript{3} (annual average)</td>
<td>PEM</td>
</tr>
<tr>
<td>SO\textsubscript{2}</td>
<td>0.31 mg/m\textsuperscript{3}</td>
<td>0.45 mg/m\textsuperscript{3}</td>
<td>SEPP (AQM)</td>
</tr>
</tbody>
</table>

The PAH criteria is considered overly conservative, as it assumes the total mass of PAH is comprised of Benzo(a)pyrene, the most toxic component of PAH. The relative toxicity of PAH is discussed further within the HIA. As all combustion sources are below the assessment criteria, with PAH just above the criteria limit, further assessment of potential health risks has not been required.

While the modelled total PAH value is close to the assessment criteria, the criteria assumes that 100 per cent of the PAH is comprised of benzo(a)pyrene, the most toxic PAH likely to be present. Given that the total PAH value modelled would only partially be comprised of benzo(a)pyrene, with a number of other less toxic PAH compounds also present, this modelled concentration is considered higher than that which would occur in reality. As such, the potential impacts of combustion emissions are within regulatory limits and considered acceptable.

As impacts will be below relevant air quality assessment criteria, potential impacts are minimal, with a risk matrix consequence of ‘Negligible’.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>Unlikely</td>
<td>Very low</td>
</tr>
</tbody>
</table>

Risk management of combustion emissions will therefore not be required.
8 Environmental Impact Assessment

Asbestos
An assessment of asbestos is required for sites where naturally occurring asbestos is present.

Issue identification
Samples were collected from Big Hill to enable assessment of asbestos, with samples collected from locations considered representative of likely materials to be mined during the Project. No asbestos was detected in any samples analysed. On this basis, further assessment of asbestos has not been required.

Environmental arsenic
Naturally elevated levels of arsenic in soil are known to occur in gold-bearing ores and in soil across the gold mining region of central Victoria. While the bioavailability of this mining-related arsenic is generally low, potential health effects associated with an increase in exposure to such arsenic needs to be considered. Where arsenic is present, pathways of exposure that require consideration for properties surrounding the Project area include:

- inhalation of dust which contains arsenic (as PM$_{10}$)
- ingestion of arsenic that has entered tank water from dust deposition.

Issue identification
Samples of overburden and ore were collected from Big Hill to enable assessment of arsenic within the ore body. Samples collected were from locations considered representative of likely materials to be mined during the Project. In addition, analyses of arsenic concentrations within PM (both respirable PM$_{10}$ and total dust deposition) have been undertaken at Stawell, as part of the preliminary dust sampling conducted between May and September 2013. Dust deposition data are also available from historical monitoring conducted at the mine.

Low levels of arsenic were detected in both soil and PM. Data have been compared against relevant health based assessment criteria, for sensitive receptors, as outlined within Table 8-109.

Table 8-109 Background arsenic concentrations in soil and particulate matter from Stawell Gold Mines

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Units</th>
<th>Maximum measured concentration</th>
<th>Assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic – soil</td>
<td>mg/kg</td>
<td>583</td>
<td>1,000 (Adjusted HIL-A$^a$)</td>
</tr>
<tr>
<td>Arsenic – dust deposition</td>
<td>g/m$^2$/month</td>
<td>0.0074</td>
<td>NA</td>
</tr>
<tr>
<td>Arsenic – PM$_{10}$</td>
<td>µg/m$^3$</td>
<td>&lt;0.02</td>
<td>$1^b$ (RIVM 2001)</td>
</tr>
</tbody>
</table>

$^a$ HIL-A adjusted to allow for regional bioavailability (25 per cent), as per the Amended NEPM HIL calculator. This value is protective of a generic residential exposure scenario, including incidental inhalation of PM.

HIL = Health Investigation Level, a screening or guideline value adopted nationally in the NEPM. HIL-A refers to a sensitive land use, and is used when assessing residential sites, child care centres, primary schools and other scenarios where young children may be exposed to soil.

$^b$ Inhalation toxicity reference value (TRV) protective of arsenic inhalation, as utilised in the Amended NEPM.
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The data indicate that arsenic is naturally present in the environment at Stawell Gold Mines but background arsenic levels in dust and soil are below human health based assessment criteria and unacceptable health impacts would not be expected.

**Qualitative assessment**

**Arsenic inhalation**

Concentrations of arsenic in PM$_{10}$ were calculated within the AQIA, by applying the mean arsenic percentage content from analyses of materials at the site, and applying this percentage to the annual mean PM$_{10}$ dispersion modelling results. This provided predicted annual mean arsenic ground level concentrations for assessment against the relevant screening criteria.

The calculated maximum annual average concentration of arsenic in PM$_{10}$ was 0.0034 µg/m$^3$, which is slightly above the PEM assessment criteria of 0.003 µg/m$^3$. This estimated value is taken from the maximum estimated annual average at a single receptor point, and is considered to be an overestimate of exposure concentrations that would be experienced across the wider area where PM emissions may occur, as impacts are rapidly dispersed with distance from the site.

The maximum value is well below the risk based inhalation value of one mg/m$^3$, as proposed for use within the Amended ASC NEPM (NEPC 2013). The value of one mg/m$^3$ is considered to be protective of human health via the inhalation of arsenic pathway under this regulatory framework.

As the estimated maximum concentration of arsenic in PM$_{10}$ is well below levels that are considered to cause adverse health impacts, the potential impacts associated with arsenic inhalation are limited, with a risk matrix consequence of ‘Negligible’.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>Unlikely</td>
<td>Very low</td>
</tr>
</tbody>
</table>

Risk management will not be required.

**Arsenic deposition in water supplies**

A screening assessment of potential pathways for dust deposition into water supplies, with subsequent potential for ingestion by receptors in Stawell, is detailed in Section 8.10. This assessment indicated that maximum potential concentrations of metals in the GWMWater water storage reservoirs located to the northeast of the Project area would be below Australian drinking water guidelines, based on a conservative assessment of potential dust deposition impacts.

The Victorian Government *Guidance on Use of Rainwater Tanks* (2006) recommends the installation of a ‘first flush’ diverter, particularly for tanks used for drinking water supplies. This system diverts the first rainfall following a dry period, which is designed to collect the majority of contaminants deposited on the roof, such as dust, bird and animal droppings, leaves and other debris. If rainwater tanks in the area are used in accordance with this guidance, potential impacts on drinking water supplies would be significantly mitigated. Further investigation of rainwater tank occurrence and use within the area surrounding the site will be undertaken, to confirm whether rainwater is in use and whether tanks are installed in accordance with the guidance.
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**Assessment of heavy metal impact on GWMWater water storage reservoirs**

A screening level review of the potential impact of dust that carries heavy metal (including arsenic) and deposits on the GWMWater water storage reservoirs was undertaken to assess any potential adverse impacts on water quality within the reservoirs (refer Section 8.10).

This review found that the additive effect of airborne particulates from the Project, when combined with background levels of iron and aluminium in the reservoirs, will likely result in an exceedance of the criteria as the background water quality from Lake Fyans, prior to treatment, exceeds criteria. However, as outlined in Section 8.10, raw water from the GWMWater water storage reservoirs undergoes treatment at the Aquatower treatment plant and drinking water quality after treatment is compliant with all regulatory criteria. The additional iron and aluminium load resulting from the Project would be minimal and will not necessitate further treatment over and above that already in place at the treatment plant. The additive effect of metals other than iron and aluminium are minimal and do not create risks to drinking water quality.

As water quality within the town supply will comply with drinking water criteria after treatment, potential impacts from the Project are minimal with a risk matrix consequence of ‘Negligible’.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>Unlikely</td>
<td>Very low</td>
</tr>
</tbody>
</table>

**Naturally occurring radioactive materials**

An assessment of naturally occurring radioactive materials (NORM) was undertaken in accordance with the PEM, with analyses of selected soil samples for a range of radionuclides. NORM is the term used to describe materials containing radionuclides that exist in the natural environment.

**Issue identification**

Samples were collected from within the soil, overburden and ore body at Big Hill to enable assessment of these materials. Samples collected are considered representative of likely materials to be mined during the Project.

Low levels of uranium and radionuclides were detected, as summarised in Table 8-110 below. Information regarding the assessment and potential impacts associated with NORM is provided in the *Safety Guide for the Management of Naturally Occurring Radioactive Material (NORM)* (ARPANSA 2008). In addition, the ARPANSA (Australian Radiation Protection and Nuclear Safety Agency) has also published a technical report on *A Survey of Naturally Occurring Radioactive Material Associated with Mining* (ARPANSA 2012). These documents indicate that if the individual radionuclide concentration in the material does not exceed 1,000 Becquerel per kilogram (Bq/kg), further assessment is not required.
8 Environmental Impact Assessment

Table 8-110  Concentrations of radionuclides in naturally occurring radioactive material

<table>
<thead>
<tr>
<th>Compound/ radionuclide</th>
<th>Units</th>
<th>Maximum measured concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uranium</td>
<td>mg/kg</td>
<td>4.5</td>
</tr>
<tr>
<td>Uranium 238</td>
<td>Bq/kg</td>
<td>100</td>
</tr>
<tr>
<td>Thorium 234</td>
<td>Bq/kg</td>
<td>86</td>
</tr>
<tr>
<td>Radium 226</td>
<td>Bq/kg</td>
<td>88</td>
</tr>
<tr>
<td>Uranium 235</td>
<td>Bq/kg</td>
<td>5</td>
</tr>
<tr>
<td>Protactinium 231</td>
<td>Bq/kg</td>
<td>5</td>
</tr>
<tr>
<td>Actinium 227</td>
<td>Bq/kg</td>
<td>2.5</td>
</tr>
<tr>
<td>Thorium 227</td>
<td>Bq/kg</td>
<td>2.5</td>
</tr>
<tr>
<td>Radium 228</td>
<td>Bq/kg</td>
<td>83</td>
</tr>
<tr>
<td>Thorium 228</td>
<td>Bq/kg</td>
<td>85</td>
</tr>
<tr>
<td>Potassium 40</td>
<td>Bq/kg</td>
<td>920</td>
</tr>
</tbody>
</table>

While the Potassium 40 value is close to the screening value of 1,000 Bq/kg, the screening level is protective of potential human health impacts from all radionuclides, regardless of activity levels. Given that the radioactivity of Potassium 40 is relatively low compared to the other radionuclides for which the ARPANSA value is protective (such as uranium 238 and thorium 234), the presence of it at levels close to the ARPANSA screening level is not considered indicative of potential for concern. In addition, the Victorian Radiation Regulations 2007 provide different activity concentrations for different radionuclides to be defined as ‘radioactive materials’ under the Radiation Act 2005; that value is 100 times higher for Potassium 40 (100 Bq/g or 100,000 Bq/kg).

On the basis that none of the individual radionuclide concentrations exceed the suggested screening value of 1,000 Bq/kg per compound (ARPANSA 2012), and none reach concentrations that are defined as radioactive under the Radiation Act and Regulations, further assessment of NORM has not been required for the purposes of this Health Report.

8.16.3.3 Environmental Determinants

A qualitative assessment of potential health impacts associated with environmental factors, including noise, blasting and stress associated with the impact of loss of visual amenity, is presented below.

Noise

A complete assessment of the potential noise impacts resulting from the Project is described in Section 8.5.

Factors that contribute to adverse effects of noise as they relate to health (including annoyance), include whether the noise is transient or continuous; whether the noise is perceived to be unwanted; the frequency (pitch) of the sound; and when the noise is expected to occur (i.e. during daytime or night time).
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In general, intermittent intense sounds of high frequency and short duration have greater effects on health than continuous, low frequency, long duration, low intensity sounds (London Health Commission 2003).

Issue identification

Noise was identified by Stawell residents during community consultation as one of the primary concerns relating to the Project (URS 2013a).

The relevant guidelines for noise from industrial operations in regional Victoria are the EPA Publications 1411-1413 *Noise from Industry in Regional Victoria* (NIRV). NIRV is a non-statutory guideline that recommends maximum noise levels for existing and new noise sources.

Table 8-111  Applicable maximum noise levels for the Project

<table>
<thead>
<tr>
<th>Time Period</th>
<th>For existing noise sources (e.g. existing SGM activities)</th>
<th>For new noise sources (e.g. the Project)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing EMP limit $L_{\text{eff}}$ dB</td>
<td>NIRV maximum noise level target $L_{\text{eff}}$ dB</td>
</tr>
<tr>
<td>Monday – Friday (0700 – 1800hrs)</td>
<td>50 dB</td>
<td>46 dB</td>
</tr>
</tbody>
</table>

Note: The effective noise level ($L_{\text{eff}}$) is measured in decibels (dB) over a half-hour period and is adjusted for the character of the noise such as tonality, intermittency and impulsiveness.

The existing processing plant will continue to operate 24 hours a day, with no changes to current use required as part of the Project. The Project has taken a best practice approach to minimise noise impacts. Most notably, and in recognition of the proximity of the mine to residential areas, SGM has restricted the mining works to day time hours (7.00am - 6.00pm).

The noise modelling outlined in more detail in Section 8.5 predicts that areas that are currently exposed to noise from SGM activities will continue to comply with the existing daytime EMP limit of 50 dB at all times.

With the exception of site rehabilitation, the modelling indicates minor exceedances of NIRV of between one and four dB at some locations during day time hours, and at various stages of the Project, which may be perceptible at times. A two to three dB change in noise is at the limits of what is perceptible by the human ear and represents only a small increase in the context of current ambient daytime noise levels of 42 dB to 61 dB $L_{\text{Aeq}}$. It can be expected that residents are therefore adapted to projected ambient noise levels of up to 50 dB.

During Quarter 8, site rehabilitation of the North Pit will be undertaken by a compactor for a period of approximately four weeks. Noise levels during these works are predicted to exceed 60 dB $L_{\text{eff}}$ at times at up to four residential properties.
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Qualitative assessment

If environmental noise impacts are experienced, there is evidence that it can affect health due to sleep disturbance and increased blood pressure, which can result in cardiovascular disease. A decrease in an individual’s quality of life due to an increased level of annoyance can also have a negative effect on health. However, as noted above, operations associated with the Project will occur during day time hours only and impacts on sleep should be minimal, although operations associated with existing mining operations at Stawell will continue to occur at night.

To provide some context to the predicted maximum noise levels during daytime, environmental noise above 40 to 55 dB is likely to lead to annoyance, higher noise levels in the range of 65 to 70 dB may be risk factors for reduced school performance for students and increased ischaemic heart disease, while outdoor noise levels in the range of 40 to 60 dB could disturb sleep (London Health Commission, 2003). Any sound above 85 dB can cause hearing loss, with eight hours of exposure to noise levels of 90 dB potentially causing hearing loss. Any exposure to noise levels of 140 dB an above can cause immediate damage and physical pain (enHealth, 2004).

Research indicates that day time noise levels up to 75 dB for less than eight hours duration, or instantaneous peak noise levels below 130 dB are unlikely to cause hearing damage to adults (Safe Work Australia, 2011). These noise levels and associated impacts are summarised in Table 8-112.

Table 8-112 Summary of daytime noise levels and associated potential impacts for the Project

<table>
<thead>
<tr>
<th>Environmental noise</th>
<th>Potential impact</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 40 to 55 dB</td>
<td>Likely to lead to significant annoyance and can disturb sleep</td>
<td>Mining of the North and South Pits will occur during daytime hours only (7am – 6pm)</td>
</tr>
<tr>
<td>65 to 75 dB</td>
<td>Potential risk factor for school performance and ischaemic heart disease Unlikely to cause hearing damage to adults</td>
<td>These levels are not predicted near schools, hospitals, aged care facilities.</td>
</tr>
<tr>
<td>Above 85 dB</td>
<td>Can cause hearing loss (eight hours at 90 dB can cause damage to ears). Any exposure to 140 dB causes immediate damage and actual pain Instantaneous peak below 130 dB unlikely to cause hearing damage to adults</td>
<td>These levels are not predicted to occur</td>
</tr>
</tbody>
</table>

Young children may be more sensitive to noise induced hearing impairment than adults, as the effect of noise exposure decreases with age (National Institute of Public Health, 2001). Other noise related effects on children include tasks related to cognition (thinking) and learning, such as reading, attention, problem solving and memory (National Institute of Public Health, 2001).
While the predicted daytime noise levels associated with the Project are expected to exceed the NIRV guidelines at some residential locations during certain stages of the Project, the noise levels are unlikely to be associated with adverse health effects, other than annoyance and amenity issues. Residents in the vicinity of Big Hill are highly unlikely to be exposed to noise levels that could cause adverse health effects (sounds above 85 dB). Overall, consequences of the Project in respect of noise impacts on health are considered to be minor.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>Possible</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Blasting**

A complete assessment of the potential impacts associated with blasting during the Project is described in Section 8.6.3.

