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South32 Worsley Alumina Pty Ltd

Hotham Mine Expansion and Refinery Production Increase S38 Referral Supporting Report

May 2017

Acronyms

BBM	Boddington Bauxite Mine
BRDA	Bauxite Residue Disposal Areas
DER	Department of Environment Regulation
DoW	Department of Water
DPaW	Department of Parks and Wildlife
EIA	Environmental Impact Assessment
EP Act	<i>Environmental Protection Act 1986</i>
EPA	Environmental Protection Authority
GHG	Greenhouse Gas
MS	Ministerial Statement
Mtpa	million tonnes per annum
OEPA	Office of the Environmental Protection Authority
PBA	Primary Bauxite Area
Refinery	Worsley Alumina Refinery
Tpa	tonnes per annum
Worsley	South32 Worsley Alumina Pty Ltd

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1. Introduction

1.1 Background

South32 Worsley Alumina Pty Ltd (Worsley) currently operates the Boddington Bauxite Mine (BBM) and Worsley Alumina Refinery (Refinery) (collectively, the Worsley Bauxite-Alumina Project), which is pursuant to the *Alumina Refinery (Worsley) Agreement Act 1973* (Agreement Act). Operations involved in the Worsley Bauxite-Alumina Project include:

- Mining bauxite ore from deposits on the Darling Plateau at the BBM
- Processing and refining of crushed ore to produce alumina at the Refinery
- Exporting the alumina product through the Port of Bunbury.

Worsley is seeking approval to develop existing operations through:

- Extending the current mining envelope at the BBM to incorporate areas adjacent to the Primary Bauxite Area (PBA) (referred to as the 'Hotham Mining Extension')
- Increasing the overall production of alumina at the Refinery by approximately 10%, from 4.7 Mtpa to 5.1 Mtpa (referred to as the 'Refinery Production Increase').

1.2 Purpose of this document

This document has been prepared to support the formal referral of the Hotham Mining Extension and Refinery Production Increase under section 38 of the *Environmental Protection Act 1986* (EP Act). It provides information on the proposal activities, potential environmental impacts and proposed mitigation measures. This document has been prepared in accordance with *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016*.

1.3 The Proponent

The Proponent for the expansion of the Hotham Mining Extension and Refinery Production Increase is:

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1.4 Location of the proposal

The Hotham Mining Extension is located at the BBM, which is located approximately 3 km from the town of Boddington and 130 km south-east of Perth (Figure 1).

The Refinery Production Increase will occur at the Refinery, which is located 175 km south of Perth. The subsequent increased volume of alumina will then be transported 55 km by rail to the Port of Bunbury for export (Figure 1).

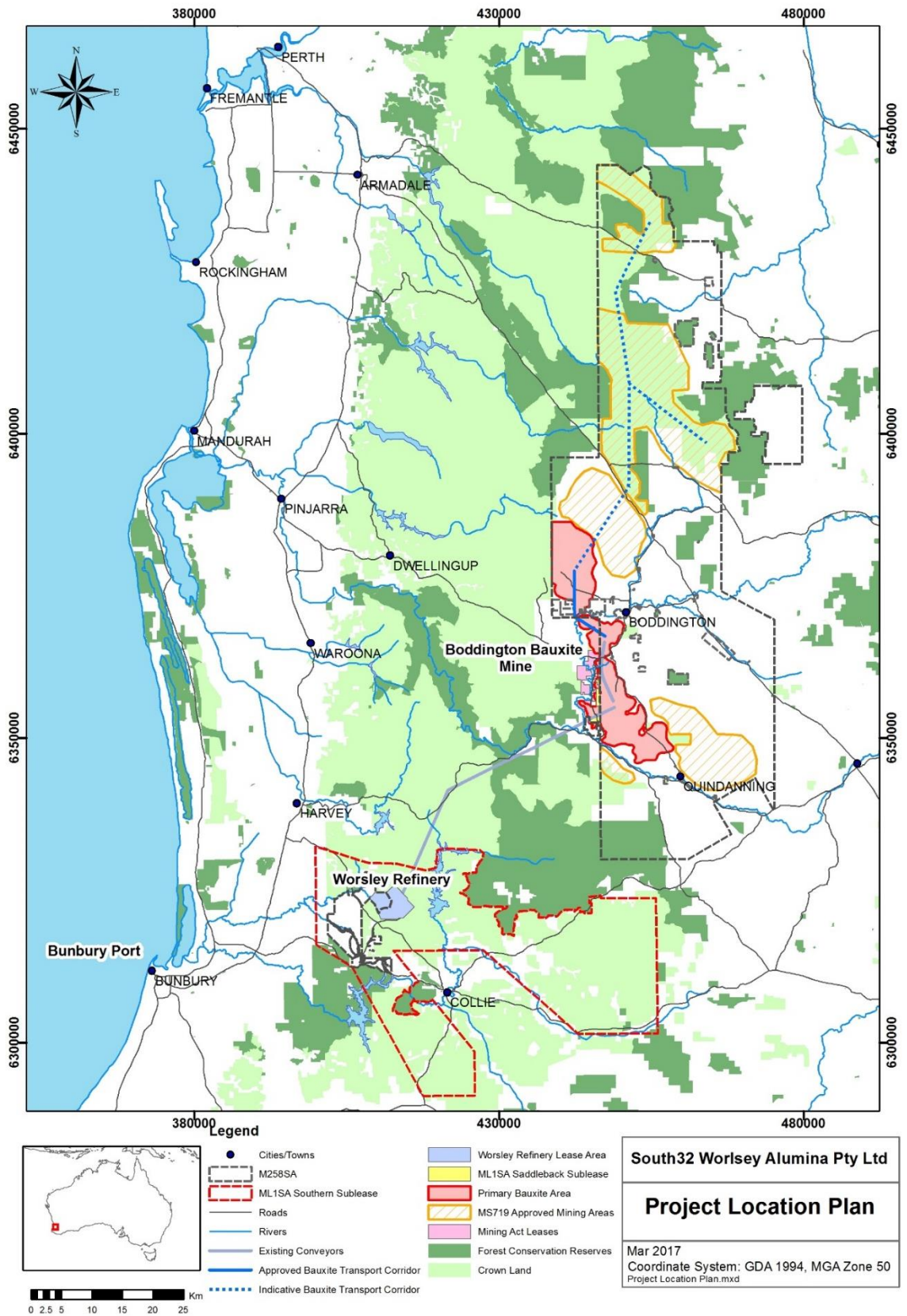


Figure 1 Current approved project location

2. Proposal description

2.1 Proposal overview

Worsley is seeking approval under section 38 of the EP Act to:

1. Extend the current mining envelope at BBM to incorporate areas adjacent to the PBA (referred to as the 'Hotham Mining Extension')
2. Increase the overall production of alumina at the Refinery by approximately 10%, from 4.7 Mtpa to 5.1 Mtpa (referred to as 'Refinery Production Increase').

2.1.1 Hotham Mining Extension

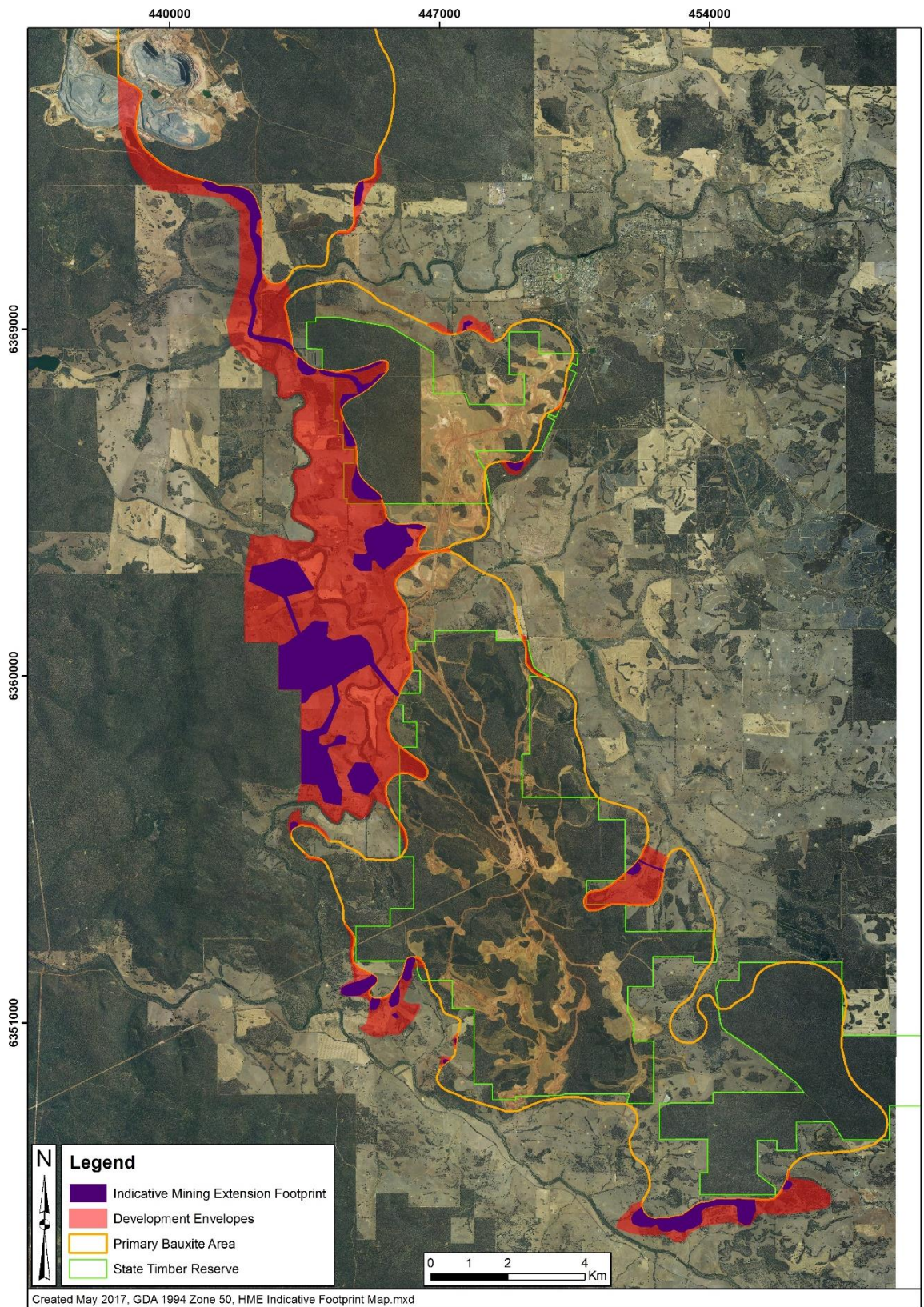
The BBM mining envelope is currently 97,000 ha and includes the PBA covering 22,000 ha and areas approved under Ministerial Statement (MS) 719 covering 75,000 ha. The proposed mine extension area covers an additional 4,687 ha, with an indicative mining footprint of approximately 1,205 ha (Figure 2). It is anticipated that up to two haul road crossings over the Hotham River will be required for the extension as well as some crossings of minor tributaries. No additional processing infrastructure or conveyors will be required to support the proposed mine extension area. A bauxite transport corridor from the Marradong mining envelope to the Hotham North mining envelope (within the PBA) will be constructed in the future. This corridor, which could include a conveyor, has already received Ministerial approval (Figure 1).