Blasting is an important process in hard rock mining because it fragments and separates rock pieces from the rock mass, enabling their extraction. Some of the blast energy creates vibration in the form of waves in the surrounding rock and air. These energy waves result in ground vibrations, airblast (atmospheric pressure waves) and flyrock (unexpected excessive throw of broken rock).

**Issue identification**

The main regulatory requirements relating to annoyance and nuisance from blasting are the DSDBI guidelines for *Ground Vibration and Airblast Limits for Blasting in Mines and Quarries* which apply to sensitive sites such as residences and schools as shown below in Table 8-113.

### Table 8-113 DSDBI blasting guidelines for sensitive sites

<table>
<thead>
<tr>
<th>Environmental effects</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground vibration (The vibration that is transmitted through the ground from a blast)</td>
<td>≤ 5 mm/s for 95 per cent of blasts in a 12 month period, ≤ 10 mm/s for all blasts</td>
</tr>
<tr>
<td>Air vibration (airblast) (The shockwave or pressure pulse generated by a blast.)</td>
<td>≤ 115 dB for 95 per cent of blasts in a 12 month period, ≤ 120 dB for all blasts</td>
</tr>
<tr>
<td>Flyrock (Rock fragments that are thrown from a blast)</td>
<td>Must be contained within the mine property and not present a danger to people and property</td>
</tr>
</tbody>
</table>

The most sensitive sites for the purposes of blast vibration control are houses within 100 metres of the blasting areas, St Patrick’s School and Stawell Secondary College (both approximately 300 metres from pit operations).

The blasting assessment in Section 8.6 indicated that blast effects (vibration and airblast) can be controlled below DSDBI guideline limits at all sensitive sites such as residences and schools with appropriate control measures outlined in the Blasting Management Plan. During blasting, an exclusion zone will be established to ensure that there is no risk to persons or property from flyrock.
Ground vibrations and airblast caused by the proposed blasting would be perceptible to Stawell residents living in close proximity to the mine site but at levels within regulatory limits. It is also anticipated that blasting will be restricted to a limited portion of the overall mining operation and primarily at depth within the pits (refer Section 8.6).

The peak airblast at St Patrick’s School and the Stawell Secondary College is predicted to be below 100 dBL, which is below human threshold perception levels and the peak ground vibration is predicted to be less than 0.6 millimetres per second (mm/s), which is at or below human perception levels (Terrock 2013).

**Qualitative assessment**

Air blast overpressure, vibration and flyrock were raised by Stawell residents as concerns about the Project (refer to Chapter 7). The health impact associated with air blast and vibration could cause higher than normal levels of anxiety and sleeping difficulties, however operations will be limited to day time hours only with blasting occurring up to once per day within a one hour period over particular periods of mining. Although blast vibration does result in community complaints, the Stawell community is somewhat accustomed to it as underground blasting and some open-cut blasting has continued to occur over the past 30 years. SGM also has an SMS alert service whereby residents can be alerted of an upcoming blast to reduce the ‘fright’ factor.

The predicted levels of air blasts and vibration are unlikely to be associated with adverse health effects to the general population of Stawell township. However, as blasting is conducted during the day, individuals who need to sleep during the day, for example shift workers, could suffer from an increased stress level due to interrupted sleep. In addition, people suffering from post-traumatic stress disorder could experience an increased level of anxiety during blasting.

Given that impacts are associated with low level stress and anxiety, consequences are therefore classified as minor.

A reduction of the air quality and potential adverse health impacts from blasting, including the release of PM, is assessed within the air quality modelling completed for the AQIA.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>Possible</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Visual amenity**

The visual impact assessment is described in Section 8.16.

While the Big Hill landform and vegetation has been impacted by historic activities, it is prominent both physically and culturally within the Stawell Township due to its proximity, history and the range of structures on its peak.
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Issue identification

There are no relevant guidelines or legislation relating to the potential visual amenity impacts of the Project on the Stawell community.

However, the short term physical and visual loss of Big Hill has been described as one of the key community concerns relating to the Project and there are potential health impacts associated with the loss. It is noted in the visual impact assessment that from many viewing points around Stawell, the existing ridgeline of Big Hill remains intact and visible, the primary visual impact being the open pit face prior to rehabilitation.

Qualitative assessment

While there is significant importance placed on Big Hill by the community, and there is potential for anxiety and stress associated with its loss, albeit temporary, there are unlikely to be significant direct health impacts associated with this stress. Overall, consequences of the Project in terms of visual impacts having adverse effects on human health are classified as negligible.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>Possible</td>
<td>Very low</td>
</tr>
</tbody>
</table>

Risk management will therefore not be required.

Public safety

Aspects of public safety associated with blasting, noise, or air quality have been assessed above, and have not been covered in this section.

A key aspect of the Project relating to public safety is the improvement of the Big Hill landform, post-mining. The Project proposes to rehabilitate the Big Hill landform to a standard that improves on the existing landform condition, with works to include compaction, removal of existing void spaces, and revegetation. In addition, the mine site itself will not be accessible during the Project lifecycle, with fencing and stable pit walls proposed.

With regards to public safety at Big Hill following completion of the Project, it is expected that the Project will have a positive outcome with an improvement to public safety by removing a number of potential hazards such as old mine shafts and tunnels. Overall, consequences of the Project with respect to public safety are classified as negligible.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>Unlikely</td>
<td>Very low</td>
</tr>
</tbody>
</table>

Risk management will therefore not be required.
8 Environmental Impact Assessment

Socio-economic determinants of health

As the Project is an extension of the existing mine operations which utilises local labour resources, the socio-economic aspects of the Project are generally positive. Potential impacts which are often associated with mine site developments, such as altered demographics due to influx of construction workers, are not expected to be issues of concern for this Project.

Socio-economic factors associated with maintaining the current workforce will have a positive effect on employment and income within Stawell, as assessed in the Economic Impact Assessment (Aither, 2013). In addition, given the current workforce (and ongoing workforce, should the Project proceed) are largely existing residents of Stawell, demographics and general socio-economic determinants of health should not change to any significant extent.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>Unlikely</td>
<td>Very low</td>
</tr>
</tbody>
</table>

Risk management will therefore not be required.

Mental health

The Project may result in anxiety and stress in members of the Stawell population, within both the population present in close proximity to the mine (i.e. those potentially impacted by noise or dust), and within the broader community. However, the potential direct health impacts associated with these factors have been assessed within the relevant sections of the HIA.

There is reasonable evidence to suggest that exposure to noise can result in psychological symptoms; however, there is limited evidence that noise (at levels potentially generated by the Project) is responsible for serious mental ill-health impacts. Individuals suffering from depression are likely to be more sensitive to noise and annoyance from noise, and it is known that noise sensitive people pay more attention to noise, find noise more threatening and react and adapt to noise more slowly than less noise sensitive people (enHealth, 2004).

Blasting and vibration could cause a higher than normal level of anxiety, as well as potential sleeping difficulties (noting that operations are scheduled for day time hours only).

In addition, other factors may impact on mental health, due to general anxiety in the wider population about the impact of the Project on the community. Equally, a continuation of mining in Stawell with the attendant employment and economic benefits, as opposed to complete cessation of mining, could have positive mental health effects in the community.

Overall, while there is some potential for anxiety and stress associated with the Project, these are likely to be temporary and the consequences are classified as minor.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>Possible</td>
<td>Low</td>
</tr>
</tbody>
</table>
8 Environmental Impact Assessment

8.16.4 Management and Mitigation Measures
As discussed in this section, key aspects of the Project with the potential to impact on health in the community are noise, blasting and air quality. Management and mitigation measures to address these issues are detailed in the respective EES sections covering these topics and are not discussed further here.

Potential for heavy metals in rainwater tanks
Consultation with surrounding residents will be undertaken, to assess whether rainwater tanks are used for drinking water supplies. If tanks are used as a source of drinking water, a limited rainwater tank monitoring (and analysis) program will be undertaken prior to the commencement of site operations. The number and location of houses chosen will depend on their proximity to the Project and rainwater uses. Baseline monitoring will be compared to an ongoing rainwater tank monitoring program as detailed in Chapter 11.

Consultation and communications Strategy
The site will maintain an ongoing consultation and communication strategy for the duration of the Project. The purpose is to establish an interface with residents in close proximity to the proposed open pit operations whereby a positive line of communication is maintained.

This will include:

- A phone number for complaints / concerns and a mechanism for resolving complaints
- Quarterly bulletins distributed to all households in Stawell
- Quarterly Environment Review Committee (ERC) meetings – this includes regulators, community and community group leaders. In this meeting, SGM reports on compliance with environmental monitoring and details of any complaints received directly to SGM or that have been passed onto SGM by regulators
- Direct mail out to nearby residents to keep them informed
- Individual meetings with nearby residents as required.

8.16.5 Conclusion
The general approach by SGM in relation to the Project has been to commit to management, mitigation and operational measures to reduce the potential amenity and health impacts of the Project on the community acknowledging its proximity to an urban area.

Potential health impacts associated with the Project are generally considered low to very low prior to mitigation measures being implemented, and are considered very low following implementation and maintenance of appropriate mitigation measures.

While the Health Report found that the majority of potential health determinants were unlikely to result in significant negative health impact on the community, the potential for increased exposure to respirable dust (PM₁₀, PM₂.₅) in the surrounding areas did require further consideration. This was due to atmospheric modelling of respirable dust emissions indicating a potential increase in dust concentrations in areas adjacent to the Project area.
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For the purposes of investigating health impacts associated with respirable dust, there is no published ‘acceptable risk level’. The PEM was utilised as the main assessment criteria for the Project, as it has specifically been developed by the Victorian EPA for the assessment of potential impacts associated with mining in Victoria.

The air quality impact assessment, which considers total dust levels from both background and the mine operations, has indicated that there is potential for respirable dust to increase in some areas surrounding the mine at some times to concentrations exceeding the adopted PEM assessment criteria. However, the exceedances are for a limited number of occasions under certain worst-case scenarios, where background concentrations are elevated, for example, from events such as bushfires, dust storms and certain climatic conditions.

With full implementation of the real time air quality monitoring program and Air Quality Management Plan proposed by SGM, it is expected that on days when background levels are elevated, works at the site are modified or ceased depending on the severity of conditions so that the adopted PEM assessment criteria are not exceeded at nearby residences. If the PEM is not exceeded at nearby residences, the Project will comply with the requirements of the Victorian EPA guidance requiring the protection of health from exposure to respirable dust associated with mining.

The potential for direct health impacts caused by stress and anxiety amongst the impacted communities during the Project due to loss of amenity (acoustic, vibration and visual) is considered to be minor and can be managed through effective consultation and communications.

After management and mitigation measures are implemented, the potential health impacts as a result of this Project are considered to be low and acceptable.
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8 Environmental Impact Assessment

8.17 Economic

8.17.1 Introduction
This section of the EES provides an overview of the economic impact assessment for the Project. It is based primarily on information presented in:


This report is included in Technical Appendix 16 of this EES and should be referred to for more detail on the issues discussed in this section.

**Relevant sections of EES Scoping Requirements**
This section of the EES covers each of the following components of the EES Scoping Requirements insofar as they relate to the potential economic impacts:

*4.2 Resource Development*

**Draft Evaluation Objective**
To enable an economically viable mining project that makes the best use of available gold resources.

**Key issues**
- Opportunity for development of a known gold resource.
- Efficient and environmentally sustainable mining of available resources.

**Priorities for characterising the existing environment**
- Identify opportunities for workers and suppliers of goods and services that could support the project.

**Design and mitigation measures**
- Describe alternative mine configurations or strategies to access gold reserves.

**Assessment of likely effects**
- Assess the positive and negative economic effects from construction and operation of the project, including income to the State and regional economies, employment and opportunities for local suppliers.'

*4.10 Sustainable Development*

**Draft Evaluation Objective**
Overall, to demonstrate that the project would achieve a balance of economic, social and environmental outcomes that contribute to ecologically sustainable development and provide a net community benefit.

**Key issues**
- The balance of economic, social and environmental outcomes from the project needs to be beneficial.
Assessment of likely effects

- Provide an integrated assessment of the economic, social and environmental performance of the project either proceeding or not, drawing on the findings of the specific assessments set out above, including the proposed approaches to avoiding, minimising, mitigating, managing and offsetting potential adverse effects.

Evaluate the overall implications of the project in the context of key aspects of legislation and statutory policy as well as the principles and objectives of ecologically sustainable development and environment protection.’

Key issues emerging from EES studies and community consultation

Key issues that have emerged from the community in the course of the EES investigations and as a result of the ongoing community engagement and communications program are:

- The community expressed mixed views about the economic benefits of the Project, which would vary amongst individuals.
- A desire for the Project to generate long, as well as short-term employment / economic benefits (e.g. in the form of a community trust fund).
- The Project will enable some residents to remain in Stawell that may otherwise have sought employment elsewhere. Greater population retention would result in a larger skill-base to contribute to the area's social and economic fabric.
- The Project would improve the welfare of households in Stawell and the local region, as measured by aggregate consumption. Most of this increase is due to higher household incomes in the region, either due to those directly employed by the mine or the effect of these consumers spending more on goods and services locally.

Summary of findings

The assessment of potential economic impacts of the Project compared to the ‘no Project’ scenario which will occur if the Project is not approved are summarised as follows:

- The Project will result in a net welfare gain of $38 million, which implies that the local economy will be better off by this amount.
- The Project will generate a total peak employment of 286 jobs, consisting of 100 direct employees and 186 indirect jobs.
- The Project is estimated to result in higher wages (which is the current situation due to the mine) compared to the no Project scenario. Beyond 2018, there is a small negative impact on jobs relative to the baseline due to higher real wages built up in earlier years of the Project.
- At its peak the Project will increase the gross regional product (GRP) of the North Grampians-Stawell economy by 4.9 per cent above baseline in its first year of operation, which is equivalent to $47 million.
- Industries estimated to benefit from the Project include mining, construction industry, utilities, government administration and the housing sector.
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- Manufacturing is negatively impacted by the Project due to manufacturing having to incur higher costs for labour than would otherwise be the case (which is also the current situation due to the mine).
- Housing rental prices in Stawell are estimated to increase by 6 per cent in 2015 relative to the Project not proceeding (which is also the current situation due to the existing mine). By 2020, prices are estimated to approximately return to baseline with all gains being dissipated.
- The residential market in Stawell has not been significantly impacted by the announcement of the Project (Aither, 2014). However, it is likely that the impending closure of all mining operations in Stawell will result in a reduction in the value of commercial and residential properties.

8.17.2 Existing Conditions
This section describes existing socioeconomic conditions in Stawell and the wider regional context in which Stawell is located. Australian Bureau of Statistics (ABS) boundaries have been used to define the regions of interest. The township of Stawell is located in Stawell statistical local area (SLA). The wider region is defined by the South Wimmera statistical sub-division (SSD) (Figure 8-146). This subdivision includes five SLAs:
- Horsham - central
- Balance of Horsham
- Northern Grampians - St Arnaud
- Northern Grampians - Stawell
- West Wimmera.

The two Northern Grampians SLAs together make up the Northern Grampians Shire (NGS). In the economic impact assessment, potential impacts are modelled at both the local level for the Northern-Grampians Stawell SLA and at the broader, regional level – the South Wimmera SSD.
To the southeast of the South Wimmera SSD is the township of Ararat, which is only 30 kilometres away by road. The Ararat township is within the Ararat (RC) SLA. Because of its close proximity, the economies of Ararat Shire and the NGS are thought to be closely linked.

**The Stawell economy**

Stawell is a medium-sized district town with a population of 5,736 (ABS 2011 Census). It has a diverse population with good access to services such as hospital, education and other related facilities. It provides a range of government services and retail trade to the immediate region, which is primarily agricultural. Stawell is located approximately 65 kilometres southeast from Horsham, which is the major centre in the region and is experiencing a growing population.

As at 2011, the economy was operating at almost full employment, with an unemployment rate of just 5.4 per cent.
The local government authority presiding over Stawell is NGSC. An assessment of the financial sustainability of NGS was undertaken in 2010 (Whelan and Whelan, 2010). The assessment compared the NGS capacity to pay to provide required services with the costs associated with doing so.

The assessment found that the NGS rates and charges are high relative to the capacity of the community to pay. Further, the financial position of the council is difficult due to high operating costs. The relative balance between the NGS ability to raise revenues to match increasing operating costs has declined in past years.

Population and workforce statistics
Stawell's population of 5,736 is about 16 per cent of the population in the South Wimmera SSD (Table 8-114). In accordance with the broader trend in small towns across Australia, the town's population has been declining since 1981, predominantly due to an aging of residents combined with a net out-migration of young people from the town to larger centres such as nearby Horsham and further afield (DPCD, 2012). In the decade since 2001, the population of Stawell has declined by eight per cent. This is in contrast to the regional centre of Horsham, whose population has grown by seven per cent over the same period. The total Victorian population has increased by 15 per cent.

Table 8-114 Population growth - Stawell and surrounding areas

<table>
<thead>
<tr>
<th></th>
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<tr>
<td>Stawell township</td>
<td>6,235</td>
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<td>South Wimmera statistical division</td>
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<tr>
<td>Horsham - central</td>
<td>13,580</td>
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<td>-0.68</td>
</tr>
<tr>
<td>West Wimmera</td>
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</tr>
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<td>35,771</td>
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<td>Rest of Victoria</td>
<td>4,768,203</td>
<td>5,498,755</td>
<td>15.3</td>
<td>1.53</td>
</tr>
</tbody>
</table>

Source: ABS Census (2001-2011)

Key industries
The key industries in the township of Stawell by number of employees are shown in Figure 8-147. Mining represents seven per cent of the workforce in Stawell, or 161 full time employees as at 2011 (ABS Census 2012). While mining is not the largest employer, it does generate almost $57 million of the economic value that is added to the community (or value-added), representing 22 per cent of the town’s total value-added, making it Stawell's highest value industry.

Other important sectors in Stawell in terms of employment include healthcare and social assistance (15 per cent of work force), manufacturing (14 per cent) and retail trade (13 per cent).
The NGSC recognises the importance of mining to the NGS, and has noted its aspirations to maintain (and grow) Stawell as a regional hub or centre of excellence for mining services (NGSC 2013).

Source: ABS 2011 Census

Figure 8-147 Employment by industry in Stawell township

Changes over time
The South Wimmera regional economy has changed over the last decade. Employment in agriculture, health care and manufacturing has declined, while employment in the mining industry has increased by 24 per cent. However, the largest employment growth has been associated with arts and recreation services (plus 51 per cent), accommodation and food services (plus 28 per cent).

With the exception of Horsham, South Wimmera experienced a shrinking population over the past decade. Farm employment throughout South Wimmera has declined in the decade to 2011 because of prolonged droughts and ongoing structural change in farming (CoPS, 2013).

As the most substantial services hub in the statistical sub-division, Horsham’s economy has fared better than other areas of South Wimmera. The service industry is relatively labour-intensive and a growing part of regional economies. In rural regions, the average age of the population is higher than in the cities. This means that demands for health care, aged care and some recreational facilities are growing.
Mining impact on the regional economy

While gold mining in Stawell is a significant industry for the immediate area, in terms of value add and contribution to GRP, mining diminishes in prominence when viewed in the wider regional context (Figure 8-148).

At the wider statistical local area level (North Grampians-Stawell SLA), mining generates 15.5 per cent of total value added and accounts for 5.9 per cent of employment. The SLA has a population of 8,599 and a GRP of $904 million. Business services are the highest value added sector, accounting for 16.3 per cent of total value added. Mining represents less than nine per cent of the total value added in Ararat (RDA 2012).

In terms of the South Wimmera SSD, mining accounts for five per cent of value added and 2 per cent of employment. The South Wimmera region, which has a population of 35,771 and a GRP of $3,873 million, is dominated by business services, agriculture, health, and trade. Agriculture, for example, accounts for 12 per cent of the region’s value added.

Mining employment

Within the Stawell township (as of March 2013) there were 145 people employed by SGM. This has declined from an estimated 288 employees in 2011, due to resignations and redundancies resulting from the planned closure of mining operations. There have also been approximately 80 contractors that have also ceased work for SGM.

Approximately 79.5 per cent of redundant employees have found alternative employment (CGC 2013). Of these, 40 per cent have remained in the mining industry, either elsewhere in Victoria or interstate. Individuals have also found employment in the manufacturing, retail, and construction (which includes all the earth works and excavation operators) industries. The remaining 20 per cent were either not working or were unable to be contacted.

Source: Statistics from RDA (2012), CoPS (2013) and ABS (2011)
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**Mining revenue**

Over the five year period from 2006-07 to 2010-11, SGM generated average gross revenue of $107 million per annum and generated profits of just over $2 million per annum. The average annual operating expenditure of the mine was $71 million. In addition, capital expenditures of almost $34 million per annum were made.

A proportion of the expenditures on wages, materials and services represent contributions to the local community of Stawell. Based on data provided by SGM (2013), about 18 per cent of purchased inputs by dollar value have been obtained locally from Stawell and a further nine per cent within the local region.

8.17.3 Impact Assessment

**Modelling approach**

A computable general equilibrium (CGE) model was used to estimate the economic impacts of the Project. This assessment uses a specific type of CGE model called The enormous regional model (TERM), which has been developed by the Centre of Policy Studies (CoPs) at Monash University. TERM is a ‘bottom-up’ CGE model of Australia that treats each region as a separate economy. TERM contains representations of 172 industry sectors in 206 statistical sub-divisions. The high degree of regional disaggregation makes TERM a useful tool for examining the regional impacts of development projects, such as major infrastructure or mining investments that may be region-specific.

The model contains assumptions about the relationships and economic linkages between each sector of the economy. These linkages draw on ABS data, customised by for the purposes of the model. The direct and indirect impacts of a new project are simulated by changing key inputs to the model — primarily expenditures, project revenues and direct employment. The model generates a number of indicators of economic activity, including estimates of changes in:

- gross regional product (GRP)
- indirect employment
- industry value-added
- real wages
- household consumption
- aggregate investment
- property rental prices.

Estimates are generated for each year of the Project period. This enables the trailing impacts of an initial project investment to be simulated over time.

Importantly, CGE models take into account both positive and negative effects of new investments in a regional economy. For example, investments in one part of the economy may stimulate one industry but draw resources (labour and capital) from another.
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Baseline scenario and model assumptions
As the processing of remaining underground and surface ore at the current Stawell Gold Mines is nearing completion, the baseline selected for this study is a scenario in which the existing mine closes in 2014 and there are no new mines opened in Stawell.

Figure 8-149 illustrates the conceptual trends in Stawell’s economic well-being under three scenarios:

1. ‘Business as usual’ scenario, in which the current mine continues to operate at the same level of output into the future. This is shown by the dotted line.

2. The baseline for the study is the ‘no Project’ scenario in which the existing mine closes and no new mines are opened. The baseline is shown by the solid black, bottom most line in Figure 8-149. The immediate impact of mine closure is a reduction in GRP but the line trends upward after the initial “shock”, reflecting an underlying forecast of economic growth for the region.

3. The scenario in which the Project proceeds is shown by the solid blue line. Because expenditures for the Project are smaller than the current operation, GRP is less than the ‘business as usual’ but higher than the ‘no Project’ scenario.

The grey shaded area in Figure 8-149 represents the benefits of the Project, measured against the baseline of ‘no Project’. This assessment quantifies the changes in GRP and other measures of economic activity.

Figure 8-149 Conceptual illustration of the economic modelling method
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The assumptions used to model scenario 3 (the Project proceeds) were based on the Project’s Preliminary Economic Assessment (PEA) and are presented as follows:

- the Project will commence in 2014
- the Project will yield 108,531 ounces of gold over its life, producing total gross revenue of $152 million
- revenue is based on a gold price of A$1400 per ounce
- capital expenditure over the life of the mine is assumed to be approximately $22 million, allowing for use of existing mine infrastructure
- operating expenditure over the life of the mine is assumed to be approximately $85 million (39 per cent is labour costs, 29 per cent is materials and 31 per cent is services), which includes excavation and the cost of backfilling the pits
- an additional $1.34 million has been assumed for the cost of rehabilitating the Project area in accordance with the rehabilitation plan by Year 5
- labour input is assumed to peak at 100 employees in Year 2 of the Project.

The revenues, expenditure, and employment are modelled based on standard industry and regional relationships that are embedded within the CoPS model that are based on historic data. Similarly for capital expenditures standard relationships are used to determine expenditure patterns within and outside South Wimmera SSD.

The Project aims to retain the current locally-based work force. For the purposes of the modelling, it is assumed that all employees are resident in the North Grampians-Stawell SLA.
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Changes in gross regional product

At its peak, the Project is estimated to increase GRP of the North Grampians-Stawell economy by $47 million (4.9 per cent) in Year 1 (2014) (Figure 8-150), relative to a baseline in which no mining is undertaken in Stawell. At the broader, regional level, the GRP of South Wimmera is estimated to increase by 1.2 per cent in 2014.

The potential impact on GRP is lower in Year 2 (2015) but still positive due to lower capital expenditures in this year.

Following completion of the Project in Year 5 (2018), the potential impact on GRP is modelled to be slightly negative for both Stawell (-0.8 per cent) and South Wimmera (-0.2 per cent). This is partly due to the effect of the Project sustaining higher real wages which increases costs for other parts of the economy looking to employ staff. It is also partly due to making capital idle upon closure of the mine.

Source: CoPS modelling

Figure 8-150 Change in gross regional product at the local and regional level - $ millions
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**Employment impacts**

During Year 2 (which has been modelled as 2015), the peak year of employment, the Project is estimated to generate:

- 100 direct jobs in the North Grampians-Stawell SLA
- 81 indirect jobs in the North Grampians-Stawell SLA
- 38 indirect jobs in the South Wimmera SSD
- 67 indirect jobs elsewhere in Victoria.

Beyond Year 5 (2018), there is a small negative impact on jobs relative to the baseline due to higher real wages built up in earlier years of the Project. That is, the additional jobs provided by the Project relative to baseline are offset by job losses elsewhere.

The industries within Stawell SLA that benefit the most from the Project in terms of indirect employment are business services, trade, health and other manufacturing.

![Figure 8-151 Direct and indirect employment impacts](image)
Industry Value-added

The Project increases total mining value-added in South Wimmera by up to $53.3 million in Year 3 (2016) compared to the baseline scenario. These changes approximate the net revenues generated by the Project.

![Graph showing the change in value-added for the gold-mining sector in South Wimmera from 2013 to 2020.](image)

Source: CoPS modelling

**Figure 8-152 Change in value-added for the gold-mining sector in South Wimmera**

A proportion of this value-added is expected to be transferred out of the region through taxes, dividends to shareholders and profits being reinvested elsewhere (the size of these transfer payments is not estimated by the model).

In addition to the mining sector, several other industries in South Wimmera are estimated to benefit from the Project, including the construction industry, utilities, government administration (which rises on the basis that government consumption increases with private consumption) and the housing sector. The standout industry to gain from the Project is the construction sector, which experiences a $3 million increase in value added (or 1.5 per cent increase) in the early phases of the Project. However, some of these gains have become negative impacts for the construction industry by Year 4 (2017) as higher real wages increases labour costs.

Manufacturing is negatively impacted by the Project by $2.1 million due to manufacturing having to incur higher costs for labour than would otherwise be the case.
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Property rental values

Economic modelling estimates that housing rental prices in South Wimmera will peak at 1.2 per cent above baseline in Year 2 (2015), reflecting higher demand for housing and higher incomes during the Project (Figure 8-153). In Stawell, the increase in rental prices is estimated to be 6 per cent in Year 2 (2015). Within two years post project (i.e. 2020), prices are estimated to approximately return to baseline with all gains being dissipated.

![Figure 8-153 Change in property rental prices in Stawell and South Wimmera](image)

Herbert Smith Freehills (2013) engaged Leader Property Practice to assess changes in the value of property based on sales data at the following times:

- January 2012 – prior to SGM announcing the cessation of underground operations and commencing redundancies
- December 2012 – immediately prior to announcement that SGM was progressing with seeking approvals on the Project, but after the planned downsizing of SGM workforce with ceasing of underground operations
- February 2013 – immediately after the Big Hill announcement, and while there was uncertainty as to whether the Project will proceed.

The assessment concluded that there has been no material change in the value of residential properties prior to the February 2013 announcement. In the four months following the February 2013 announcement, the median price and volume of sale transactions for residential property did reduce in Stawell, however it was the opinion of the authors that the reduction was due to a number of factors including the SGM announcement, the softening of the economy and the upcoming Federal election (Herbert Smith Freehills 2013).
According to Leader Property Practice, should the Project proceed, and mining continue in Stawell for the next five years, residential property prices in Stawell will generally remain stable. As land in and around the Project area is a well-regarded or preferred residential area of Stawell, while there may be a potential short term impact on property prices in the immediate vicinity during mining and rehabilitation, any long term impact will not be significant.

Leader Property Practice advised that in the ‘no Project’ scenario where all mining in Stawell ceases within three to six months, it is likely to result in a reduction in the value of commercial and residential property estimated at 10 per cent to 20 per cent due to the oversupply of the property market as vendors seek to sell their homes and relocate to other areas for employment.

**Total welfare impact**

The TERM model described earlier in this section produces a measure of welfare, which is equivalent to the net economic benefits to producers and consumers at a national level. The modelling finds that the Project will result in a net welfare gain of $38 million (discounted at 5 per cent) over the 12 years of modelling, which implies that producers and consumers will, in aggregate, be this much better off in real terms at a national level.

Varying the gold price changes the size of this welfare estimate, but does little to alter the regional economic impacts.

8.17.4 Management and Mitigation Measures

**Summary of potentially negative impacts**

Overall the impact of the Project proceeding is significantly positive for the Stawell and the wider community with a net welfare gain estimated at $38 million and Stawell’s economy experiencing a 4.9 per cent increase in GRP during the investment phase of the Project.

Potential negative impacts that have been identified in the economic assessment are:

- higher wages from mining resulting in manufacturing having to incur higher costs for labour (which is the current situation)
- higher housing rental prices in the short term returning to baseline conditions two years after the Project ceases.

It is contended that, when compared with the overall economic benefits of the Project, the potential negative impacts are minor. Even in the event that unforeseen circumstances eventuated such as a significant reduction in the gold price with attendant reductions in the value of production or the amount of gold mined is reduced resulting in decreased expenditures in the economy, the net economic benefits of the Project would still be greater than the baseline case which is closure of the existing mine.

Based on the economic evaluation of the Project, there are no mitigation measures proposed to offset the minor negative economic impacts expected to occur as the Project results in an overall net benefit to the local and regional community.
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8.17.5 Conclusions

In conclusion, the economic impact assessment shows that the Project generates a temporary gain in the form of 286 jobs and a net welfare gain of $38 million. Stawell’s economy will be a major benefactor, with an estimated 4.9 per cent increase in GRP in the investment phase of the Project.

There are some minor negative effects arising from the Project, primarily as a consequence of sustaining current higher wages which result in higher labour costs for those industries competing with the mining sector. However, these effects are relatively small.