The key proposal characteristics for the Hotham Mining Extension are identified in Table 2.

Table 1 Key proposal characteristics for the Hotham Mining Extension

Proposal Title	Hotham Mining Extension and Refinery Production Increase	
Proponent Name	South32 Worsley Alumina Pty Ltd	
Proposal Activities	Mining envelope expansion at BBM	
Relevant Characteristics	Current Approval	This Proposal
<i>Physical Elements</i>		
Mine Activities	Open cut shallow mining pits which do not intersect groundwater. Up to 18.8 Mtpa (dry).	Open cut shallow mining pits which do not intersect groundwater. Up to 20.7 Mtpa (dry).
Disturbance Footprint	Areas of bauxite reserves inside the PBA New mining areas (up to 8,400 ha of native vegetation clearing)	Inclusion of additional 4,687 ha of with an indicative mining footprint of approximately 1,200 ha. This includes up to 350 ha of native vegetation
Water Source	Groundwater and surface water in vicinity of mining areas	No change
Mine Life	Estimated 50 Years	No change

Mtpa million tonnes per annum



Note: The indicative footprint is presented to show the likely proportion of disturbance within the proposed mining extension area. Detailed planning for disturbance will be submitted in accordance with the Agreement Act 1973 in the Plan of Bauxite Mining Operations (10 Year Mine Plan) annually.

Figure 2 Proposed Mine Development Envelopes and Indicative Mining Footprint

2.1.2 Refinery Production Increase

The Refinery Production Increase will be achieved through a series of improvement projects targeting operating efficiency (utilisation and yield) and options for capital investment in debottlenecking existing processes. The improvements will result in a proportional increase in mining and residue deposition rates, as well as an increase in air emissions. No modifications to existing conveyor networks or Port of Bunbury handling facilities will be required to implement this Proposal.

The increase in production at the Refinery and increased volume of exported alumina at the Port of Bunbury is not anticipated to result in environmental impacts additional to those already managed under the current operating licence. Therefore the assessment of environmental impacts associated with the Refinery Production Increase will likely be managed under the EP Act Part V administered by the Department of Environment Regulation (DER). This is to be confirmed with the DER.

The key proposal characteristics for the Refinery Production Increase are identified in Table 2.

Table 2 Key proposal characteristics for the Refinery Production Increase

Proposal Title	Refinery Production Increase	
Proponent Name	South32 Worsley Alumina Pty Ltd	
Proposal Activities	Increased alumina production at the Refinery resulting in increased mining rate, air emissions and residue production.	
Relevant Characteristics	Current Approval	This Proposal
<i>Physical Elements</i>		
Residue Disposal Area	1000 ha	No change
Disturbance Footprint	Areas inside the Refinery Lease Area and Wellington Dam Pipeline Corridor	No change
Water Source	Freshwater Lake (Augustus River) and offsite purchase from water provider as required	No change
Mine Life	Estimated 50 Years	No change
<i>Operational Elements</i>		
Processing	4.7 Mtpa	Up to 5.1 Mtpa through efficiency gains.
Water Use	Worsley Refinery Average Usage: 2.6 GL from Freshwater Lake and offsite purchase from water provider as required	No change
Waste	Up to 18.5 Mtpa to Bauxite Residue Disposal Areas (BRDAs) (wet)	Rate change of up to 20.35 Mtpa to BRDAs (wet). No change to footprint required.
Greenhouse Gas (GHG) Emissions	3.75 Mtpa of CO ₂ -e	Up to 3.85 Mtpa of CO ₂ -e
Worsley Refinery Air Emissions	SO ₂ – Up to 13,370 tpa NO _x – Up to 6,890 tpa PM ₁₀ – Up to 520 tpa CO – Up to 1,350 tpa VOCs – Up to 300 tpa	No change No change Up to 600 tpa No change No change

Mtpa – million tonnes per annum, Tpa – tonnes per annum

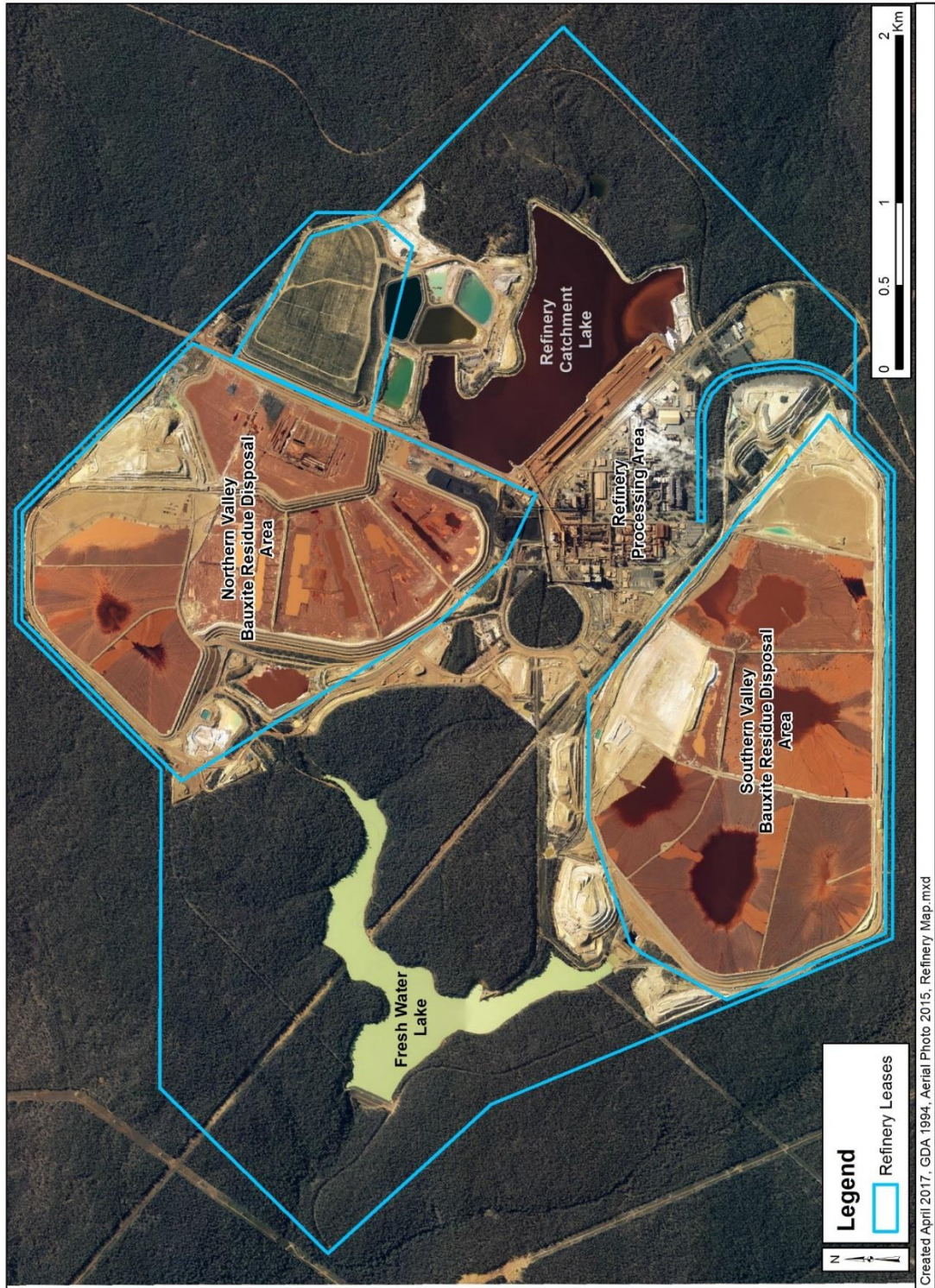


Figure 3 Refinery Region

2.2 Proposal justification

Since the receipt of the MS719 in 2006, subsequent geological investigations have identified additional bauxite resources in and adjacent to Worsley's existing mining and exploration tenements. These resources are adjacent to approved mining areas. The extension of the mining envelope to incorporate these potential ore bodies will help secure the 50 year mine life of the BBM, which is part of the planned progression of the mine (Worsley Life of Operation Plan).