The Project effectively extends the duration of gold mining in Stawell for another four to five years. Without the Project, mining is likely to cease in the near future and local businesses supplying the existing mine will need to adjust. The Project may be beneficial for local businesses and mine employees as it will ‘buy time’ for those affected to adjust and find alternative employment, either outside mining or in servicing mining operations elsewhere in Victoria or further afield. On balance, it is contended that the proposed positive economic benefits of the Project significantly outweigh the potential negative economic impacts.
8.18 Social
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8.18 Social

8.18.1 Introduction

This section of the EES describes and assesses the potential social impacts associated with the Project; identifies measures to manage and mitigate adverse impacts and assesses the overall social impacts following implementation of the proposed management and mitigation measures.

This assessment is based primarily on information provided in:

- Public Place Melbourne Pty Ltd (2014), Big Hill Enhanced Development Project: Social Impact Assessment, prepared for CGC.

This report is included in Technical Appendix 17 to this EES.

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**Relevant sections of EES Scoping Requirements**

This section of the EES covers the following components of the EES Scoping Requirements as they relate to social impacts.

### ‘4.5 Health and Social Impacts

**Draft Evaluation Objective**

To protect the health, safety and wellbeing of residents and the social fabric of the community in the area in the context of project hazards.

### 4.5.2 Social and Land-Use

**Key issues**

- Displacement of residents due to either a voluntary property acquisition or a self-initiated relocation decision because of diminished environmental quality.

- Adverse changes to community wellbeing due to displacement of residents, reduced amenity and/or other concerns over the project.

- Beneficial social effects of extended employment of local workers at Stawell Gold Mines and related business services.

- Changes to existing and future land-uses due to the project.

**Priorities for characterising the existing environment**

- Characterise the residential population in the vicinity of the project area, and the wider Stawell community, in terms of population distribution and demographic, socio-economic and cultural aspects of the population.

- Profile of the Stawell Gold Mines workforce, including the number of local and incoming workers.

- Outline of attitudes within the local residential population and the wider Stawell community to:
  - the existing environment and sense of place
  - sources of community identity and cohesion
  - underground and open-cut gold mining in Stawell.
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**Design and mitigation measures**

- Outline and evaluate both potential and proposed design and mitigation measures that could:
  - avoid or minimise the need or incentive for adjoining or nearby residents to relocate during the project’s life
  - otherwise mitigate the potential for adverse social effects.

**Assessment of likely effects**

- Assess potential effects on the local community during the project and relevant alternatives, in terms of the extent, duration, likelihood and implications of effects, including:
  - Displacement of residents, in the context of the need to avoid exposure to both unacceptable levels of airborne particulate matter and unacceptable reductions in amenity (especially due to noise or vibration).
  - The attitudes of potentially affected people towards the project and the potential options of ‘staying or going’.

**Approach to manage performance**

- Outline and evaluate any additional proposed measures to mitigate, offset or manage adverse social effects or enhance beneficial social effects during the project’s life and subsequently, as relevant.
- Provide a framework for managing social effects during the project’s life, including identifying and responding to any emerging social effects or issues.

**Key issues emerging from EES studies and community consultation**

The key issues relating to potential social impacts of the Project that emerged from the community in the course of the EES investigations and as a result of the ongoing community engagement and communications program are:

- some residents indicated that the potential impacts of the Project are a source of stress and anxiety
- potential dust and air quality impacts, particularly reduced air quality for nearby residents and schools and the potential long-term health impacts associated with reduced air quality
- concern that the Project will cause elevated levels of noise that will impact upon the amenity of nearby residents
- uncertainty about the frequency, timing and impacts of blasting and the potential for property damage to result from vibrations
- the temporary mining of Big Hill and implications for existing recreational activities and would result in the loss of views of and from Big Hill and physical traces of historical mining.
- requests for further information about the rehabilitation of Big Hill to understand what the potential community use opportunities post mining activity will be.
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Summary of findings

- Relevant social policies indicate support for mining in and around Stawell and for the employment and wealth generation associated with this industry. However, they also require that the benefits of mining be balanced against the amenity of the residential environment of Stawell and the health and wellbeing of Stawell residents.

- The demographic profile of Stawell is of an ageing population that is in overall decline leaving the township vulnerable to changes which undermine the local economy, community services, schools and sporting clubs. Stawell’s population is relatively disadvantaged compared to that of regional Victoria when considering a number of socio-economic status indicators such as income, education and employment.

- Those in the Immediate Area surrounding the Project site are less disadvantaged than the Stawell township as a whole, and their socio-economic status is more similar to regional Victoria as whole.

- Concerns about potential amenity and health impacts and the capacity of SGM to successfully reinstate Big Hill are common and are not restricted to those who oppose the Project. These concerns have caused some in the community to feel anxious and stressed. Others in the community have indicated they would feel a sense of loss if they could not access Big Hill as a place of recreation during the Project.

- Those who support the Project see it as an exciting opportunity for the town, both as a source of employment and wealth creation, and as a chance to enhance Big Hill. Many indicated they see the Project as a continuation of Stawell’s long standing association with mining.

- A potential positive social impact of the Project is the retention of population in Stawell and the surrounding district and the contribution that these residents would make to the area’s social and economic fabric. The Project would assist Stawell and surrounding communities to counter a trend of population loss and ageing, and provide time for relevant authorities and business to explore other sources of wealth and employment for the region.

- The community recognise that the existing condition of Big Hill could be improved. The Project would provide an opportunity to rehabilitate Big Hill and to deliver an open space reserve that is more accessible and useable.

- Views of Big Hill would be lost/modified in short to medium term. This would diminish the aesthetic appeal of the township for many residents.

- Access to Big Hill would be severed for a period of approximately five years. During this time, all existing social and recreational activities conducted at Big Hill would need to re-locate or cease.

- The Big Hill landscape would be completely modified and regardless of the quality of the restoration, and the thoroughness with which existing historic fabric is recorded, those in the community who value the historic fabric of Big Hill in situ, may feel a lasting sense of loss.

- The extent of change to historic cultural heritage values, sites and places will initially be significant however as Big Hill is restored and information recorded during the Project is made available for public viewing, this would result in positive social impacts.
Concerns about potential reductions in residential amenity and health caused by the mining project are common in the community:

— Noise impacts are projected to exceed noise guidelines at a small number of residential properties for short durations. Also, vibrations from blasting may be perceived by residents adjoining the Project site during. While this is not expected to exceed guideline limits inside nearby dwellings, affected residents may potentially see this as unreasonable/unfair.

— Air quality modelling results show the Project will result in an increase in dust emissions (PM$_{10}$ and PM$_{2.5}$) in the Immediate Area which has been quantitatively assessed by the health impact assessment (Section 8.16) as a 'low' risk which is reduced to 'very low' with active management on days of high background concentrations. However, anxiety about potential health impacts of increased dust levels may itself have a negative impact on the local community.

— Short to medium term loss of views to Big Hill within the township during mining and prior to rehabilitation of Big Hill may result in a decline in the visual amenity of Stawell, and for some residents, a reduced sense of place and connection to Stawell.

— Fears of the community in relation to health impacts in particular, have the potential to cause stress and anxiety. While the proposed mitigating actions would allay these fears to a degree, some may continue to hold fears.

— Many in the community would feel a sense of uncertainty regarding Big Hill and its future, until Big Hill is reinstated.

8.18.2 Existing Conditions

A range of data collection activities were undertaken to inform the Social Impact Assessment (SIA) including a review of the relevant social policy context, demographic analysis using Australian Bureau of Statistics (ABS) Census data, mapping of existing community facilities and places of special interest, face-to-face and telephone consultation and a community survey.

A community survey was undertaken of residents in the Stawell township and surrounding area over a two week period which provided an opportunity for residents to express their views and concerns regarding the Project. The survey invitation was distributed to approximately 88 per cent of Stawell residents with one member of each household invited to complete the survey either via the internet or, alternatively, with face-to-face assistance from the research team. The community survey was completed by a member of 246 households, a response rate of approximately 10 per cent. The data collected provides a very useful insight into the reasons why people in the community support or have concerns about the Project. It should be noted that data from a community survey is “point in time” data and that attitudes to a Project such as this can change over time as more information becomes available to the community.
8 Environmental Impact Assessment

8.18.2.1 Social Policy Context
The relevant State and local social policies, strategies and plans that apply to the Project include:

- **A Fairer Victoria** – highest level social policy adopted by the Victorian Government
- **Wimmera South Mallee Regional Strategic Plan** – sets the strategic vision for the region and identifies priority areas for actions to improve the quality of life, sustainability and productivity in the region
- **Northern Grampians Shire Council Plan** – focuses on creating a better lifestyle and environment for Shire residents by responding to community needs and delivering services
- **Municipal Public Health and Wellbeing Plan** – identifies the key health and wellbeing priorities for the municipality
- **State Planning Policy Framework** – integrates relevant social factors in the interests of net community benefit and sustainable development
- **Local Planning Policy Framework** – consists of a Municipal Strategic Statement and Local Planning Policies with components relevant to assessing the potential social impacts of the Project.

In the context of the Project, the social policies:

- indicate support for mining in and around Stawell and the employment and wealth generation associated with this industry
- recognise the potential of tourism and industry to contribute to the economic base of Stawell and the region
- highlight the potential economic benefits of mining and tourism, and at the same time the need for these benefits to be balanced against the amenity of the residential environment of Stawell and the health and wellbeing of Stawell residents.

8.18.2.2 Population Characteristics and Trends
The following discussion provides an overview of the existing population and demographic trends in Stawell and surrounding areas, for these geographic areas:

- the ‘Immediate Area’, which has been defined as the area within approximately 200 metres of the Project boundary, including the unpopulated region to the north and east of the Project area to align with the ABS boundaries (ABS SA1: 2139213 & 2139224)
- the balance of the Stawell township
- the Stawell township (Stawell Urban Centre Locality)
- the Stawell Statistical Local Area (SLA)
- Northern Grampians Shire
- regional Victoria.

These areas are shown in Figure 8-154.
Figure 8-154 Census reporting areas for Stawell and surrounding areas

The demographic indicators discussed in the following sections have been sourced from the 2011 Census data (unless specified) and are summarised in Table 8-115.

Table 8-115 Demographic indicators for selected areas (place of enumeration20)

<table>
<thead>
<tr>
<th>Age &amp; population</th>
<th>Immediate area</th>
<th>Township balance</th>
<th>Stawell township</th>
<th>Stawell SLA</th>
<th>Regional Victoria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>561</td>
<td>5,175</td>
<td>5,736</td>
<td>8,521</td>
<td>1,345,715</td>
</tr>
<tr>
<td>0-4 years</td>
<td>6.2%</td>
<td>5.5%</td>
<td>5.5%</td>
<td>5.2%</td>
<td>6.3%</td>
</tr>
<tr>
<td>5-14 years</td>
<td>9.6%</td>
<td>11.8%</td>
<td>12.0%</td>
<td>12.4%</td>
<td>12.9%</td>
</tr>
<tr>
<td>15-24 years</td>
<td>14.7%</td>
<td>11.8%</td>
<td>11.9%</td>
<td>11.3%</td>
<td>12.3%</td>
</tr>
<tr>
<td>25-54 years</td>
<td>41.0%</td>
<td>34.8%</td>
<td>35.3%</td>
<td>36.2%</td>
<td>37.4%</td>
</tr>
<tr>
<td>55-64 years</td>
<td>13.7%</td>
<td>13.1%</td>
<td>13.6%</td>
<td>15.5%</td>
<td>13.5%</td>
</tr>
<tr>
<td>65 years +</td>
<td>14.7%</td>
<td>23.0%</td>
<td>21.7%</td>
<td>19.3%</td>
<td>17.6%</td>
</tr>
<tr>
<td>Median age</td>
<td>40</td>
<td>44</td>
<td>44</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>Households</td>
<td>231</td>
<td>2,133</td>
<td>2,366</td>
<td>3,413</td>
<td>514,026</td>
</tr>
<tr>
<td>Household size</td>
<td>2.3</td>
<td>2.2</td>
<td>2.2</td>
<td>2.3</td>
<td>2.4</td>
</tr>
</tbody>
</table>

20 Place of enumeration is the location in which the Census is completed
### 8 Environmental Impact Assessment

<table>
<thead>
<tr>
<th>Weekly income</th>
<th>Immediate area</th>
<th>Township balance</th>
<th>Stawell township</th>
<th>Stawell SLA</th>
<th>Regional Victoria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median personal income</td>
<td>$497</td>
<td>$438</td>
<td>$441</td>
<td>$464</td>
<td>$493</td>
</tr>
<tr>
<td>Median household income</td>
<td>$907</td>
<td>$790</td>
<td>$793</td>
<td>$864</td>
<td>$945</td>
</tr>
<tr>
<td>Negative/nil income</td>
<td>1.5%</td>
<td>1.0%</td>
<td>0.8%</td>
<td>1.4%</td>
<td>1.3%</td>
</tr>
<tr>
<td>$1-$399</td>
<td>15.5%</td>
<td>17.5%</td>
<td>18.4%</td>
<td>17.3%</td>
<td>15.4%</td>
</tr>
<tr>
<td>$400-$799</td>
<td>26.0%</td>
<td>31.8%</td>
<td>30.8%</td>
<td>27.7%</td>
<td>25.7%</td>
</tr>
<tr>
<td>$800-$1,499</td>
<td>27.0%</td>
<td>27.5%</td>
<td>27.1%</td>
<td>28.5%</td>
<td>28.4%</td>
</tr>
<tr>
<td>$1,500-$2,999</td>
<td>26.0%</td>
<td>19.4%</td>
<td>19.9%</td>
<td>21.4%</td>
<td>24.1%</td>
</tr>
<tr>
<td>$3,000+</td>
<td>4.0%</td>
<td>2.8%</td>
<td>2.9%</td>
<td>3.6%</td>
<td>5.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Employment &amp; training</th>
<th>Unemployment rate</th>
<th>Labour force participation</th>
<th>Completed Year 12</th>
<th>Bachelor degree or higher</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.2%</td>
<td>55.2%</td>
<td>35.7%</td>
<td>7.7%</td>
</tr>
<tr>
<td></td>
<td>6.1%</td>
<td>52.0%</td>
<td>31.2%</td>
<td>6.9%</td>
</tr>
<tr>
<td></td>
<td>5.4%</td>
<td>52.4%</td>
<td>31.7%</td>
<td>6.9%</td>
</tr>
<tr>
<td></td>
<td>4.7%</td>
<td>55.9%</td>
<td>34.0%</td>
<td>8.5%</td>
</tr>
<tr>
<td></td>
<td>5.2%</td>
<td>58.2%</td>
<td>38.9%</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dwellings</th>
<th>Separate house</th>
<th>Semi-detached, townhouse</th>
<th>Flat, unit or apartment:</th>
<th>Other dwelling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>84.1%</td>
<td>90.5%</td>
<td>90.2%</td>
<td>1.6%</td>
</tr>
<tr>
<td></td>
<td>6.0%</td>
<td>4.4%</td>
<td>4.4%</td>
<td>1.4%</td>
</tr>
<tr>
<td></td>
<td>9.9%</td>
<td>3.5%</td>
<td>4.1%</td>
<td>1.4%</td>
</tr>
<tr>
<td></td>
<td>0.0%</td>
<td>1.6%</td>
<td>1.4%</td>
<td>2.3%</td>
</tr>
<tr>
<td></td>
<td>88.9%</td>
<td>3.9%</td>
<td>6.1%</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tenure</th>
<th>Fully owned</th>
<th>Being purchased</th>
<th>Rented</th>
<th>Public/social Housing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>36.4%</td>
<td>42.8%</td>
<td>41.8%</td>
<td>9.8%</td>
</tr>
<tr>
<td></td>
<td>32.4%</td>
<td>29.7%</td>
<td>30.2%</td>
<td>6.0%</td>
</tr>
<tr>
<td></td>
<td>33.7%</td>
<td>31.5%</td>
<td>31.5%</td>
<td>6.5%</td>
</tr>
<tr>
<td></td>
<td>30.3%</td>
<td>34.3%</td>
<td>23.4%</td>
<td>4.4%</td>
</tr>
<tr>
<td></td>
<td>27.9%</td>
<td>39.6%</td>
<td>25.2%</td>
<td>4.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Households</th>
<th>Lone person household</th>
<th>Group household</th>
<th>Family household</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>32.9%</td>
<td>33.8%</td>
<td>33.7%</td>
</tr>
<tr>
<td></td>
<td>33.7%</td>
<td>3.4%</td>
<td>3.5%</td>
</tr>
<tr>
<td></td>
<td>30.3%</td>
<td>62.8%</td>
<td>66.7%</td>
</tr>
<tr>
<td></td>
<td>27.9%</td>
<td>3.0%</td>
<td>69.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Families</th>
<th>Couple family no children</th>
<th>Couple family with children</th>
<th>One parent family</th>
<th>Other family</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>34.7%</td>
<td>44.4%</td>
<td>43.9%</td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
<td>46.8%</td>
<td>42.3%</td>
<td>1.7%</td>
<td>1.2%</td>
</tr>
<tr>
<td></td>
<td>43.9%</td>
<td>46.8%</td>
<td>1.2%</td>
<td>1.2%</td>
</tr>
<tr>
<td></td>
<td>34.7%</td>
<td>44.4%</td>
<td>43.9%</td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
<td>46.8%</td>
<td>42.3%</td>
<td>1.7%</td>
<td>1.2%</td>
</tr>
</tbody>
</table>
8 Environmental Impact Assessment