Mining within the proposed Hotham Mining Extension area will be undertaken in conjunction with current planned mining activities, and has the following benefits:

- Ability to conduct rehabilitation in a logical sequence, minimising edge effects and ensuring better rehabilitation outcomes
- Minimised potential for re-clearing of rehabilitation areas to allow access to the ore at a later stage
- Improved cost effectiveness for accessing the identified ore resources.

The Refinery currently operates under a licence for a nominal rated throughput of 4.7 Mtpa of alumina. The Refinery currently has the capacity to deliver production rates greater than this for short periods of time. The proposed Refinery production increase to 5.1 Mtpa will enable utilisation and optimisation of latent capacity. This Proposal will allow Worsley to continue to provide long term employment opportunities within the South-Western Australia region and the generation of significant economic revenue for the Shires of Collie and Boddington.

2.3 Alternative options considered

Worsley has considered a number of preliminary alternative designs or approaches in developing this proposal. The preliminary alternative designs and approaches reviewed environmental, financial and social aspects. The options are provided in sections 2.3.1- 2.3.3.

2.3.1 No development of Hotham mining area

Worsley has considered a 'no development alternative' for the mine expansion. The environmental values under 'no development alternative' would be retained within the proposed mine extension areas.

The social and economic values under 'no development alternative' would result in a loss of taxation and mining royalties for both the State and Commonwealth Governments. Under this alternative, there would be fewer employment opportunities and reduced economic growth within both the local and broader region including the Shires of Boddington and Collie and the City of Bunbury and Shires of Dardanup and Harvey.

2.3.2 Larger mine extension area footprint

Worsley considered a larger mining extension area of 6,311 ha which included a large section of the Quindanning Timber Reserve. This alternative would have similar effects on the existing environment, economic and social values of the area. The larger mining envelope would result in an increased mining footprint and therefore an increased impact on the surrounding environment primarily in the areas of vegetation and flora, fauna and terrestrial environmental quality. In addition, the larger area would result in an increase in available ore to realise the full life of mine and increased taxation and mining royalties for both the State and Commonwealth Governments and also extend employment opportunities and economic benefits within both the local and broader region.

This option was originally considered by Worsley with the primary intent of joining existing approved mining envelopes to allow maximum flexibility for haul route design options for the development of the Quindanning East Mining Envelope. Consultation with the Department of Parks and Wildlife (DPaW) indicated that updated baseline flora and fauna studies over multiple years were required to support the inclusion of this area in the current proposal. Given that the Life of Operation Plan currently does not include these areas in the current 10 Year Plan inclusion of this area has been postponed until further baseline surveys are completed. This will ensure that a greater understanding of the receiving environment is gained prior to submission of any subsequent proposals. This will ensure that potential environmental impacts associated with development of the area will be well understood and that suitable management and mitigation measures can be selected, designed and implemented to ensure that activities can be conducted in such a way that the EPA's Statement of environmental principles, factors and objectives are met.

2.3.3 No increase to refinery production

An alternative scenario was considered with no increase in alumina production rate at the Refinery. This option would not allow for improvements in operating efficiency associated with production increase that are available through process improvements and optimisation of the latent capacity within the process. This scenario results in no change to the current operation in terms of operating unit cost, unit intensity of environmental impacts, total revenue and therefore royalty payments. This is considered to be a sub-optimal outcome to the preferred production increase scenario.

3. Key environmental factors

The following preliminary environmental factors have been identified for this Proposal.

Hotham Mining Extension

- Flora and vegetation
- Terrestrial environmental quality
- Terrestrial fauna
- Hydrological processes
- Inland water environmental quality
- Air quality
- Social surroundings.

Refinery Production Increase

- Air quality.

3.1 Flora and vegetation

3.1.1 EPA objective

The EPA's environmental objective of the factor 'Flora and Vegetation' is:

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

For the purposes of EIA, the EPA defines flora as native vascular plants and vegetation as groupings of different flora patterned across the landscape.

3.1.2 Policy and guidance

- Environmental Factor Guideline Flora and Vegetation (EPA 2016b)
- Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016h)
- Protection of Naturally Vegetated Areas Through Planning and Development, Environmental Protection Bulletin No. 20 (EPA 2013)

3.1.3 Consultation

The Office of Environmental Protection (OEPA) was consulted on 21 February 2017. This pre-referral meeting discussed the Proposal including activities and potential impacts relating to flora and vegetation.

The Department of Parks and Wildlife (DPaW) was consulted on 18 October 2016. Requirements for flora and fauna surveys on State Forest and private property were discussed at this meeting. Meeting outcomes included agreement on Level 1 surveys for private property, and that a risk based approach should be considered.

3.1.4 Receiving environment

Regional biogeography

The mine extension area is located in the Jarrah Forest bioregion and Northern Jarrah Forest sub-region as described by the Interim Biogeographic Regionalisation for Australia (IBRA). This subregion is characterised by Jarrah-Marri forest on laterite gravels, and in the eastern part, by woodlands of Wandoo-Marri on clayey soils. Eluvial and alluvial deposits support *Agonis* shrublands and in areas of Mesozoic sediments, Jarrah forests occur in mosaic with a variety of species-rich shrublands (Williams and Mitchell 2011).

The mine extension area and indicative footprint supports native, rehabilitated and plantation vegetation, as well as cleared areas (e.g. pasture) and water bodies (e.g. dams and the Hotham and Williams Rivers). Indicative extents of each of these land types are provided in Table 3.

The indicative footprint as presented in Figure 2 shows the likely proportion of disturbance within the proposed mine extension area. Detailed planning for disturbance will be submitted in accordance with the Agreement Act 1973 in the Plan of Bauxite Mining Operations (10 Year Mine Plan) annually.

Table 3 Land types within the mine extension area and indicative footprint

Land type	Area (ha) (%)	
	Mine extension area	Mining indicative footprint
Native vegetation	1,529 ha	342 (22%)
Plantation	23 ha	12 (53%)
Rehabilitation	9 ha	0.01 (0.1%)
Cleared / Water bodies	3,125 ha	844 (27%)
Total	4,687 ha	1,199 (26%)

Vegetation types

The mine extension area consists primarily of land cleared for agriculture. Broad scale (1:250,000) pre-European vegetation mapping of the Pinjarra area was completed by Beard (1979) at an association level. The mapping indicates that two vegetation associations are present within the mine extension area.

- Medium forest; jarrah-marri (association 3)
- Medium woodland; marri & wandoo (association 4)

Conservation or other significant ecological communities

No Threatened or Priority Ecological Communities have been recorded in the vicinity of the mine extension area. The area is likely to support other significant vegetation such as riparian vegetation that grows in association with the Hotham and Williams Rivers.

Conservation significant flora

Desktop searches identified the presence of conservation significant flora within 10 km of the mine extension area. Cossack Spider Orchid (*Caladenia dorrienii*), listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Threatened under the *Wildlife Conservation Act 1950* (WC Act) has been previously recorded in the region.

3.1.5 Proposal activities

The proposal activities that have the potential to impact flora and vegetation include: clearing; and mine operations associated with the Hotham Mine Extension. Activities associated with the Refinery Production Increase will not impact flora and vegetation, and therefore the Refinery Production Increase is not discussed further in this section.

3.1.6 Potential impacts

The proposal will result in the direct loss of native, plantation and rehabilitated vegetation through clearing associated with mine operations. Native vegetation clearing may also result in the loss of Threatened (Declared Rare) and Priority flora taxa, reducing their known extents in the local area.

The Proposal could also potentially result in the following indirect impacts to vegetation:

- Further fragmentation of vegetation in the local area through partial or complete clearing of isolated remnant bands or patches. Fragmentation of vegetation at a regional scale is not anticipated.
- Vegetation death from invasive pathogens through the introduction and/or spread of *Phytophthora cinnamomi* (Dieback) and/or *Armillaria luteobubalina* (Australian Honey Fungus).
- Increased competition from invasive species (weeds) through the introduction and/or spread into adjacent areas of vegetation.
- Changes to vegetation structure and floristic composition through altered surface water drainage patterns and flows.

3.1.7 Mitigation

Worsley propose to manage and mitigate the environmental effect of the Proposal to vegetation and flora with the following actions:

- Avoidance through establishing protected areas for remnant vegetation comprising a high level of biodiversity (e.g. Protected Areas Procedure – Worsley 2013b)
- Reducing the environmental footprint associated with the mine pits and haul road, through environmentally sound designs to minimise vegetation clearing
- Compliance with internal clearing procedures and standards including Native Vegetation Clearing Planning Procedure (Worsley 2012), Mine Clearing Procedure (Worsley 2015d), Mine Clearing Standard (Worsley 2015e) and Forest Hygiene Management Procedure (Worsley 2014a)
- Implementation of the Biodiversity and Forest Management Plan (Worsley 2016), which includes the rehabilitation prescription for topsoil and overburden, and compliance reporting and reviewing.
- Compliance with internal rehabilitation procedures and standards including Rehabilitation Standard (Worsley 2013c), Mine Rehabilitation Operations (Worsley 2015f), Private Land Rehabilitation Management Procedure (Worsley 2015g), and BBM Revegetation Management Procedure (Worsley 2015a).

3.1.8 Assessment of impacts

Worsley has commissioned vegetation and flora surveys to identify and map vegetation types, condition and conservation significant or other significant communities and flora within the proposed mine extension area. The results of the surveys will identify high value remnant

vegetation, assist with mine design and clearing footprint finalisation, and inform the rehabilitation aspects of the Biodiversity and Forest Management Plan (Worsley 2016).

3.2 Terrestrial fauna

3.2.1 EPA objective

The EPA's environmental objective of the factor 'Terrestrial Fauna' is:

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained

For the purposes of EIA, the EPA defines terrestrial fauna as animals living on land or using land for all or part of their lives. Terrestrial fauna includes vertebrate and invertebrate groups.

3.2.2 Policy and guidance

- Environmental Factor Guideline Terrestrial Fauna (EPA 2016g)
- Technical Guidance Sampling methods for terrestrial vertebrate fauna (EPA 2016i)
- Technical Guidance Terrestrial Fauna Surveys (EPA 2016j)

3.2.3 Consultation

The OEPA was consulted on 21 February 2017. This pre-referral meeting discussed the Proposal including activities and potential impacts relating to terrestrial fauna.

The DPaW was consulted on 18 October 2016. Survey requirements for flora and fauna surveys on State Forest and private property were discussed at this meeting. Meeting outcomes included agreement on Level 1 surveys for private property, and that a risk based approach should be considered.

3.2.4 Receiving environment

Fauna habitats

The mine extension area consists primarily of land cleared for agriculture. Fauna habitats present in the mine extension area are likely to include woodlands dominated by Jarrah, Marri and Wandoo, riparian and associated communities, heath communities, rehabilitation/plantation areas and dams.

Ecological linkages

The vegetation within the mine extension area is fragmented, but some linkages and corridors between areas of native habitats and remnants are present. Several areas within the mine extension area contain native forest remnants of relatively high quality.

An existing and important movement corridor system within the current landscape is the Hotham River, its tributaries and remnant feeder creek systems. These waterways are mostly fringed by narrow riparian and associated communities. The waterways provide habitat for aquatic and semi-aquatic species.

Conservation significant fauna

Desktop searches of the EPBC Act Protected Matters and DPaW *NatureMap* databases, and review of the DPaW Threatened and Priority Fauna List identified the presence / potential presence of 32 conservation significant fauna species. The likelihood of occurrence of each of these species was assessed based on previous fauna surveys and an understanding of the available habitat within the mining extension area and broader region (Table 4).

Table 4 Potential occurrence of conservation significant fauna recorded within the Mine Extension Area

Common Name	Species	Status: EPBC Act	Status: WC Act/ DPaW	Potential Occurrence
Common Sandpiper	<i>Actitis hypoleucos</i>	Mi		Moderate
Fork-tailed Swift	<i>Apus pacificus</i>	Mi	Mi (S5)	Seasonally High
Great Egret	<i>Ardea alba</i>	Mi		Moderate to Low
Cattle Egret	<i>Ardea ibis</i>	Mi		Moderate
Woma	<i>Aspidites ramsayi</i>		P1	Extremely Unlikely
Woylie	<i>Bettongia penicillata ogilbyi</i>	En	CR (S1)	Moderate (Previously Recorded)
Curlew Sandpiper	<i>Calidris ferruginea</i>	CEn	(S3, S5)	Extremely Unlikely
Forest Red-tailed Black-Cockatoo	<i>Calyptorhynchus banksii</i>	Vu	Vu (S3)	Seasonally High (Previously Recorded)
Baudin's Black Cockatoo	<i>Calyptorhynchus baudinii</i>	Vu	En (S2)	Seasonally High (Previously Recorded)
Carnaby's Black Cockatoo	<i>Calyptorhynchus latirostris</i>	En	En (S2)	Seasonally High (Previously Recorded)
Darling Range Heath Ctenotus	<i>Ctenotus delli</i>		P4	High (Previously Recorded)
Chuditch	<i>Dasyurus geoffroii</i>	Vu	Vu (S3)	High (Previously Recorded)
Peregrine Falcon	<i>Falco peregrinus</i>		OS (S7)	Moderate to High (Previously Recorded)
Western False Pipistrelle	<i>Falsistrellus mackenziei</i>		P4	High (Recorded)
White Bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	Mi		Moderate
Water-rat	<i>Hydromys chrysogaster</i>		P4	High (Recorded)
Southern Brown Bandicoot	<i>Isoodon obesulus fusciventer</i>		P5	High (Recorded)
Malleefowl	<i>Leipoa ocellata</i>	Vu	Vu (S3)	Extremely Unlikely
Western Brush Wallaby	<i>Macropus irma</i>		P4	High (Previously Recorded)
Bilby	<i>Macrotis lagotis</i>	Vu	Vu (S3)	Extremely unlikely
Rainbow Bee-eater	<i>Merops ornatus</i>	Mi	Mi (S5)	Seasonally High
Grey Wagtail	<i>Motacilla cinerea</i>	Mi	Mi (S5)	Unlikely
Numbat	<i>Myrmecobius fasciatus</i>	Vu	En (S2)	Unlikely
Southern Boobook	<i>Ninox novaeseelandiae</i>	Mi		High (Previously Recorded)
Eastern Curlew	<i>Numenius madagascariensis</i>	CEn (Mi)	Vu, Mi (S3, S5)	Moderate to Low
Osprey	<i>Pandion cristatus</i>	Mi	Mi (S5)	Moderate
Red-tailed Phascogale	<i>Phascogale calura</i>	Vu	Vu (S3)	Unlikely

Common Name	Species	Status: EPBC Act	Status: WC Act/ DPaW	Potential Occurrence
Southern Brush-tailed Phascogale	<i>Phascogale tapoatafa wambenger</i>		CD (S6)	High (Previously Recorded)
Western Rosella	<i>Platycercus icterotis xanthogenys</i>		P4	
Western Ringtail Possum	<i>Pseudocheirus occidentalis</i>	Vu	CR (S1)	Moderate to Low
Australian Painted Snipe	<i>Rostratula australis</i>	En (Mi)	En (S2)	Moderate
Hooded Plover	<i>Thinornis rubricollis</i>		(P4)	Moderate to Low

3.2.5 Proposal activities

Proposal activities that have the potential to impact terrestrial fauna include clearing and mine operation associated with the Hotham Mine Extension. Activities associated with the Refinery Production Increase will not impact terrestrial fauna, and therefore the Refinery Production Increase is not discussed further in this section.

3.2.6 Potential impacts

The potential impacts to fauna as a consequence of developing the proposal are:

- Habitat loss – the proposal will result in the direct loss of native, plantation and rehabilitated habitats through clearing associated with mine operations. The required clearing may result in the loss of Black Cockatoo foraging habitat, potential habitat trees, as well as habitat suitable for the Woylie, Chuditch, Australian Painted Snipe and other species listed as Migratory.
- Further habitat fragmentation in the local area through partial or complete clearing of isolated bands or patches.
- Death, injury or displacement of fauna species during clearing and mine operation (including vehicle strike).
- Secondary impact from dust, noise and vibration during clearing and mine operation.

3.2.7 Mitigation

Worsley propose to manage and mitigate the environmental effect of the Proposal to the terrestrial fauna with the following actions:

- Avoidance through establishing protected areas for habitat comprising a high level of biodiversity and critical habitat to conservation significant fauna species
- Reducing the environmental footprint associated with the mine pits and haul road, through environmentally sound designs to minimise vegetation clearing
- Implementation of fauna management measures during clearing and mine operation
- Providing advice for Bilateral assessment and determination of offsets
- Compliance with Rehabilitation Standards and BBM Revegetation Procedures.

3.2.8 Assessment of impacts

Worsley has commissioned a terrestrial fauna survey to identify fauna habitat types and identify fauna ecological values within the proposed mine extension area. The results of the surveys will inform selection of conservation areas for habitat, assist with mine design and mining footprint finalisation, and inform the rehabilitation aspects of the Biodiversity and Forest Management Plan (Worsley 2016).