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Immediate area</th>
<th>Township balance</th>
<th>Stawell township</th>
<th>Stawell SLA</th>
<th>Regional Victoria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Born in Australia</td>
<td>96.6%</td>
<td>93.6%</td>
<td>93.6%</td>
<td>92.9%</td>
<td>88.8%</td>
</tr>
<tr>
<td>Born overseas</td>
<td>3.4%</td>
<td>6.4%</td>
<td>6.4%</td>
<td>7.1%</td>
<td>11.2%</td>
</tr>
<tr>
<td>Indigenous</td>
<td>0.9%</td>
<td>1.4%</td>
<td>1.3%</td>
<td>1.4%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Speaks english only</td>
<td>96.0%</td>
<td>97.3%</td>
<td>97.3%</td>
<td>97.4%</td>
<td>94.5%</td>
</tr>
<tr>
<td>Speaks other language</td>
<td>4.0%</td>
<td>2.7%</td>
<td>2.7%</td>
<td>2.6%</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cars</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Household owns a car</td>
<td>89.5%</td>
<td>89.7%</td>
<td>89.9%</td>
<td>92.2%</td>
<td>93.3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disability</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Needs assistance</td>
<td>6.0%</td>
<td>9.1%</td>
<td>9.1%</td>
<td>7.7%</td>
<td>5.7%</td>
</tr>
<tr>
<td>Not stated</td>
<td>5.3%</td>
<td>5.1%</td>
<td>4.9%</td>
<td>5.0%</td>
<td>4.9%</td>
</tr>
</tbody>
</table>

**Population**

At the time of the 2011 Census, the Stawell township was the NGS’s most populous centre with almost 50 per cent of the NGS population residing in Stawell (5,736 residents). Approximately 70 per cent of the NGS population lived in the Stawell SLA.

Between 1991 and 2011, Stawell’s population declined at a rate of 0.6 per cent per annum in contrast to Victoria’s population which grew at a rate of 1.2 per cent per annum over the same period. Table 8-116 shows the decline in population across the Stawell township and NGS.

**Table 8-116  Population decline - Stawell and surrounding areas**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stawell township</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enumeration</td>
<td>6,339</td>
<td>6,272</td>
<td>6,142</td>
<td>5,752</td>
<td>5,650</td>
</tr>
<tr>
<td>Northern Grampians Shire – Stawell, SLA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enumeration</td>
<td>9,093</td>
<td>9,211</td>
<td>9,081</td>
<td>8,553</td>
<td>8,590</td>
</tr>
<tr>
<td>Northern Grampians Shire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enumeration</td>
<td>12,957</td>
<td>13,001</td>
<td>12,700</td>
<td>11,873</td>
<td>11,815</td>
</tr>
</tbody>
</table>

The Victorian Government population projection for the Stawell SLA is 0.1 per cent growth per annum to 2031 in contrast to the population or regional Victoria which is projected to grow at 1.3 per cent per annum.

**Age profile**

The age profile of the Stawell township was comparable with that observed for the Stawell SLA, although somewhat older than for regional Victoria (see Figure 8-155). To illustrate, the median age of Stawell residents as at 2011 was 44, compared with 41 for regional Victoria.

21 Source: ABS Census 1991-2011
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The Immediate Area was populated by a notably lower proportion of older residents aged over 65 than the balance of the town (14.7 per cent compared with 23.0 per cent) and a relatively higher proportion of persons aged from 15-64 (69.4 per cent compared with 59.7 per cent). This is reflected in a lower median age for the Immediate Area (40) compared with the balance of Stawell (44). It is noted however, that Eventide Homes, which provides residential care and independent living units, is located just beyond the Immediate Area.

Against a background of gradual population decline, the Stawell township has aged progressively over the last decade (refer to Table 8-116). To illustrate, in 2001 the township’s population comprised a relatively high proportion of young children aged 0-14 and younger adults aged 25-45. However, by 2011 the number of younger children and adults had reduced substantially, indicating a reduction in families with dependent children. The Stawell population also saw notable growth in the number of people aged 55-69 and over 80 over the period 2001 to 2011.

The trend of ageing and in particular loss of population from within the 0-14 and 25-55 age groups has been common across much of regional Victoria in the past decade.

As at 2011, a lower proportion of households in the Stawell township were family households (62.8 per cent), compared with the Stawell SLA (66.7 per cent) and regional Victoria (69.0 per cent), with no notable differences evident between the segments of Stawell. The proportion of family households with children in Stawell (54.3 per cent) was similar to the Stawell SLA (51.9 per cent) and regional Victoria (56.5 per cent), although single parent families comprised a higher share in Stawell. In the Immediate Area, families with children comprised 60.4 per cent of family households compared with 54.0 per cent for the balance of Stawell, a notably higher proportion.
The proportion of the Stawell population living in family households with children aged less than 15 has declined since 2001 (Table 8-117). This reduction is likely the result of a combination of reducing household size, ageing of existing children without replacement, and the relocation of some family households.

**Table 8-117 Household’s and families in the Stawell township- count of persons (place of enumeration**

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2006</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Couple family with no children</td>
<td>1,299</td>
<td>1,307</td>
<td>1,299</td>
</tr>
<tr>
<td>%</td>
<td>22.9%</td>
<td>24.8%</td>
<td>25.4%</td>
</tr>
<tr>
<td>Families with children under 15</td>
<td>2,637</td>
<td>2,258</td>
<td>1,975</td>
</tr>
<tr>
<td>%</td>
<td>46.5%</td>
<td>42.8%</td>
<td>38.7%</td>
</tr>
<tr>
<td>Families with children aged over 15</td>
<td>763</td>
<td>709</td>
<td>784</td>
</tr>
<tr>
<td>%</td>
<td>13.5%</td>
<td>13.4%</td>
<td>15.3%</td>
</tr>
<tr>
<td>Other family</td>
<td>48</td>
<td>45</td>
<td>51</td>
</tr>
<tr>
<td>%</td>
<td>0.8%</td>
<td>0.9%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Lone person</td>
<td>720</td>
<td>764</td>
<td>798</td>
</tr>
<tr>
<td>%</td>
<td>12.7%</td>
<td>14.5%</td>
<td>15.6%</td>
</tr>
<tr>
<td>Group household</td>
<td>199</td>
<td>192</td>
<td>202</td>
</tr>
<tr>
<td>%</td>
<td>3.5%</td>
<td>3.6%</td>
<td>4.0%</td>
</tr>
</tbody>
</table>

**Source: ABS Census 2001-2011**

This trend has resulted in declining enrolments and participation rates in schools and sporting clubs and has potential implications for the viability of services.

**Weekly income**

Median individual and household income for Stawell ($441 and $793) were slightly lower than observed for the Stawell SLA ($464 and $864) and notably lower than for regional Victoria ($493 and $945). The income profile of the Immediate Area was more similar to that observed for regional Victoria, indicating a higher level of affluence in this part of Stawell, despite an elevated level of public housing in this section of the town.

**Employment and training**

Labour force participation was lower in Stawell when compared with the Stawell SLA and regional Victoria as a whole. This may reflect the slightly older age profile of Stawell in relation to the comparison areas. Also, the rate of unemployment in Stawell (5.4 per cent) was higher than for the Stawell SLA (4.7 per cent) and regional Victoria as a whole (5.2 per cent).

---

22 Place of enumeration is the location in which the Census is completed
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The population of Stawell had an overall lower level of educational attainment at the time of the last census (31.7 per cent completed year 12, 6.9 per cent obtained a bachelor degree or higher) when compared with the respective percentage figures in the Stawell SLA (34.0 per cent & 8.5 per cent) and regional Victoria (38.9 per cent and 12.5 per cent).

Consistent with observations relating to income, the Immediate Area had lower unemployment and higher labour force participation than the balance of the township at the time of the 2011 Census. Educational attainment was higher in this part of the town, although still lower than regional Victoria as a whole.

Dwellings, tenure and private housing

As at 2011, housing in the Stawell township was comprised predominantly of single detached dwellings (90.2 per cent), which is consistent with the Stawell SLA and regional Victoria as a whole. The remainder of dwellings in the township were a mix of townhouses, flats, units and apartments. Home ownership was very common in the Stawell township, with 72.0 per cent of households owning their home (41.8 per cent owned their home outright) and is again comparable with that observed for Stawell SLA and regional Victoria.

Housing in the Immediate Area consisted of a higher proportion of medium density dwellings (15.9 per cent) compared with the balance of Stawell (7.9 per cent). Home ownership in the area closest to the mine is also slightly lower than for the balance of the town. These statistics are in part explained by the presence of a cluster of public housing dwellings in this area.

Housing is a substantial private asset for the owners of this housing. Housing provides shelter and sense of security and stability. People often form a strong attachment to their home as it can be a place where they have lived for a number of years, raised their family and where they may be planning to retire.

The Project would be located in close proximity to established residential areas, in particular residential dwellings on Fisher Street and upper Main Street. The closest dwelling would be located approximately 60 metres from the North Pit. There is also a cluster of low density residential properties located to the north and northeast of the Project. Residents whose property is located in proximity to the Project area commonly reported that they enjoy having the Big Hill bushland area close to their property as it provides an aesthetically pleasing view and a quiet natural backdrop.

Ethnic origin

The Stawell population comprised a very high proportion of Australian born residents (93.6 per cent) and residents that speak English only (97.3 per cent). This was consistent with the Stawell SLA but higher than that for regional Victoria as a whole (88.8 per cent and 94.5 per cent respectively).

Approximately 1.3 per cent of the Stawell population identified themselves as Indigenous which is a similar proportion to regional Victoria as a whole (1.5 per cent).

Car ownership

Car ownership in Stawell was high (89.9 per cent of households owned a car), similar to that of the Stawell SLA and regional Victoria as a whole.
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Disability

Approximately 9.1 per cent of the Stawell population required assistance with core activities, which is a significantly higher proportion than for regional Victoria (5.7 per cent). In the Immediate Area the reported need for assistance with core activities was more similar to that of regional Victoria (6.0 per cent).

Socio-economic indexes for areas (SEIFA) index

The ABS SEIFA score is a composite measure which indicates the relative disadvantage of areas throughout Australia. A high score indicates that an area contains a high concentration of people with higher education qualifications employed in skilled occupations and earning higher incomes. A low score indicates an area with concentrations of people with low educational attainment, people employed in unskilled occupations, people on lower incomes or unemployed people.

The SEIFA scores from the 2011 Census indicate the populations of Northern Grampians Shire, Stawell and surrounding townships are relatively disadvantaged (refer to Table 8-118). The population of Stawell (state suburb) for example, has a SEIFA score of 911, placing it in the seventh percentile (that is 93 per cent of suburbs in Victoria had a higher score as at 2011).

<table>
<thead>
<tr>
<th>Score</th>
<th>Decile*</th>
<th>Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Grampians Shire</td>
<td>937</td>
<td>1</td>
</tr>
<tr>
<td>Stawell (state suburb)</td>
<td>911</td>
<td>1</td>
</tr>
<tr>
<td>Horsham (state suburb)</td>
<td>968</td>
<td>2</td>
</tr>
<tr>
<td>Ararat (state suburb)</td>
<td>926</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: ABS 2013.

*Note: Areas ranked in Decile 1 have a SEIFA index score placing them in the lowest 10 per cent of areas (that is they are relatively disadvantaged). Areas ranked in Decile 10 are in the highest 10 per cent.
8.18.2.3 Community Resources

There are a number of community resources in Stawell that support a range of social and recreational activities. These community resources contribute to the health and wellbeing and the quality of life of residents in Stawell as well as their sense of identity. Figure 8-156 provides a map showing the location of the community resources relative to the proposed Project area.

![Community resources in the Stawell township](image)

**Community services and facilities**

Community services and facilities play an important role in supporting the health and wellbeing and quality of life of communities.

**Children’s services**

Children’s services are delivered from three sites in Stawell, the Taylors Gully Children’s Centre which provides a mix of services, the Cooinda Kindergarten, and the Early Learning Centre (Table 8-119). Figure 8-156 shows the location of the Children’s Services in relation to the proposed mine site.
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Table 8-119  Children’s services in Stawell

<table>
<thead>
<tr>
<th>Name</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taylors Gully Children’s Centre</td>
<td>Maternal and child health</td>
</tr>
<tr>
<td></td>
<td>Long day care Licensed to accommodate 101 children. A range of childcare</td>
</tr>
<tr>
<td></td>
<td>options are offered in five play rooms</td>
</tr>
<tr>
<td>Marrang Kindergarten</td>
<td>Licensed to accommodate 29 children. Run by the Stawell and District Pre-</td>
</tr>
<tr>
<td></td>
<td>School Association</td>
</tr>
<tr>
<td>Multi-purpose rooms</td>
<td>A multi-purpose room and visiting specialist room are available for</td>
</tr>
<tr>
<td></td>
<td>community use and visiting health practitioners.</td>
</tr>
<tr>
<td>Cooinda Kindergarten</td>
<td>Licensed to accommodate 27 children</td>
</tr>
<tr>
<td>Early Learning Centre</td>
<td>Licensed to accommodate 65 children</td>
</tr>
</tbody>
</table>

The number of people aged zero to eight years across the municipality is forecast to decrease by 31.5 per cent by 2026 (Municipal Early Years Plan, Northern Grampians Shire, 2012). Combined with the projected ageing population of Stawell, this will result in reduced demand for children’s services in Stawell over time, and may influence the viability of existing services. Retaining young families residing in the Shire and attracting new families to the region will be a key challenge for the community.

Schools

There are currently, three primary schools in Stawell (two public, one Catholic), one public secondary college and a specialist school (refer to Table 8-120). Figure 8-156 shows the location of the schools in relation to the proposed mine site.