3.3 Terrestrial environmental quality

3.3.1 EPA objective

The EPA environmental objective for the key environmental factor 'Terrestrial Environmental Quality' is:

To maintain the quality of land and soils so that environmental values are protected.

For the purposes of EIA, the EPA defines the factor 'Terrestrial Environmental Quality' as the chemical, physical, biological and aesthetic characteristics of soils.

3.3.2 Policy and guidance

- Environmental Factor Guideline Terrestrial Environmental Quality (EPA 2016f)

3.3.3 Consultation

The OEPA was consulted on 21 February 2017. This pre-referral meeting discussed the Proposal including activities and potential impacts relating to terrestrial environmental quality.

3.3.4 Receiving environment

The catchment in which the BBM is located is on the Darling escarpment. Generally, the soils in the upslope areas are shallow with lateritic duricrust and granitic bedrock at or close to the surface. The mid slope regions are dominated by shallow soil with lateritic duricrust close to the surface, sandy piezolithic gravel dominates the upper strata. Clayey sandy silt is deposited by alluvial processes in the low lying areas of the catchment (Strategen 2005). Bauxite ore has developed in the upper part of the weathered lateritic profile of the upland areas.

Soil-landscape mapping of Western Australia (DAFWA 2007) indicates that the proposed mining extension footprint is primarily located within the Marradong Upland System, with soils described as sandy gravel, loamy gravel, grey deep sandy duplex and loamy duplex. Portions of the mining extension footprint that are within or nearby watercourses are generally dominated by the Quindanning System, with soils described as deep sandy duplex soils, shallow sand, loamy duplex and bare rock. A small portion of the proposed mining extension footprint, at the northern end, is located within the Darling Plateau System, with soils described as duplex sandy gravels, loamy gravels and wet soils.

Salts derived from rainfall (mostly sodium chloride) are stored within the surface soils and sediments (regolith) in the region of the BBM, at levels from 100 to 10,000 tonnes per hectare (t/ha). These salts are concentrated in the root zone but by transpiration accumulate deeper into the saturated zones of the regolith. Low rainfall, low topography and higher rates of evaporation can also contribute to the retention of salt in the soil (Strategen 2005).

An assessment of soil salinities in the existing BBM by Water and Environmental Consultants revealed that Worsley soil salinities are less than surrounding areas by approximately 50 – 60% (Croton & Dalton 2007). One explanation for this is that Worsley boreholes are in strong association with bauxite, which is known to be an indicator of better vertical drainage and will

store less salt in the soil. Croton & Dalton (2007) did not find a relationship between rainfall and soil salinity for the existing BBM.

A review of the ASRIS indicates that there is an extremely low probability of acid sulphate soils (ASS) in the majority of the mining extension area. The banks of the Hotham River have a high probability of occurrence (ASRIS 2017). There are no known contaminated sites within 10 km of the BBM and mining extension area.

3.3.5 Proposal activities

Proposal activities that have the potential to impact the quality of land and soils are; clearing of vegetation, excavation of soils associated with construction of river crossings for haul roads and mine operation.

3.3.6 Potential impacts

The potential impacts that may occur to terrestrial environmental quality as a consequence of developing the proposal are:

- Erosion impacts potentially leading to poor soil structure, reduced water infiltration and general loss of soil health from mine-related vegetation clearing and soil excavation,
- Salinisation of soils ('dryland salinity'), potentially leading to loss of plant species and decreased quality of livestock drinking water supplies
- Disturbance and release of Acid Sulfate Soils into the receiving environment
- Contamination of soils as a result of seepage or storage/use of chemicals

3.3.7 Mitigation

Worsley propose to manage and mitigate the environmental effect of the Proposal to the terrestrial environment with the following actions:

- Avoidance through establishing protected areas for remnant vegetation and habitat comprising a high level of biodiversity
- Reducing the environmental footprint associated with the mine pits and haul road, through environmentally sound designs to minimise vegetation clearing, which will reduce the potential for dryland salinity to develop
- Implementing the Topsoil and Overburden Handling procedures (Worsley 2013d)
- Implementing the Biodiversity and Forest Management Plan (Worsley 2016), which includes the rehabilitation prescription for topsoil and overburden, and compliance reporting and reviewing
- Implementing ASS avoidance, management and remediation methods.

3.3.8 Assessment of impacts

Worsley will commission a landform study as part of hydrological studies to investigate drainage and surface water quality associated with changing landform. Depending on bridge design and construction techniques, Worsley may undertake ASS investigations in the vicinity of the Hotham River if construction activities are likely to disturb PASS.

3.4 Hydrological processes

3.4.1 EPA objective

The EPA environmental objective for the key environmental factor ‘Hydrological Processes’ is:

To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.

For the purposes of EIA, the EPA defines the factor ‘Hydrological Processes’ as the occurrence, distribution, connectivity, movement and quantity of water.

3.4.2 Policy and guidance

- Environmental Factor Guideline Hydrological Processes (EPA 2016c).

3.4.3 Consultation

The OEPA was consulted on 21 February 2017. This pre-referral meeting discussed the Proposal including activities and potential impacts relating to hydrological processes.

The Department of Water (DoW) was consulted on 23 March 2017. This meeting discussed the proposal, confirmed the assessment pathway and approval requirements in relation to DoW.

Worsley will work with the DER and DoW to ensure that any changes to operational water supply or requirements are in line with current water provisions.

3.4.4 Receiving environment

Desktop searches of the DoW Geographic Data Atlas were undertaken and are summarised in Table 5.

Table 5 DoW geographic data atlas queries within the Hotham Mining Extension Proposal Area

Aspect	Details	Hotham Mining Extension
Groundwater Areas	Groundwater areas proclaimed under the <i>Rights in Water and Irrigation (RIWI) Act 1914</i>	None present
Surface Water Areas	Surface water areas proclaimed under the RIWI Act	Murray River System
Irrigation District	Irrigation Districts proclaimed under the RIWI Act	None present
Rivers	Rivers proclaimed under the Rights in RIWI Act	None present
Public Drinking Water Source Areas (PDWSA)	PDWSAs is a collective term used for the description of Water Reserves, Catchment Areas and Underground Pollution Control Areas declared (gazetted) under the provisions of the <i>Metropolitan Water Supply, Sewage and Drainage Act 1909</i> or the <i>Country Area Water Supply Act 1947</i> .	None present
Waterways Management Areas	Areas proclaimed under the <i>Waterway Conservation Act 1976</i> .	None present

Surface water hydrology

The existing BBM and mining extension area falls within the Murray River and Tributaries Surface Water Management Area, and over two Sub-areas (Hotham and Williams River). This area is also classified as a RIWI Act Surface Water Area (Murray River System).

All current BBM operations are bordered to the north and west by the Hotham River, and to the south by the Williams River. To the east, tributaries of Marradong Brook border the existing BBM. The Marradong Brook intersects the current cleared boundary in one location, where a haul road crosses the river.

The mining extension area intersects the Hotham River and associated riparian vegetation in two areas; a 9.5 km section of the river to the west of the existing mine (Saddleback), and a 2 km section of the river where it meets Thirty Four Mile Brook, north-west of the existing mine (Marradong). Two other minor drainage lines are intersected by the mining extension area; Wattle Hollow Brook (tributary of Thirty Four Mile Brook) which is located in the northern extent of the proposed mining expansion footprint for approximately 400 m, and a minor tributary of Marradong Brook which is located in the eastern portion of the existing BBM (Saddleback).

There is a high likelihood of ASS occurrence on the banks of the Hotham River, within and adjacent to the mining extension area.

The Murray River is formed by the union of the Hotham River and Williams River and discharges into the Peel-Harvey Estuary. The Peel-Harvey Estuary is a Nationally Important Wetland and is located approximately 78 km north-west of the mine site. There are no internationally important (Ramsar listed), nationally important or geomorphic wetlands within 10 km of the mining extension area.

Groundwater and hydrogeology

The existing BBM and mining extension area are not within any gazetted groundwater areas proclaimed under the RIWI Act.

The BBM site hydrogeology consists of three main aquifers formed by the in-situ weathering of basement rocks including, a shallow aquifer (shallow weathered zone aquifer), lower saprolite (deep weathered zone aquifer) and fractured bedrock aquifer (fracturing within the bedrock) (Groundwater Resource Management 2015). The lower saprolite aquifer is the principle aquifer and is the dominant aquifer of the Darling Plateau. The aquifer rests above the bedrock, with depth of between 15 to 40 m. The thickness of this aquifer ranges from one to ten metres. The groundwater flow direction is variable due to a number of factors including the sub-surface geometry, hydraulic properties and discharge locations. Broadly, groundwater levels within all aquifers appear to follow topography (i.e. groundwater level is highest in areas of highest topography and lowest in areas of lowest topography) (Groundwater Resource Management 2015).

The Hotham River and associated riparian vegetation was identified as an ecosystem that is potentially dependent on shallow groundwater (Strategen 2013). Winter flows are related to catchment-scale rainfall events, while summer flows are considered to result from groundwater baseflow throughout the catchment and leakage from Lions Weir in the Boddington town site (Golder 2005).

Previous modelling has been undertaken for the Newmont Life of Mine Extension Project, which includes the section of the Hotham River within the mining extension area (Schlumberger 2013). The model took a conservative approach and predicted drawdown of groundwater by 1 m by 2022 in the Hotham Mining Extension area due to dewatering activities at the Newmont mine site. This drawdown may affect summer flows of the Hotham River long

term, should the river be reliant on groundwater to maintain base flow. This Proposal does not include dewatering activities and will not contribute to this drawdown effect.

Historically, all proposed mining areas within the Worsley lease area at BBM have been subject to the flux density analysis (FDA) predictive modelling technique prior to the commencement of mining. A fundamental output of FDA is the prediction of water table rise associated with mine-related clearing. Worsley has used FDA as a key prediction tool since 2003.

3.4.5 Proposal activities

The Proposal activities that have the potential to impact hydrological processes include clearing and mine operation, as well as bridge design and construction in the vicinity of the Hotham River associated with the Hotham Mine Extension. Activities associated with the Refinery Production Increase will not impact hydrological processes, and therefore the Refinery Production Increase is not discussed further in this section.

3.4.6 Potential impacts

The potential impacts that may occur to hydrological processes as a consequence of developing the proposal are:

- Riverbank erosion, sedimentation, scouring of streams or release of excessively turbid water as a result of clearing riparian vegetation and alteration of surface water drainage patterns
- Changes to groundwater levels (water table rise) in the shallow aquifer associated with mine-related clearing
- Changes to vegetation structure in groundwater-dependent ecosystems along the Hotham River, as a result of groundwater level rise.

3.4.7 Mitigation

Worsley propose to manage and mitigate the environmental effect of the Proposal to hydrological processes with the following actions:

- Reducing the environmental footprint associated with the mine pits and haul roads as much as possible, through environmentally sound designs to minimise vegetation clearing (particularly riparian vegetation)
- Recording baseline monitoring data for groundwater and surface water. Ongoing monitoring will be implemented as per the Water Management Plan (Worsley 2017)
- Modelling of hydrological processes to identify groundwater dependent ecosystems and predict groundwater rise due to temporary vegetation removal for mining
- Consultation with DoW prior to seeking a Bed and Banks permit for river crossing/s, to ensure that design, controls and construction options selected at each crossing location are suitable
- Implementation of erosion and turbidity control measures during the construction of river crossings (e.g. sediment curtains and dust suppression)
- Manage drainage in accordance with the Site Drainage Standard (Worsley 2015h) and Trunk Haul Road Design and Construction specifications
- Rehabilitation of riparian vegetation as per the Biodiversity and Forest Management Plan (Worsley 2016)

- Rehabilitation of cleared areas, which are not occupied by utility corridors, buildings or fire-breaks back to native vegetation.

3.4.8 Assessment of impacts

Worsley has commissioned a modelling study that will predict the degree and significance of any changes in groundwater levels associated with the proposal activities through development of numerical or analytical models. The results of the study will assist with mine design and mining footprint finalisation, and help to identify any future monitoring requirements.

Worsley is currently assessing options for the design and location of river crossings on the Hotham River. Consultation with DoW will continue to support selection of the best option to minimise impacts.

3.5 Inland waters environmental quality

3.5.1 EPA objective

The EPA environmental objective for the key environmental factor 'Inland Waters Environmental Quality' is:

To maintain the quality of groundwater and surface water so that environmental values are protected.

For the purposes of EIA, the EPA defines the factor 'Inland Waters Environmental Quality' as the chemical, physical, biological and aesthetic characteristics of inland waters.

3.5.2 Policy and guidance

- Environmental Factor Guideline Inland Waters Environmental Quality (EPA 2016d)

3.5.3 Consultation

The OEPA was consulted on 21 February 2017. This pre-referral meeting discussed the Proposal including activities and potential impacts relating to inland waters.

The Department of Water (DoW) was consulted on 23 March 2017. This meeting discussed the proposal, confirmed the assessment pathway and approval requirements in relation to DoW.

3.5.4 Receiving environment

Surface water

The potential receiving environments for surface water quality include; the Williams River, the Hotham River and associated tributaries (Thirty Four Mile Brook and Marradong Brook) which fall within the Hotham River Catchment. These river catchments are brackish in salinity, with monthly sampling giving electrical conductivity within the Hotham River ranging from 6,300 to 20,000 $\mu\text{S}/\text{cm}$ (seawater is around 50,000 $\mu\text{S}/\text{cm}$) and 6,100 to 15,000 in the Williams River over the last five years. These high salinities are considered to be due to land clearing and agricultural practices in the broader Hotham River catchment (Schlumberger 2010). Sudden increases in salinity may occur during inflows after summer rains or after the first major flood events of winter (Morgan & Beatty 2004). Given the nature of the saline conditions of these rivers, they are considered suitable for livestock drinking water only.

Water quality investigations in the Hotham River upstream of its union with Thirty Four Mile Brook indicated neutral pH (7.11 – 7.97). Metals were generally low, with all metals recorded below detection limits except for cadmium and lead, which exceeded the ANZECC & ARMCANZ

freshwater 95% trigger value (2000), and slightly elevated levels of manganese (Streamtec 2005).

Crustaceans are known to be the dominant benthic fauna in the river systems within the mining extension area (Bunn and Davies 1992). The Hotham, Murray and Williams Rivers are also important ecosystems for freshwater fish migration (Morgan & Beatty 2004). However, the areas of the Hotham River within the mining extension area are generally above the upper salinity tolerance of freshwater fishes known to occur in the area, therefore it is unlikely that they would be present in large numbers.

The areas of the Hotham River that intersect the mining extension area are within agricultural land, however two tourist attractions exist within the mining extension area; the Tullis Bridge and Walk Trail, and the Marradong Bike Route. The Tullis Bridge and Walk Trail is located near the intersection of Thirty Four Mile Brook and Hotham River (downstream), and includes a picnic area and a 3 km walking loop. The Marradong Bike Route follows Morts Road where it crosses the Hotham River and also intersects the mining extension area near the intersection of Thirty Four Mile Brook and Hotham River (upstream). This section of the river is not considered to have significant aesthetic value.

Groundwater

Groundwater in the existing BBM consists of three main aquifers formed by the in-situ weathering of basement rocks including, a shallow aquifer (shallow weathered zone aquifer), lower saprolite (deep weathered zone aquifer) and fractured bedrock aquifer (fracturing within the bedrock). The mine site currently sources groundwater from the shallow and fractured bedrock aquifers. Within these aquifers, there are five bore field sites including the Karafil's bore field, the South East bore field, the Fawcett's bore field, Tunnell Road bore field and Marradong bore field. Monitoring bores are in place to measure groundwater level and water quality within each of the borefields.

Groundwater monitoring undertaken since 1995 indicates variable levels of the total dissolved solids (TDS) ranging from 10 mg/L (Karafil bore field, 1995) to 12,000 mg/L (Fawcett's bore field, 2005) (Groundwater Resource Management 2015). Croton and Dalton (2004) also found that groundwater quality is variable around the existing mining areas, ranging from fresh to around 15,000 mg/L (seawater is around 19,400 mg/L).

The soil salt storages on the Darling Plateau are the result of meteoric salt fall, with soil salinities being relatively low in the high rainfall zone but increasing rapidly with decreasing rainfall. Golder Associates (2005) undertook an analysis of salinity trends for the existing BBM and found flow-weighted salinity ranged from 86 to around 6000 mg/L. To date, no salt storage hot spots have been identified within the existing mine footprint (Croton & Dalton 2007).

3.5.5 Proposal activities

The Proposal activities that have the potential to impact inland waters environmental quality include clearing and mine operation, as well as bridge design and construction in the vicinity of the Hotham River associated with the Hotham Mine Extension. Mine operation will not directly obstruct groundwater or surface water (no dewatering required).

3.5.6 Potential impacts

The potential impacts that may occur to inland water environmental quality as a consequence of developing the proposal are:

- Riverbank erosion, sedimentation, scouring of streams or release of excessively turbid water as a result of clearing riparian vegetation and alteration of surface water drainage patterns
- Changes to groundwater levels (water table rise) in the shallow aquifer associated with mine-related clearing, potentially leading to salinisation
- Contamination of surface water as a result of spills of contaminated material or stormwater run-off
- Contamination of groundwater as a result of seepage or storage/use of chemicals
- Decline of aquatic fauna from changes in flow regime and water quality, potentially leading to impediment of upstream pre-spawning migrations of freshwater fishes
- Contamination of ground and/or surface water from exposure of PASS and contaminants during removal of soils and sediments at river crossings.

3.5.7 Mitigation

Worsley propose to manage and mitigate the environmental effect of the Proposal to inland waters environmental quality with the following actions:

- Reducing the environmental footprint associated with the mine pits and haul road, through environmentally sound designs to minimise vegetation clearing (particularly riparian vegetation)
- Recording baseline monitoring data for groundwater and surface water. Ongoing monitoring will be implemented as per the Water Management Plan (Worsley 2017)
- Cleared areas of native vegetation that are not occupied by utility corridors, buildings or fire-breaks will be rehabilitated back to native vegetation
- Modelling techniques will be used to predict possible salinity hazards
- Sediment controls (e.g. silt curtains, sumps, curtains etc.) will be used where necessary (Hotham River and tributaries)
- Stormwater run-off will be managed in accordance with the Site Drainage Standard (Worsley 2015h) and Trunk Haul Road Design and Construction specifications
- Consultation with DoW prior to seeking a Bed and Banks permit for river crossing/s, to ensure that design, controls and construction options selected at each crossing location are suitable
- Construction works within river crossings will be prioritised to ensure the duration of any impacts are minimised
- Spills of contaminated material will be managed in accordance with BBM Spill Management Procedures, including the Trigger Action Response Plan (TARP)
- The impacts and management of PASS/ contaminants are discussed in Section 3.3.