Table 8-120  Schools in Stawell

<table>
<thead>
<tr>
<th>Name</th>
<th>School details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stawell West Primary</td>
<td>Currently 193 enrolments.</td>
</tr>
<tr>
<td>Stawell Primary (known as 502)</td>
<td>Currently 310 enrolments. School has maximum capacity for 400+ enrolments.</td>
</tr>
<tr>
<td></td>
<td>Enrolment numbers have declined steadily over the past 15 years from a maximum</td>
</tr>
<tr>
<td></td>
<td>of 470 students.</td>
</tr>
<tr>
<td>St Patrick’s Primary</td>
<td>Currently 90 enrolments. School has maximum capacity for 100 enrolments.</td>
</tr>
<tr>
<td></td>
<td>Enrolment numbers have increased in recent years.</td>
</tr>
<tr>
<td></td>
<td>The school is located approximately 300 metres from the proposed pit boundary.</td>
</tr>
<tr>
<td>Stawell Secondary College</td>
<td>Currently 454 enrolments. School has maximum capacity for 700+ enrolments.</td>
</tr>
<tr>
<td></td>
<td>Enrolment trends indicate a decline in recent years. In past years enrolment</td>
</tr>
<tr>
<td></td>
<td>levels reached 700 students.</td>
</tr>
<tr>
<td>Skene Street School</td>
<td>A Department of Education, Employment and Training School servicing the needs</td>
</tr>
<tr>
<td></td>
<td>of students with intellectual or multiple disabilities from 5-18 years, in</td>
</tr>
<tr>
<td></td>
<td>the Stawell and Ararat districts.</td>
</tr>
</tbody>
</table>
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A notable proportion of students in each school are the children of employees of Stawell Gold Mines, or related industries, such as engineering practices. Of the 59 respondents to the community survey who work for Stawell Gold Mines (or have a family member that does), 45.5 per cent indicated that they have children attending a local school.

Social and community services

Social and community services operating within Stawell are outlined in Table 8-121 and shown on the map in Figure 8-156. A brief interview was undertaken with a selection of providers to gain an insight into local social issues and demand for their services.

Table 8-121 Social and community services in Stawell

<table>
<thead>
<tr>
<th>Agency</th>
<th>Services provided</th>
<th>Comments from interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>St Laurence Stawell Employment agency</td>
<td>Noticeable increase in demand for the service occurred following previous round of redundancies at the mine. It is becoming progressively more difficult to place individuals in employment throughout the region.</td>
<td></td>
</tr>
<tr>
<td>Western District Employment Services</td>
<td>Demand for the service has increased progressively over the past 10 years. If the mining project does not go ahead this will have a pretty big impact for Stawell, the town is struggling a little at the moment. A lot of businesses feed off the mine and the spending of the mine employees.</td>
<td></td>
</tr>
<tr>
<td>Wimmera Uniting Care Counselling services</td>
<td>The issue of the mining proposal has been a source of division/conflict in the community. However, this has not flowed through to increased demands for counselling services. The 1999 Big Hill proposal divided community sentiment. The organisation does not use Big Hill, so there are no direct implications.</td>
<td></td>
</tr>
<tr>
<td>Stawell Regional Health (SRH) 29-bed ward and six day surgery beds, birthing suite, operating theatres, accident and emergency department, a medical imaging department, pharmacy department and pathology.</td>
<td>SRH reported losing nursing staff after partners had been made redundant from Stawell Gold Mines and that they are having difficulties filling the positions.</td>
<td></td>
</tr>
<tr>
<td>Neighborhood House (NH) Adult education services including computer classes and provides HACC services.</td>
<td>The NH is not typically used by mine employees as the focus is unemployed or older retired person in Stawell. The NH does not use Big Hill, so the project has no direct implications.</td>
<td></td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Agency</th>
<th>Services provided</th>
<th>Comments from interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stawell Library</td>
<td>Branch library, part of West Wimmera network. Regular programs are provided for children and adults. The library also offers computers and free Wi-Fi internet access.</td>
<td></td>
</tr>
<tr>
<td>Eventide Homes</td>
<td>Residential Aged Care and Independent Living Units - offers a range of independent and residential living options for people requiring varying levels of care</td>
<td></td>
</tr>
<tr>
<td>Macpherson Smith Residential Aged Care</td>
<td>Operated by Stawell Regional Health. Offers a safe living environment for those who can no longer live independently and require 24-hour nursing care.</td>
<td></td>
</tr>
</tbody>
</table>

**Recreation and leisure**

There are a number of parks, gardens and recreational facilities located in Stawell that support passive recreation and also formal recreation and sporting competitions (refer to Table 8-122 and map showing locations in Figure 8-156).

**Table 8-122  Recreational facilities and open space in Stawell**

<table>
<thead>
<tr>
<th>Name</th>
<th>Use</th>
<th>Recreational and open space facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Park</td>
<td>Stawell Leisure Complex</td>
<td>Incorporates an indoor/outdoor swimming pool complex, the center also caters for an array indoor recreational pursuits for all age groups which can be accessed throughout the year. Squash/racquetball courts, basketball, volleyball, netball, indoor soccer, indoor cricket, badminton. A recent review has indicted that the center has a substantial operating deficit, and is in need of physical upgrades to existing infrastructure in order to bring the facility in line with modern standards (SGL 2012).</td>
</tr>
<tr>
<td>Stawell Amateur Athletic Club</td>
<td>The club was formed in 1966 and has a current membership of about 50 active members, with a permanent clubroom at North Park, Stawell.</td>
<td></td>
</tr>
<tr>
<td>Stawell Swifts Football and Netball Club</td>
<td>Participates in district league competition. Declining membership for football.</td>
<td></td>
</tr>
<tr>
<td>Taylors Gully Park</td>
<td>Passive open space</td>
<td>Local park with children’s playground.</td>
</tr>
<tr>
<td>Central Park</td>
<td>Stawell Athletics Club</td>
<td>Regional level formal open space, suitable for athletics football, cricket, etc. Home of the Stawell Gift.</td>
</tr>
<tr>
<td></td>
<td>Stawell Warriors Football/Netball Club</td>
<td>Participate in major league competition. Declining membership for football, experienced difficulties field a reserve grade side in 2013.</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Name</th>
<th>Use</th>
<th>Recreational and open space facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cato Lake Park</td>
<td>Passive open space</td>
<td>A passive recreation area including the lake, grassed surrounds, plantings of trees and shrubs. The two entries are marked by pointed arched doorways.</td>
</tr>
<tr>
<td>Stawell Bowls Club</td>
<td>Located to the southwest corner of the park. Includes two bowling greens and clubhouse.</td>
<td></td>
</tr>
<tr>
<td>Stawell Trotting Track</td>
<td>Trotting</td>
<td>Accommodates the Stawell Harness Racing Club, which holds 10 race meetings throughout the year.</td>
</tr>
</tbody>
</table>

**Sporting clubs**

Consultation indicated that some sporting clubs in Stawell and the surrounding area are struggling to field teams and remain viable. This is due to declining memberships and a shortage of players that has coincided with the recent downsizing of the mine. Further loss of employment at the mine is likely to exacerbate player shortages, with implications for the viability of the existing clubs.

Of the 59 community survey respondents that work for or subcontract to SGM, or have a family member that does, 38 (64.4 per cent) are currently a member of a local sporting club. Membership of sporting clubs was less common (29.9 per cent) among respondents who do not work for or subcontract to SGM.

**Stawell Leisure Complex**

The Stawell Leisure Complex was built in the late 1980s and is operated by the Northern Grampians Shire Council. The Complex operates at approximately a $150,000 per annum deficit and requires substantial upgrade to bring it in line with modern standards (SGL 2012). Notwithstanding, a community survey completed as part of the review indicates the Complex is reasonably well used and appreciated by the community. It is not uncommon for Council-run leisure facilities to be operating in deficit, with substantial council funds required to maintain and upgrade these facilities.

**Historical society**

Stawell has an active historical society. The members of the society work to preserve the history of Stawell and the surrounding district. The society operates a museum, located in the original 1860 Pleasant Creek court house. Historical society members have investigated and documented the historic values of Big Hill. Society members have a clear connection to Big Hill. Big Hill has played an important role in Stawell’s history and development and is a prominent feature in many of the historical photographs and arts works which the society holds. In these images the hill is a clear orientation point in terms of understanding the township’s development through time.

**Places of interest – Big Hill**

Big Hill is a prominent feature of the Stawell townscape, due to its topography and location immediately to the north of town’s main street. Access to the top of Big Hill is available via Big Hill Road and Scenic Road and provides an expansive view of the district, including the Grampians to the southwest.

The historical mining of Big Hill was the impetus for the establishment of the township of Stawell. Big Hill’s current physical state reflects this history. Several historical features of this mining heritage remain today including a number of historical mining shafts. The Stawell community have erected a number of memorials and monuments to recognise the importance of Big Hill.
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8.18.2.4 Social Issues and Values

Social issues and values have been documented from a number of sources to understand the current community sentiment relating to Stawell and specifically for Big Hill.

**Stawell**

Community survey respondents were asked to rate their level of concern with respect to a number of issues. As Figure 8-157 shows, the majority of respondents were extremely or very concerned about issues relating to employment and opportunities for youth in Stawell. A range of views were held in relation to the other issues.

In the case of the proposal to conduct open cut mining at Big Hill, respondents were divided. Approximately 39 per cent of respondents were extremely concerned about the potential impacts of the Project. However, concerns were not held consistently across the respondent group with 41 per cent being not at all concerned or slightly concerned.

![Figure 8-157 Level of community concern relating to a number of issues](image)

Community survey respondents also rated the desirability of Stawell as a place to live and commented on the aspects of Stawell they like the most. Generally speaking responses were very positive, with 86 per cent of respondents rating Stawell as a good or excellent place to live and only two per cent rating Stawell as a poor or very poor place to live. Likes and dislikes of Stawell identified by respondents are as follows:

**Likes**

The features of Stawell the community survey respondents like the best were relatively consistent and included because it is a safe and friendly community, which is quiet, free of congestion and located in a beautiful landscape setting. The proximity of the Grampians and the fresh country air were commonly mentioned.
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Respondents considered Stawell to be a perfect place to raise children, with people enjoying having family living in the area and historic family ties to the town and district. They also appreciate that they can live in an idyllic country setting, while still having access to excellent health care and other facilities and services.

Respondents were also commonly proud of the gold mining heritage of the town. Big Hill was often raised spontaneously as a feature of Stawell that people like.

Dislikes

The township’s economy and concern about the potential for further economic decline was raised frequently by respondents in the context of poor employment and training opportunities. The lack of retail, entertainment and recreational opportunities in Stawell were also raised as aspects of Stawell disliked most. An overreliance on the existing gold mine for employment was mentioned.

The proposal to conduct open cut mining at Big Hill and the implications for amenity, access and social division in Stawell were identified as the other main dislike of Stawell. Approximately 60 per cent of survey respondents agreed that the mining proposal has caused social division in Stawell. However, fears that mining at Big Hill may cease were also reported and the implications this would have on employment and businesses in the town.

When commenting on aspects of Stawell they dislike, five per cent of respondents indicated that they don’t like the noise, dust and vibrations produced by the current mining operation. To put these comments in context, complaint data provided by SGM is shown in Table 8-123. Complaints made directly to government departments are passed onto SGM and are included in the data presented.

Table 8-123  Noise, vibration, odour and dust complaints received by SGM: 2002 - 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Noise</th>
<th>Vibration</th>
<th>Odour</th>
<th>Dust</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>3</td>
<td>18</td>
<td>15</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>2</td>
<td>22</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>1</td>
<td>21</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>1</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>2</td>
<td>41</td>
<td>0</td>
<td>0</td>
<td>26 vibration complaints from one blast on 14 January. 10 vibration complaints from one blast on 8 May.</td>
</tr>
<tr>
<td>2010</td>
<td>3</td>
<td>44</td>
<td>2</td>
<td>0</td>
<td>41 vibration complaints from one blast on 27 May.</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>16</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>2</td>
<td>32</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>5</td>
<td>25</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>22</td>
<td>268</td>
<td>26</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Source: SGM (2013)
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The low number of air and noise complaints (on average one or two per year) indicates that for the majority of existing residents, noise and dust caused by the existing mining operation is tolerable. It is noted that the Project may expose more residents to potential air and noise impacts because of the proximity of mining to residents, many of whom would have little exposure to impacts from current operations.

Complaints about blasting have been more frequent. Complaints records indicate that for a number of people in the local community, previous blasting activities have been disconcerting, and raised concerns about damage to properties. Environmental monitoring data confirm that previous blasting activities have regularly created vibrations that would be noticeable to Stawell residents and on two occasions (14 January 2009 and 27 May 2010) between 2002 to 2013, regulatory limits have been exceeded (SGM, 2013). Blasting associated with the underground mining operation and with the Project is discussed in more detail in Section 8.6.

**Big Hill**

There is general community consensus that Big Hill is a highly valued feature of Stawell and a local landmark which is important to Stawell residents’ sense of place. The connections that residents of Stawell have with Big Hill reflect memories of family outings such as picnics, the adventures of childhood and many varied other experiences. The Hill’s topography and location immediately to the north of the town’s main street, and its importance in the physical and economic development of the town, strengthens these connections.

Only 12.1 per cent of community survey respondents disagreed with the statement, ‘Big Hill is an important local landmark’. Even among those who indicated they support the Project, the majority of respondents (60.8 per cent) agree that Big Hill is an important local landmark as shown in Figure 8-158.

![Figure 8-158 Level of agreement - ‘Big Hill is an important local landmark’](image)
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Frequency of visitation

It is clear from community survey responses that Big Hill is visited frequently by Stawell residents, with 34.5 per cent of respondents reporting that they visit Big Hill at least once a week, and over 90 per cent visiting at least a couple times a year.

Table 8-124 shows that the most common reason for visiting Big Hill (86 per cent) was to enjoy the view. The opportunity to view the surrounding district from Big Hill was considered to be very important by 58 per cent of respondents who use the Hill for this purpose, with a further 31 per cent indicating that the view from Big Hill is quite or fairly important to them. Showing the town to visitors and walking for exercise were also very common reasons for visiting Big Hill. Respondents reported visiting Big Hill for a variety of other reasons including jogging and bike riding, to relax and reflect on life and to paint and take photos. Comments provided indicate that Big Hill sometimes becomes a point of congregation for a large number of people, who gather to observe phenomenon such as fires and weather events. The Stawell inter-church council for religious services reported that it conducts two ceremonies at Big Hill over the Easter period.

Table 8-124 Reasons for visiting Big Hill

<table>
<thead>
<tr>
<th>Reason for visiting</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very</td>
</tr>
<tr>
<td>To enjoy the view</td>
<td>86%</td>
</tr>
<tr>
<td>To show the town to visitors</td>
<td>66%</td>
</tr>
<tr>
<td>Walking for exercise</td>
<td>50%</td>
</tr>
<tr>
<td>To visit the historical monuments</td>
<td>14%</td>
</tr>
<tr>
<td>Monitor weather/fires</td>
<td>13%</td>
</tr>
<tr>
<td>Place of reflection</td>
<td>8%</td>
</tr>
<tr>
<td>Monitor the mine</td>
<td>5%</td>
</tr>
<tr>
<td>Painting/photography</td>
<td>4%</td>
</tr>
</tbody>
</table>

Source: community survey (2013)

Big Hill and tourism

Big Hill is commonly visited by persons visiting Stawell. Big Hill was recognised as a good vantage point very early on in the town’s development and over the years visitor infrastructure has been added to the western crown of the hill. Visitors who attend the local visitor information centre are advised that a visit to Big Hill would be worthwhile. However, the Northern Grampians Shire reported that Big Hill is not currently a key factor bringing visitors to Stawell.
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Existing condition of Big Hill

Community survey respondents rated the existing condition of Big Hill as shown in Table 8-125. Only 6.9 per cent of residents rated the condition of Big Hill as ‘very good’ and 40 per cent rated Big Hill’s condition as ‘poor or worse’, suggesting some scope for improvement.

Table 8-125 Rating of the existing condition of Big Hill

<table>
<thead>
<tr>
<th>Rating</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>6.9%</td>
</tr>
<tr>
<td>Good</td>
<td>25.2%</td>
</tr>
<tr>
<td>Fair</td>
<td>28.0%</td>
</tr>
<tr>
<td>Poor</td>
<td>19.9%</td>
</tr>
<tr>
<td>Very poor</td>
<td>19.9%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

Source: community survey (2013)

The suggestions from community survey respondents about ways in which Big Hill could be improved include:

- improved access through installation of walking tracks
- development of seating and picnic facilities
- construction of an information centre at the peak, with information on Stawell’s History, etc.
- improvement of vegetation including removal of weeds
- general clean-up to remove signs of mining.