3.5.8 Assessment of impacts

Worsley has commissioned a modelling study that will predict the degree and significance of any changes in groundwater levels associated with the proposal activities through development of numerical or analytical models. The results of the study will help identify salinity risk areas, which will assist with mine design and mining footprint finalisation, and help to identify any future monitoring requirements.

Worsley is currently assessing options for the design and location of river crossings on the Hotham River. Consultation with DoW will continue with regards to developing the best option to minimise impacts to inland waters environmental quality.

3.6 Air quality

3.6.1 EPA objective

The EPA's environmental objective for the factor Air Quality is:

To maintain air quality and minimise emissions so that environmental values are protected.

For the purposes of EIA, the EPA defines the factor Air Quality as the chemical, physical, biological and aesthetic characteristics of air.

3.6.2 Policy and guidance

- Environmental Factor Guideline Air Quality (EPA 2016a)

3.6.3 Consultation

The OEPA was consulted on 21 February 2017. This pre-referral meeting discussed the Proposal including activities and potential impacts relating to air quality.

South32 is in consultation with the DER regarding this Proposal, specifically the assessment pathway for the Refinery Production Increase.

3.6.4 Receiving environment

Hotham Mining Extension

Potential sensitive receptors in the BBM vicinity include local residents (located at Boddington and in semi-rural areas) and mine employees. Local air emissions are influenced by the land use in the BBM area. In addition to bauxite mining, the land use is predominantly agricultural, with the majority of air emissions likely to be attributed to agricultural activities and vehicles.

Air emissions of potential community concern at the BBM is dust produced from mining activities. Generation of dust from construction and operations depends on the type and frequency of activities, meteorological conditions, composition of dust and condition of the source. Dust emissions are usually highest during summer, and biased toward the southeast, due to wind conditions.

On adjoining agricultural land, farming activities also contribute to background dust levels throughout much of the local and wider region. Dust levels show marked seasonal trends as the agricultural land ground cover changes on a seasonal basis. In addition, smoke from hazard reduction burning, cleared vegetation stockpiles and wildfires is a substantial contributor to elevated levels of airborne particulates.

An ambient dust monitoring program for mining and associated activities has been underway at the BBM since 2006. Dust from mining and associated activities is subject to air quality standard as described by the *National Environment Protection Measure for Ambient Air Quality 2003* (NEPC).

Refinery Production Increase

Potential sensitive receptors in the Refinery vicinity include local residents (located at Collie and in semi-rural areas) and refinery employees. The Refinery has been in operation since the 1980's. Existing air emission sources within the Refinery lease area include:

- Coal fired powerhouse (sulphur dioxide (SO₂), nitrogen oxides (NO_x), carbon monoxide (CO) and particulates (PM₁₀))
- Multi-fuelled cogeneration facility (SO₂, NO_x, CO and PM₁₀)
- Liquor burner emission control system (NO_x, CO, odour and Volatile Organic Compounds (VOCs))
- Calciners (NO_x, CO, PM₁₀, VOCs and odour)
- Digestion emissions control system (VOCs and odour)
- Refinery catchment lake (VOCs and odour)
- Solar evaporation ponds (odour)
- Bauxite residue disposal areas (PM₁₀).

Other emission sources including unsurfaced areas, accumulation of dusty materials on surfaced areas, grinding mills, bauxite reclaimers (PM₁₀), package boilers, and fugitive sources in digestion, residue filtration and clarification areas (odour and VOCs).

The most recent version of the emissions inventory was completed in 2005 as part of the Efficiency and Growth Expansion Project to 4.4 Mtpa (and subsequently 4.7 Mtpa) alumina production. The emissions inventory included 47 substances. Air quality modelling was last conducted in 2005 for the Efficiency and Growth Expansion Project.

The implementation of the Refinery Production Increase to 5.1 Mtpa will result in total emissions of PM₁₀ and Greenhouse Gas (GHG) being greater than the current approved limit. However, it is anticipated that current target emission rates, as defined within the current EP Act Licence (L4504/1981/17) (Table 2) will not require any amendment to achieve the proposed production increase.

There is currently duplication between Part IV and Part V approvals for management of air emissions from the Refinery. Given that concentrations are largely accepted as the most appropriate management method for the types of emission generated from the Refinery, it is anticipated that the air emissions component of the EPA assessment will be managed under Part V of the EP Act.

3.6.5 Proposal activities

Hotham Mining Extension

Proposal activities that have the potential to impact air quality include clearing and mine operation associated with the Hotham Mine Extension. This includes dust generated from mining activities, haulage and light vehicles on unsealed roads. SO₂, CO and NO_x emissions will occur from the combustion of fuel in light and heavy earthmoving vehicles and stationary sources such as generators. NO_x and CO emissions also arise from blasting activities.

Refinery Production Increase

The Refinery Production Increase has the potential to impact air quality through ongoing operation of the Refinery after the production increase has been implemented. This includes a slight increase in PM₁₀ emissions.

3.6.6 Potential impacts

Hotham Mining Extension

The potential impacts that may occur to air quality as a consequence of developing the proposal are:

- Health impacts on sensitive receptors, native fauna and livestock as a result of increased dust emissions
- Social impacts, including nuisance and aesthetical problems that arise from visible dust emissions

Greenhouse gases and air emissions produced through operation of the mining extension area are minor, temporary and not considered a significant impact.

Refinery Production Increase

The potential impacts that may occur to air quality as a consequence of developing the proposal are:

- Health impacts on sensitive receptors as a result of increased air emissions
- Increased GHG and particulate emissions to the Collie airshed. No increase in other conditionally approved emissions (as shown in Table 2) will occur as a result of the proposal.

3.6.7 Mitigation

Hotham Mining Extension

Worsley proposes to manage and mitigate the environmental effect of the Proposal to air quality through the implementation of:

- Dust Management Plan – Bauxite Mining and Transport (Worsley 2015b)
- Landholder agreements to relocate impacted residents
- Gaseous and particulate emissions from light and heavy vehicle engine exhausts will be minimised by the use of current generation diesel engine technology and minimising the use of the equipment were practicable.

Refinery Production Increase

Worsley proposes to manage and mitigate the environmental effect of the Proposal to air quality through the implementation of:

- Energy and Greenhouse Gas Emissions Management Plan
- Worsley Alumina Refinery Air Quality Management Plan.

3.6.8 Assessment of impacts

Worsley has commissioned a dust study for the Hotham Mining Extension. The study will assess the potential dust emissions from both the current and proposed mining extension areas and model potential impacts on nearby sensitive receptors.

Worsley has commissioned an air quality study for the Refinery Production Increase at the Refinery. The study will include development of an updated Air Emissions Inventory for the Refinery and completion of Air Dispersion Modelling.

The results of these studies will inform risk assessments and subsequent analysis of suitable management measures to ensure that any impacts are minimised.

3.7 Social surroundings

3.7.1 EPA objective

The EPA environmental objective for the key environmental factor ‘Social Surroundings’ is:

To protect social surroundings from significant harm.

For the purposes of EIA, the EP Act defines social surroundings as the social surroundings of man are his aesthetic, cultural, economic and social surroundings to the extent that those surroundings directly affect or are affected by his physical or biological surroundings.

3.7.2 Policy and guidance

- Environmental Factor Guideline Social Surroundings (EPA 2016e)
- Guidance for the Assessment of Environmental Factors, Assessment of Aboriginal Heritage No. 41 (EPA 2004)

3.7.3 Consultation

The OEPA was consulted on 21 February 2017. This pre-referral meeting discussed the Proposal including activities and potential impacts relating to social surroundings.

Local landowners have been consulted from September 2016 to February 2017 to date. Discussions with landowners include information regarding the proposal and negotiating land access (where possible) to conduct supporting technical studies.

The BBM Community Liaison Committee has also been informed of this proposal.

Worsley will consult with the Department of Aboriginal Affairs, the South West Land and Sea Council (SWALSC) and the Gnaala Karla Booja (GKB) WC1998/058 Native Title Claim with regard to Aboriginal heritage matters associated with this proposal.

3.7.4 Receiving environment

Cultural

European heritage

Database searches were undertaken to determine if the mining extension area would impact on World Heritage sites or Commonwealth Heritage Sites. No sites were identified within the mining extension area.

A search on the inHerit Western Australia database identified three sites within the mining extension area listed as “Other Heritage Listings” including:

- Tullis Bridge – Municipal Inventory Adopted 18 Jul 2001 (Shire of Boddington)
- Jarrah Tree – Municipal Inventory Adopted 18 Jul 2001 (Shire of Boddington)
- Railway Line Precinct – Boddington to Dwellingup – Municipal Inventory Adopted 18 Jul 2001 (Shire of Boddington).

Aboriginal heritage

A search of the Aboriginal Heritage Inquiry System identified two 'Registered' sites of Aboriginal heritage significance, and 22 sites lodged as 'Other Heritage Places' that intersect with the proposed mining extension footprint.

Table 6 Registered Aboriginal Sites and 'Other Heritage Places' intersecting with the Hotham Mining Extension Proposal

Place ID	Name	Status	Type
20216	Archer's Farm - Caves	Lodged	Mythological, Rockshelter
20219	Dilyan's Burial and Additional Burial Site	Lodged	Historical, Skeletal Material / Burial
21471	Dukatj (34 Mile) Creek	Stored Data / Not a Site	Mythological, Camp, Water Source, Other: food source
4050	Wandoo Flats	Stored Data / Not a Site	Artefacts / Scatter
4126	Worsley Timber 3	Stored Data / Not a Site	Artefacts / Scatter
4175	Lower Hotham River 1	Stored Data / Not a Site	Artefacts / Scatter
4180	Mt Saddleback 20	Stored Data / Not a Site	Artefacts / Scatter
4198	Corridor 18	Stored Data / Not a Site	Artefacts / Scatter
4214	Siding Road	Lodged	Artefacts / Scatter
4223	Mt Saddleback 09	Stored Data / Not a Site	Artefacts / Scatter
4263	Boddington Forest 17	Stored Data / Not a Site	Artefacts / Scatter
4265	Boddington Forest 19	Stored Data / Not a Site	Artefacts / Scatter
4266	Boddington Forest 20	Stored Data / Not a Site	Artefacts / Scatter
4267	Boddington Forest 21	Stored Data / Not a Site	Artefacts / Scatter
4268	Boddington Forest 22	Stored Data / Not a Site	Artefacts / Scatter
4269	Boddington Forest 23	Stored Data / Not a Site	Artefacts / Scatter
4270	Boddington Forest 24	Stored Data / Not a Site	Artefacts / Scatter
4276	Boddington Forest 30	Stored Data / Not a Site	Artefacts / Scatter
4291	Westrail Survey 04	Stored Data / Not a Site	Artefacts / Scatter
4304	Boddington Forest 05	Stored Data / Not a Site	Artefacts / Scatter
5256	Quindanning Farms 05	Stored Data / Not a Site	Artefacts / Scatter
18447	Thirty four mile brook, north bank	Stored Data / Not a Site	Artefacts / Scatter
27935	Hotham River	Registered Site	Mythological
17214	Mt Saddleback (Mokine)	Registered Site	Mythological

WARU Consulting Pty Ltd (WARU) (2012) was commissioned to confirm the locations of 15 Aboriginal heritage sites known within the active mine tenements and activities. Based on the outcome of the archaeological assessment 8 of the 15 Registered Sites' existence and position were verified including Site No. 4049, 4052, 4054, 4057, 4060, 4063, 4138 and 4230.

Brad Goode and Associates Consulting Anthropologists and Archaeologists (Brad Goode) (2015) was commissioned to undertake a Site Identification Ethnographic Aboriginal Heritage Survey. Brad Goode confirmed the location and extent of Mt Saddleback (Mokine) Aboriginal Registered Site (No. 17214). In addition, the Gnaala Karla Booja WC1998/058 Native Title Claim group (GKB) advised Brad Goode that this Site was of special importance and any disturbances within the buffer should be avoided. The GKB also reported a male initiation site, corroboree site and ochre deposit within the vicinity of the Mokine Site located east of Fletcher Road,

however this Site could not be located. Based on the outcomes of the report, Brad Goode recommended further consultations with the GKB, ethnographic consultation and an archaeological inspection for a site east of Fletcher Road.

Brad Goode is currently completing a due diligence study for the mining extension area. Archaeological and/or Ethnographic surveys will be undertaken upon finalisation of the mining footprint.

Land use

The mining extension area is predominately within private property and Crown Land. Crown Land includes the Marradong and Saddleback Timber Reserves. DPaW manages the Timber Reserves for timber production, recreation and biodiversity conservation. The mining extension area also falls within a State Managed Forest Products Commission *Eucalyptus saligna* Plantation.

Picnics, camping grounds and walking trails that form part of the Bibbulmun walking trail lie within and adjacent to the existing PBA in the northern extent. An undesignated mountain bike trail also lies within the mining extension area.

Noise

Mining operations result in emissions of noise and vibration, which may impact on the amenity of nearby residents (Strategen 2005) and structural integrity of heritage sites. Mining occurs on a continuous basis (24 hour operations) and is subject to Worsley's noise management strategy, which ensures compliance with noise regulations (*Environmental Protection (Noise) Regulations 1997*) through modelling and monitoring.

Background noise levels during the night in the existing BBM region are typically very low and are dominated by agriculture and traffic related noise. Existing mining operations are situated predominantly in State Forest with few residential noise sensitive receptors, or on private land consisting of a small number of isolated premises. Several such premises are relatively close to mining operations, some of which are located within 500 m. The extent that mining noise may be audible at residences is strongly dependent on atmospheric conditions, proximity to mining activities and local topography. Noise characteristics include the noise level, but also tonality, duration and impulsiveness.

Approximately 40 sensitive receptors (residents of agricultural properties) are located within 5 km of the mining extension area. A technical noise modelling study has been commissioned for the Hotham Mining Extension proposal, which will locate all current sensitive receptors within the mining extension area.

Demography

The Worsley Bauxite-Alumina Project operates in the South West, Peel and Wheatbelt Regions of Western Australia. The BBM is located near the town of Boddington and in the Peel Region. Boddington town site has a population of approximately 2,523 (ABS, 2017). The Peel region of Western Australia has a population of 98,693 (ABS, 2017). Construction is the key local industry sector accounting for 13.7% of employment, with mining accounting for approximately 7.3%.

Visual amenity

The Darling Plateau is characterised by an expansive undulating landscape with green forest vegetation and occasional rocky outcrops and peaks. Changes to amenity are greatest in areas with a high perceived scenic amenity value and are visible from public locations, such as roads, walk trails and lookouts (Strategen 2013).

The existing operation is visible from public roads, the Bibbulmun Track and a number of elevated locations. Bibbulmun Track users generally experience an enclosed view, with the exception of high points along the track where the canopy vegetation reduces and views extend across the landscape (Strategen 2013). The mining extension area will become a more dominant feature of the landscape when viewed from high points, however the mining extension area is in primarily agricultural land that does not have a high perceived amenity.

3.7.5 Proposal activities

Proposal activities that have the potential to impact social surroundings include clearing and mine operations associated with the Hotham Mine Extension. Noise would be generated by the implementation of the Proposal through construction and operational activities, including blasting and excavation, haulage, disposal activities, audible warning signals (such as reversing alarms and signals), off-site transport activities.

The Refinery Production Increase does not require any activities that have the potential to impact social surroundings. Increasing the volume of alumina produced will not result in an increase in noise. Therefore, there are no receiving environments for this Factor and the Refinery Production Increase is not discussed further in this section.

3.7.6 Potential impacts

The following potential impacts may occur to the social surroundings as a result of the Hotham Mining Extension:

- Heritage site disturbance through clearing/excavation or blast vibration
- Noise and vibration impacts to sensitive receptors from blasting, equipment operation and vehicle operation
- Changes to land use through land acquisition or access agreements for the mining extension area
- Reduced visual amenity whereby mining operations will become a more dominant feature of the landscape when viewed from above

The potential impacts will be further assessed during the following technical studies, which have been commissioned:

- Noise modelling and impact assessment
- Aboriginal Heritage Consultation and Assessment.

3.7.7 Mitigation

Worsley proposes to manage and mitigate the environmental effect of the Proposal to social surrounds through the implementation of:

- Landholder agreements for land uses that intersect or are in close proximity to the mining footprint
- Relocation of nearby sensitive receptors
- Consultation with the GKB and SWALSC, and potentially environmental approvals (section 18) through the Department of Aboriginal Affairs (DAA)
- Ongoing management of Aboriginal heritage through ongoing consultation
- Ensure that the Proposal complies with the requirements of the noise regulations through the implementation of the Noise Management Plan (Worsley 2014b, c), which includes

noise modelling to predict emissions from mining operations (noise and blast noise) and ongoing monitoring.

- Respond to community noise complaints and queries as specified in the Excessive Mining Noise Withdrawal standard (Worsley 2013a)
- Noise emissions associated with the Hotham Mining Extension will be controlled as described in the Noise Management Plan (Worsley 2014b, c) along with proposed management measures
- Minimising the environmental footprint associated with the mine pits and haul roads, through environmentally sound designs to minimise vegetation clearing
- Maintain vegetation buffers and planting of vegetation along boundaries to assist in screening the operations where they are visible to the public
- Progressively rehabilitate vegetation as per the Biodiversity and Forest Management Plan (Worsley 2016)
- Integrating mine landforms with the surrounding landscape, in accordance with standard mine closure planning management procedures.

3.7.8 Assessment of impacts

Worsley has commissioned a noise study for the Hotham Mining Extension which will assess the noise emissions from both the current and proposed mining extension and identify impacts on nearby sensitive receptors under worst case meteorological conditions. The results of the study will inform a risk assessment and determination of management measures required to ensure that noise emissions will remain in compliance with the noise regulations.

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