8.18.3 Impact Assessment

Social impacts of the Project were assigned a significance rating using a nine point ordinal rating scale which allows for assessment of performance ranging from extremely positive to extremely negative. Qualitative descriptions of performance consistent with each rating were developed to enable ratings to be assigned. The significance ratings were assigned taking into account the magnitude of social changes or effects likely to generate impacts and the sensitivity of social receptors to these changes.

Table 8-126 provides a guide as to the way in which impact ratings are assigned. Projects typically rate differently on each factor (sensitivity, duration, scale and reversibility) and therefore a degree of professional judgement has been employed.
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Table 8-126  Social impact assessment rating scale

<table>
<thead>
<tr>
<th>Rating</th>
<th>Sensitivity</th>
<th>Duration</th>
<th>Scale</th>
<th>Reversibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely negative</td>
<td>Change is unacceptable for social receptor</td>
<td>Greater than 10 years</td>
<td>State-wide community</td>
<td>Permanent</td>
</tr>
<tr>
<td>Major negative</td>
<td>Change is considered detrimental by social receptor</td>
<td>5-10 years</td>
<td>Regional community</td>
<td>Largely permanent</td>
</tr>
<tr>
<td>Moderately negative</td>
<td>Change is undesirable for social receptor</td>
<td>2-5 years</td>
<td>Local community</td>
<td>Some important aspects are permanent</td>
</tr>
<tr>
<td>Minor negative</td>
<td>Change is somewhat acceptable but not desirable for social receptor</td>
<td>6 months to 2 years</td>
<td>Part of a local community</td>
<td>In most important respects can be reversed</td>
</tr>
<tr>
<td>Negligible</td>
<td>Change is neither desired or resisted by social receptors</td>
<td>Less than 6 months</td>
<td>A small number of individuals in a local community</td>
<td>Can be fully reversed</td>
</tr>
<tr>
<td>Minor positive</td>
<td>Change has limited benefits for social receptors</td>
<td>6 months to 2 years</td>
<td>Part of a local community</td>
<td>In most important respects can/would be reversed</td>
</tr>
<tr>
<td>Moderately positive</td>
<td>Change is beneficial for social receptors</td>
<td>2-5 years</td>
<td>Local community</td>
<td>Some important aspects are permanent</td>
</tr>
<tr>
<td>Major positive</td>
<td>Change is highly beneficial for social receptors</td>
<td>5-10 years</td>
<td>Regional community</td>
<td>Largely permanent</td>
</tr>
<tr>
<td>Extremely positive</td>
<td>Change is necessary for social receptors</td>
<td>Greater than 10 years</td>
<td>State-wide community</td>
<td>Permanent</td>
</tr>
</tbody>
</table>

Mining and social implications

Concerns expressed in relation to the Project relate to potential reductions in amenity, risks to health and reduced property values which may be felt unevenly throughout the community. Also, some of the uncertainty and concerns expressed (for example, change in the image of the town and possibly stigmatisation of the town) reflect those typically expressed in relation to what are termed locally unwanted land uses (LULU) (for example, power plants, waste dumps/storage facilities, prisons, etc.). LULU are land uses that are useful to society, but objectionable to neighbours due their perceived effects on area reputation, health and amenity in their immediate surrounds.

There may be divergence between residents’ subjective evaluation of risks to area reputation, health and amenity, and assessments provided by technical experts. However, perceived changes can still drive important social changes and impacts.

The SIA therefore has regard to social impacts (positive and negative) likely to arise due to physical changes (as identified by technical assessments) and also impacts likely to arise due to the subjective views held within the local community.

The implications of the Project not proceeding and of various Project alternatives have been discussed in Chapter 5.
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Reactions to the Project proposal

A range of opinions regarding the desirability of the Project exist in the Stawell community. The community survey results indicate the level of support for the Project from respondents. Figure 8-159 provides evidence that opinion is divided, with large proportions of respondents reporting both strong support and strong opposition to the proposal. A relatively small proportion of respondents who completed the survey were neutral.

![Graph showing support levels: Strongly Support 31%, Support 18%, Neither 7%, Oppose 12%, Strongly Oppose 32%](image)

Source: community survey (2013)

Figure 8-159 Level of support for the Project

The level of support for the Project expressed by survey respondents varied on the basis of gender and age, specifically:

- female respondents were more likely to oppose (55.3 per cent) than men (34.1 per cent)
- older residents were more likely to oppose than younger residents
- no relationship between length of residence in Stawell and level of support was identified.

Concerns about potential amenity and health impacts and the capacity of Stawell Gold Mines to successfully reinstate Big Hill are common and are not restricted to those who oppose the Project. These concerns have caused some in the community to feel anxious and stressed.

Residents raised concerns regarding potential reductions in residential amenity in the area close to the mine as a result of the proposal. Community survey respondents indicated their level of concern relating to the potential amenity impacts of the proposal. As shown in Figure 8-158, concerns about reduced amenity are common in the community, with 53-59 per cent of respondents indicating that they are least moderately concerned depending on the issue in question.
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![Graph showing levels of concern relating to potential amenity impacts from the Project]

Source: community survey (2013)

Figure 8-160 Level of concern relating to potential amenity impacts from the Project

Those who oppose the Project are more likely to consider it to be technically risky, both in terms of the successful rehabilitation of Big Hill and also the potential amenity and health impacts for the Stawell community.

Many people in the community use Big Hill as a place of recreation, and would feel a sense of loss if they could not access Big Hill during the Project period. Those who use Big Hill regularly are more likely to oppose the Project.

Some members of the community value the existing Big Hill landscape and its historic fabric \textit{in situ} and believe strongly that Big Hill should not be disturbed. A large proportion of those who indicated that they oppose the Project, via the community survey, hold the view that the Project is morally wrong.

Those who support the Project see it as an exciting opportunity for the town, both as a source of employment and wealth creation, and as a chance to enhance Big Hill. Many indicated they see the Project as a continuation of Stawell’s long standing association with mining.

The following section provides an evaluation of the likely social impacts of the Project (positive and negative) and describes the social changes likely to be created by the Project and assesses these for the predicted social impacts.

8.18.3.1 Resources Development

Social effects

The Project would improve the welfare of households in Stawell and the local region, as measured by aggregate consumption. The value of consumption is estimated to peak at $6.4 million above baseline in 2015 (equivalent to an increase of 0.5 per cent) (refer to Section 8.17.4). Most of this increase is due to higher household incomes in the region, either due to those directly employed by the mine or the effect of these consumers spending more on goods and services locally.
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Between 86 and 100 fulltime jobs would be retained in Stawell in the first four years of the Project should it be approved. Table 8-127 shows this would decline to 35 jobs in the fifth and final year of the Project. None of the jobs are expected to be fly-in-fly-out, although job numbers and categories remain subject to further evaluation. The intent is to predominately retain employees from the current workforce.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mining</th>
<th>Administration</th>
<th>Processing</th>
<th>Mining Contractors</th>
<th>Processing Contractors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29</td>
<td>4</td>
<td>43</td>
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<td>5</td>
<td>28</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

| TOTAL | 86     | 100            | 96         | 81                | 35                     |

Indirect employment would peak in Year 3 at:
- 81 indirect jobs in the North Grampians-Stawell SLA
- 38 indirect jobs in the South Wimmera SSD
- 67 indirect jobs elsewhere in Victoria.

The major social effect of the Project would be the presence of the mining workforce and their families during the operational phase of the Project, which would mitigate the current trend of population decline and ageing in Stawell. The experience of the previous reductions in SGM workforce suggests that some existing mining workers would leave the area if the Project did not go ahead. In the short term, the Project can be expected to assist the township to retain/attract in the order of 25+ workers and their families.

Over the medium term, the risk of a further loss of population would be mitigated through retention of employment (direct and indirect) for workers and families who would not leave Stawell immediately following mine closure, but that may need to consider this option if they cannot secure employment in the medium term.

**Potential social impacts**

The continued presence of mine employees in Stawell would enable the contribution that this segment of the community makes to the social fabric of Stawell to continue. Existing mine employees are active members of the community, being involved in a number clubs and activities, and users of local services such as schools. Mine employees are also economically active, and their spending supports the existing retail and entertainment offerings in the town. Immediate adverse effects were experienced by sporting clubs following the previous round of job losses at the mine.

Some local residents who are opposed to the Project have indicated that they would consider leaving Stawell if the Project was approved. The concerns of the majority of these residents are focussed on potential health and amenity impacts. The technical assessments indicate these concerns can be addressed and potential impacts can be minimised.
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**Impact rating**

**Scale** - As at 2011, there were approximately 2,341 employed persons in Stawell. Of these, approximately 57 per cent were working full time. The 80 to 100 jobs associated with the Project is equivalent to 3.4-4.3 per cent of Stawell’s working population and 6.0 per cent to 7.5 per cent of the town’s fulltime workforce. The immediate effect of the Project would be to encourage 25+ workers and their families to remain in Stawell, and enable others who would stay in the area regardless, to find employment. Indirect employment creation would also contribute to the retention of households in the township and surrounding district. The Project would positively impact the local and regional community. Potential impacts on property values would be confined to isolated cases.

**Duration** - The employment benefits of the Project and the resulting positive impacts for the Stawell population and its demographic character would last at least as long as the mine is operational, which is estimated to be five years. The Project may have longer lasting benefits for the local and regional economy (and hence social conditions in Stawell) as it would provide more time for alternate sources and employment and wealth creation to be identified. Any isolated negative impacts on property values would most likely occur in the operational phase of the Project.

**Reversibility** – The Project is not a ‘fix all’ scenario for the Stawell economy, which is in transition. However, the Project delays a move to a no-mining scenario, providing further time for Stawell residents to adjust and find alternative employment, either outside mining or in servicing mining operations elsewhere in Victoria or further afield. In this respect, the Project may have longer term benefits (greater than five years) for the Stawell community. Any isolated negative impacts on property values which reflect reduced amenity conditions would most likely be reversed once the Project is concluded or potentially even enhanced with the reinstatement and improvements to Big Hill.

**Sensitivity** – The community of Stawell is somewhat vulnerable to further population loss and ageing. Families with children are a segment of the community that is in decline. Mine employees are more likely to include families with dependent children than non-mine residents in Stawell, as a high proportion of persons living in Stawell are of retirement age. Mine employees are economically active, and their spending supports other industries such as retail. Accordingly, the Project would be highly beneficial for the local community.

<table>
<thead>
<tr>
<th>Table 8-128 Social impact rating table – resource development</th>
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<tbody>
<tr>
<td><strong>Rating</strong></td>
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<tr>
<td>Positive impacts</td>
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<td>Negative impacts</td>
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</table>
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An overall major positive rating is assigned for resource development. This reflects the significant short to medium term benefits of the Project, for the local and regional economy and flow on benefits for the demographic character and economic and social vitality of Stawell.

8.18.3.2 Landscape, Visual and Recreational Impacts

Social effects

Big Hill would be mined and progressively reinstated over a five year period, with full rehabilitation not complete for at least five years depending on the approach taken. Historic monuments such as the Pioneer’s Memorial would be removed and reinstated. Some historic relics (mining voids and shafts) would be permanently removed and the internal composition of Big Hill would be modified.

SGM has discussed with Council the potential to involve the community in developing an end use master plan for Big Hill to guide rehabilitation and make Big Hill more accessible/useable for the community as an open space reserve. Some segments of community have expressed interest in the potential restoration of Big Hill and provided suggestions regarding potential improvements of Big Hill as part of the rehabilitation process.

Views of Big Hill would be lost or modified for a period of up to five years (refer Section 8.15). The proposal would temporarily sever access to Big Hill for approximately five years. All users of Big Hill would be required to relocate their recreational activity during the Project period.

Potential social impacts

The Big Hill landscape would be altered by the Project. Some Stawell residents consider this process of alteration followed by rehabilitation as the final part of an ongoing process of mining at Big Hill, initiated by the town’s founders. For these residents the social impacts of the Project are tangible impacts, which arise from changed access and amenity and which they happily balance with the positive aspects of the Project for the local economy. However, other residents consider Big Hill to be ‘sacred’ and are very sensitive concerning potential major alterations to Big Hill, irrespective of the length of the Project, or the quality of Big Hill post- rehabilitation. Included in this group are historical society members who are concerned the Project would erase physical signs of historic mining, including destruction of existing historic mine workings and relics. For these residents Big Hill would be changed forever, potentially leading to a lasting sense of loss.

Regardless of their position on the acceptability of the Project, many within the community hold concerns about SGM’s capacity to successfully reinstate Big Hill. These concerns are unlikely to be fully resolved until the hill is successfully reinstated.

Views of Big Hill are available throughout various sections of the town, and these views are valued by many residents. For some, the loss of the view would represent a decline in the aesthetic appeal of Stawell noting that for the main part, the Big Hill ridgeline remains largely intact, the main visual impact being the open pits cut into the side of the hill. For others, the temporary absence of Big Hill would remind them of the Project and its effect on Big Hill.
Some recreational activities which currently occur at Big Hill such as walking for exercise, painting, or taking photos could be undertaken elsewhere in Stawell. However, there is not a comparable location offering similar topography or views in the local area. Accordingly, the quality of the recreational experience for numerous people may be diminished by the Project. Other activities, such as viewing the district or observing existing flora and fauna on Big Hill (which is highly degraded) could not occur.

Big Hill is an obvious choice as a location for the Easter ceremonies conducted by the Stawell Inter-Church Council. It is a significant local landmark and offers a picturesque location. Big Hill also allows for participants to re-enact the Easter story by ascending a hill carrying the cross.

**Impact rating**

**Scale** – Negative impacts on landscape, visual and recreational values would be felt by the local community of Stawell, as would the potential longer term positive impacts of the Project (refer to Chapter 10).

**Duration** – Negative impacts on landscape, visual and recreational values would affect Stawell in the medium term (5-10 years). Over the longer term (5-10 years+), the Project would potentially deliver positive impacts relating to landscape, visual and recreational values.

**Reversibility** – Negative impacts on the landscape, visual and recreational values are all reversible, with the exception of modifications to the internal composition of Big Hill and loss of some heritage fabric.

**Sensitivity** – Sensitivity to the medium term changes to landscape, visual and recreational values is different for different parts of the community of Stawell. There are clearly some within the community who are not concerned about the Project. Others will miss the tangible benefits which Big Hill provides to Stawell, but happily balance this loss with the benefits of the Project, including potential longer term improvements to the condition of Big Hill. However, some are opposed to the Project because they view Big Hill as a sacred place which should not be modified. Many will hold concerns about the effect of the Project on Big Hill until it is successfully rehabilitated.

**Table 8-129 Social impact rating table – landscape and visual impacts**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Negligible</th>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Impacts</td>
<td>Sensitivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Duration</td>
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<td></td>
<td>Scale</td>
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<tr>
<td></td>
<td>Reversibility</td>
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</tr>
<tr>
<td>Negative Impacts</td>
<td>Sensitivity</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Duration</td>
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<td>Scale</td>
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<tr>
<td></td>
<td>Reversibility</td>
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</tbody>
</table>

An overall moderate negative rating is assigned for landscape and visual impacts. This reflects initial negative impacts which are most severe in the first five years. These negative impacts would be followed by lasting impacts which are likely to be generally more positive.
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8.18.3.3 Health and Social Impacts

Social effects
The predicted levels of blasting and vibration are unlikely to be directly associated with adverse physical and emotional health effects for the general population of Stawell. However, as blasting is conducted during the day, shift workers who sleep during the day could suffer from an increased stress level due to interrupted sleep. In addition, people suffering from post-traumatic stress disorder could experience an increased level of anxiety during blasting. It is noted that underground blasting currently occurs. For the Project, blasting will only be required at depth when hard rock is encountered.

Air quality modelling results show the Project will result in an increase in PM$_{10}$ and PM$_{2.5}$ in the Immediate Area which has been quantitatively assessed by the HIA as a ‘low’ risk that is reduced to ‘very low’ with active management of Project activities on days of high background concentrations.

Regarding the effects on the social fabric of the community, the Project would enable some residents to remain in Stawell that may otherwise have been forced to consider moving to find employment. There are mixed views about the benefits of the Project, and an approval would suit some and not others.

Potential social impacts
The prospect of the Project carries with it a sense of dread for some residents, due to potential impacts and perceived negative implications for their health despite air quality monitoring and modelling showing the Project is not likely to result in unacceptable health impacts. While strong concerns relating to potential physical health impacts may not be warranted, these residents are still at risk of lowered emotional wellbeing as a result of the Project.

Other residents may feel a sense of loss as a result of the Project, due to their intangible connection to Big Hill. For some, their concerns may be resolved following successful reinstatement of Big Hill.

The provision of employment opportunities would enable some families to remain living in Stawell who may have considered relocating, and in doing so assist in preserving existing social relationships.

Over the medium term, the restoration of Big Hill (including the removal or historic voids) would make the open space reserve more accessible and therefore may potentially promote greater level of physical and social activity.

Impact rating

Scale - Negative impacts on physical and emotional wellbeing and the social fabric of the community would be felt by parts of the local community of Stawell, as would the longer term positive impacts of the Project. Residents living in close proximity to the mine in particular may consider their health to be at risk.
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**Duration** – The technical studies from the EES have concluded that compliance with regulatory requirements relating to particulate matter levels can be achieved with active management (on days of high background concentrations, adverse meteorological conditions or high site emissions). Negative impacts would be a combination of potential exposure to incremental particulate levels and also from perceptions of risk relating to health impacts. Perceived impacts should decline quickly (less than 2 years), once the proponent can demonstrate its ability to undertake the Project without causing obvious/ongoing reductions in amenity. Moreover, the positive opportunity presented by remediation could, over time, take precedence over fears about the negative short to medium terms consequences of the Project.

**Reversibility** - Negative impacts on the physical and emotional wellbeing of residents and the social fabric of the community are **reversible**. However, it should be recognised that there may be some individuals who would experience a lasting sense of loss due to the proposed modifications to Big Hill.

**Sensitivity** – Sensitivity in the short term is heightened by the technical nature of the Project, and associated (and understandable) concerns about the risks the Project presents for health and wellbeing. Parts of the community consider the health risks presented by the Project to be undesirable/detrimental for the community. Many in the community hold the view that Big Hill is in a relatively poor condition and could be improved.

<table>
<thead>
<tr>
<th>Table 8-130 Social impact rating table – health and social impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rating</strong></td>
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<tr>
<td>Positive impacts</td>
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<td></td>
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<td></td>
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<tr>
<td>Negative impacts</td>
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</table>

An overall **minor negative rating** is assigned. This reflects the initial negative impacts of the Project and in particular the high level of sensitivity in some parts of the local community. Over the longer term the Project is likely to have a net benefit on the health and social status of community, as the rehabilitation of Big Hill takes precedence over the current and noteworthy levels of concerns about air pollution, noise and other potential impacts.

**8.18.3.4 Amenity Impacts**

Amenity impacts on the Project are considered to include those affecting dust, noise levels and blast effects. Visual amenity is considered separately above.
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**Social effects**

The noise modelling predicts that the Project is expected to comply with NIRV requirements relating to noise, with exceptions during:

- Quarter 5, when mining commences in the South Pit.
- Quarter 8, when backfilling of North Pit in nearing completion and there is no landform shielding available. However, it is noted that site rehabilitation is an activity for which the NIRV allows a variation to the noise target.

The processing mill will continue to operate 24 hours a day, with no changes to current use required as part of the Project. The predicted noise from mill activities for evening and night-time periods would comply with the existing permit noise limits with the exception of possible minor night-time exceedences at one dwelling depending on meteorological conditions.

It is expected that some blasting will be required for the Project. The most sensitive sites are houses within 100 metres of the blasting areas as well as St Patrick’s School and Stawell Secondary College (both approximately 300 metres from the pit boundary). The blasting assessment indicated that blast effects (vibration and airblast) can be controlled below DSDBI guideline limits at all sensitive sites (5mm/s and 115 dBL respectively). The peak air-blast expected at St Patrick’s Primary School and the Stawell Secondary College, will be below human perception thresholds. Ground vibrations caused by the proposed blasting would be perceptible to Stawell residents living in close proximity to the mine site.

**Potential social impacts**

The average ambient noise levels along Fisher Street currently range from 39-61 dB during the daytime. The predicted change in noise level will therefore vary with the fluctuating ambient noise levels present regardless of the Project noise. When ambient noise levels at residential locations are higher (e.g. 50-61 dB), noise from the mine will be less noticeable than at times when ambient noise levels are lower (e.g. 39-50 dB) (refer to Section 8.5).

Predicted daytime noise levels in Quarter 8 would be consistent with a busy urban environment between the hours of 7am and 6pm. However, noise levels are projected to be significantly lower than the level where they directly cause health impacts (Health Impact Assessment, URS 2013).

At locations with low existing ambient noise levels, daytime noise generated by the Project, even when this is within the limits of relevant permit conditions, may be seen as unreasonable by some local residents. Some residents are likely to feel that any reduction in their acoustic amenity by the Project is unfair.

Vibrations caused by blasting would regularly be perceptible at residential premises in close proximity to the pits. Previous underground blasting activities have caused concerns within the community and a notable number of complaints. SGM has recently implemented management measures to reduce community annoyance such as undertaking blasting activities at the set times and an SMS alert service which provides advance notification of blasts to nearby residents. Without effective management, proposed blasting would cause concerns and complaints. However, the projected levels of vibrations would not cause damage to homes. Notwithstanding, particular individuals may still attribute property damage to mining activities. However, SGM has an existing policy of compensating or repairing any damage resulting from mining operations, meaning this should not be an issue.
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Dust deposition levels resulting from the Project would largely be within prescribed criteria set by relevant legislation. Notwithstanding, increases in dust are predicted in residential areas in proximity to the Project. Some residents are likely to feel that any increase in dust deposition as a result of the Project is unreasonable.

**Impact rating**

**Scale** – While the Project can comply with regulatory requirements with the exception of some noise exceedances at certain times, some negative impacts on amenity would be experienced by part of the Stawell community, specifically, a limited number of residents living in close proximity to the Project area (refer to the noise contour plots in Section 8.5). Concerns about potential amenity impacts are currently held by a broader section of the community who are located beyond the Immediate Area and will not be directly impacted.

**Duration** – Negative impacts resulting from elevated noise levels would occur in Quarter 8 of the Project. Concerns about potential amenity impact should decline following commencement of the Project, once the actual Project amenity conditions become apparent. However, amenity impacts will cease at the completion of the Project, when mining activities end in the Big Hill area.

**Reversibility** – Impacts relating to reduced amenity would cease when the mining operation ceases. Impacts resulting from fears about future amenity impacts should reverse for most in the community once the actual Project amenity conditions become apparent.

**Sensitivity** – Sensitivity is heightened by the relatively high level of acoustic amenity enjoyed by residents of the areas in close proximity to the mine site, and the fact that changes will be ‘imposed’. Some affected residents may see increased noise levels as being unacceptable and unreasonable.

**Table 8-131 Social impact rating table – amenity impacts**

<table>
<thead>
<tr>
<th></th>
<th>Rating</th>
<th>Negligible</th>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
<th>Extreme</th>
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<tbody>
<tr>
<td>Positive impacts</td>
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An overall **moderate negative rating** is assigned. This reflects the fact that increases in noise, dust and vibrations would largely be within prescribed limits, but may still be unwelcome. During periods of the Project cycle, some residential receptors would be exposed to reductions in amenity.
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8.18.3.5 Historic Heritage Impacts

Social effects
A number of the historic memorials and monuments on Big Hill would be removed before mining commences and would be reinstated on completion. These include the Pioneer Memorial Rotunda, Dane Memorial, Water Supply Memorial and the Quartz Reef Discovery Monument.

Some of the historic fabric of Big Hill, including historic shafts and open cut pits, would be permanently removed. Prior to works commencing, it is proposed that these historic elements of Big Hill would be recorded in detail (assuming this has not already occurred).

Potential social impacts
The removal and reinstatement of monuments would satisfy the concerns of many in the community relating to preservation of the historic value of Big Hill. Some in the community are concerned that removal and reinstatement of monuments would lead to damage, and these people may feel a degree of anxiety until successful reinstatement is complete.

The removal of historical mines workings and open cut pits may be perceived as a loss by those with extensive knowledge of or passion for the history of Stawell and, Big Hill in particular. For these individuals, a lasting sense of loss may be experienced, although this may be mitigated somewhat by the research and archaeological investigation of these sites undertaken as a result of the development. Publicly displaying this historical information would ensure some aspects of Big Hill’s historic value are more accessible to the public.

Impact rating
Scale – Effects of the Project on socially important historic cultural heritage would impact different parts of the Stawell community in different ways. Some residents, in particular historical society members, are likely to see the Project’s effects in negative terms, while others are less sensitive to the proposed changes. For the majority of the community, the historic values of Big Hill would be made more accessible, once monuments are restored and information recorded as part of the Project is made available to the public.

Duration – Some changes would be for the five year duration of the Project such as the relocation of the monuments. Others would be permanent, such as the removal of some historic fabric. Similarly, impacts for various parts of the community would be short to medium term in some cases (like the ability to view the monuments) and long term in others (sense of loss regarding heritage fabric that is destroyed and/or improved access to information about the history of human activity at Big Hill).

Reversibility – Impacts associated with removal and reinstallation of monuments are reversible however impacts associated with the removal of heritage fabric are not. Notwithstanding, impacts would diminish overtime as Big Hill is restored and information recorded during the Project is made available for public viewing.

Sensitivity – Sensitivity to the proposed changes is highest among members of the Historical Society, who value the retention of historic fabric in situ. However, the majority of the community is likely to see re-installation of monuments and recording and display of information gathered during the Project as an adequate mitigating action.
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Table 8-132  Social impact rating table – historic heritage impact

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<tr>
<th>Rating</th>
<th>Negligible</th>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
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<td>Positive Impacts</td>
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<td>Reversibility</td>
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<td>Negative Impacts</td>
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An overall **minor negative** rating is assigned for historic heritage. This reflects initial negative impacts and some lasting negative impacts for particular residents, which would be followed by lasting positive impacts.

8.18.4  Management and Mitigation Measures

Due to the Project's location in proximity to local residents, best practice noise, dust, blasting, health and heritage mitigation measures have been incorporated into the Project design to reduce overall social impacts of the Project on the community, particularly for the surrounding residents.

The following section highlights the management and mitigation measures that have been adopted for the Project.

$Landscape and visual$

SGM will liaise with NGSC to investigate the feasibility of an information shelter and viewing platform in the area adjacent to Main Street. A temporary lookout is proposed for the duration of the open cut works and will be located in the elevated area north of North Pit amongst the existing trees. It will include a car park, walking track, lookout, information shelter, picnic table and fencing. Draft concept drawings for the temporary lookout tower are included as Appendix G to the EES.

The information shelter will include information boards detailing the mine operations and potential rehabilitation plans. A mural fence could be incorporated into the security fence to create a more aesthetically pleasing entrance. The mural fence could incorporate historical images of Stawell’s mining history, art work by community schools or interest groups, or images of proposed rehabilitation.

The facility will be located in a position that has a low geotechnical risk and will be subject to the blasting exclusion zone as outlined in Chapter 8, Section 8.3.6.3. While such a platform would not replicate the experience of Big Hill as it is, it would offset some of the negative impacts of the Project, by providing views over the township and offering an alternative destination of interest for visitors to the town.

The long term strategy for the Project site is for it to be returned as a community asset. The site will be rehabilitated to a safe, stable and sustainable landform by SGM as part of the mine closure process. The surrender of SGM’s rehabilitation bond will occur following the satisfactory rehabilitation of the Project site.
The rehabilitation of Big Hill will be undertaken in consultation with DEPI, the NGSC and the community to determine the best possible future use of the site and surrounding public open space as discussed in Chapter 10.

**Health and social**
Management and mitigation for potential noise, vibration, air and health impacts and are outlined in the preceding sections (Sections 8.5, 8.6, 8.7 and 8.16 respectively) and are summarised in Chapter 11.

In addition to these, SGM will undertake transparent monitoring and reporting for air, health, noise and vibration, including a process for resolving complaints.

SGM will continue to maintain ongoing community consultation and facilitate quarterly ERC meetings that provide an opportunity to compare resident’s perceptions over time.

A social impact monitoring tool will also be incorporated as part of the EMP, so that measurements of air quality, noise, etc. can be compared with resident perceptions over time.

**Amenity**
SGM will undertake consultation with the local community regarding the timing of works to minimise impacts with potential to cause notable amounts of noise. For example, SGM could potentially schedule options to suit the nearby residents during periods of site clearing at the beginning and end of the Project. As an example, site clearing may be conducted over two weeks (Monday-Friday) continuously, or in two separate blocks with a break period in between.

A process for notifying residents about upcoming blasting activities is currently in place and will be maintained such as the current mobile SMS system being used for the underground blasting.

In some cases, a possibility would be to assist residents who would experience reduced residential amenity, to find alternative accommodation within Stawell for a short term period during specific activities when all other forms of mitigation are exhausted (or inappropriate) and following consultation with the affected resident and regulatory authorities. This would be assessed on a case-by-case basis depending on operational activities.

**Historic Heritage**
Management and mitigation for potential historic heritage impacts are outlined in Section 8.4, which includes the temporary relocation and storage of historic monuments during the Project and detailed survey and photography of items to be destroyed in order to create a permanent record of the place.

In consultation with the future land manager and the local community, SGM will develop an appropriate way of making information about the historical values of Big Hill accessible to the public. One approach may be to develop a facility to display historic information on Big Hill post-rehabilitation.

**8.18.5 Conclusion**
The potential social impacts likely to arise due to physical changes, as identified by the technical assessments, and also impacts likely to arise due to the subjective views held within the local community have been considered.
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The retention of population in Stawell and the surrounding district and the contribution that these residents make to the social and economic fabric is the main positive social impact of the Project. The Project assists the Stawell and surrounding communities to counter a trend of population loss and ageing, and provides time for relevant authorities and business to explore alternative sources of wealth and employment for the region.

This Project also presents a unique opportunity to rehabilitate Big Hill to deliver a site that is more accessible and useable for community purposes at the end of the proposed Project. The existing condition of Big Hill is recognised by many in the community as in need of improvement.

However, even following the implementation of the proposed mitigating actions, the Project would generate a number of negative social impacts including the loss of views from Big Hill in the short to medium term. This would diminish the aesthetic appeal of the township for many residents. Access to Big Hill would be severed for up to five years. During this time, all existing social and recreational activities conducted at Big Hill would need to re-locate or cease. While other locations are available, these may be seen as less desirable.

The Big Hill landscape would be modified and, regardless of the quality of the restoration, and the thoroughness with which existing historic fabric is recorded, those in the community who value the historic fabric of Big Hill in situ, may feel a lasting sense of loss.

While the Project can comply with all regulatory requirements with the exception of some noise exceedances, concerns about potential reductions in residential amenity and health caused by the Project are common in the community. In this context it is recognised that:

- Noise impacts are projected to exceed NIRV guidelines at a small number of residential properties for limited durations throughout the Project. Also, vibrations from blasting could be perceptible on a regular basis. Affected residents may potentially see this as unreasonable/unfair but noting that blasting is not expected to be a frequent occurrence.
- Fears of the community in relation to health impacts in particular, have the potential to cause stress and anxiety. While the proposed mitigating actions will allay these fears to a degree, some may continue to hold fears and perceptions even though the technical studies indicate that potential health impacts will be within regulatory limits (PEM).

Many in the community will feel a sense of uncertainty regarding Big Hill and its future, until Big Hill is reinstated.

Best practice noise, dust, blasting, health and heritage mitigation measures have been incorporated into the Project design to reduce the overall social impacts on the community, particularly for the surrounding residents. The potential negative social impacts arising from the Project are considered to be manageable following implementation of the mitigation measures, and overall, it is contended that the social impacts of the Project are acceptable particularly as the Project brings considerable economic benefit to the community for an additional five years when compared with the significant negative impact on Stawell should the Project not proceed and mining cease.