Draft Environmental Impact Statement
Nelson Bay River Magnetite Mine
(EPBC 2011/5846)

Prepared for: Shree Minerals

Prepared by: Dr Ian Woodward, Dr Michael Pollington, Charlie Livesey
28 November 2011

transport infrastructure | community infrastructure | industrial infrastructure | climate change




Images of Nelson Bay River mine site

pitt&sherry

Volume 1 of 2 – Main Report

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Cover images: Various locations on proposed mine site (Photos: pitt&sherry)

Authorised by: ______________________ Date: 28 November 2011
Dr Ian Woodward

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1. Purpose

The Minister for Sustainability, Environment, Water, Population and Communities, the Hon. Tony Burke, has determined that Shree Minerals' proposed Nelson Bay River magnetite and hematite mine is a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999*.

The Minister considered that the project was likely to have a significant impact on the following Matters of National Environmental Significance:

- Listed threatened species and ecological communities; and
- Listed migratory species.

The specific matters were:

- *Sarchophilus harrisii* (Tasmanian devil), Endangered;
- *Aquila audax fleayi* (wedge-tailed eagle – Tasmanian), Endangered;
- *Dasyurus maculatus maculatus* (spotted-tailed quoll), Vulnerable;
- *Prasophyllum pulchellum* (pretty leek-orchid), Critically Endangered;
- *Prasophyllum favonium* (western leek-orchid), Critically Endangered;
- *Haliaeetus leucogaster* (white-bellied sea-eagle), Migratory;
- *Myiagra cyanoleuca* (satin flycatcher), Migratory.

The Minister also determined that the project will be assessed using an Environmental Impact Statement.

The Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) has provided *Nelson Bay River Magnetite Mine (EPBC 2011/5886) Tailored guidelines for the preparation of draft environmental impact statement*.

This draft Environmental Impact Statement (EIS) has been prepared in accordance with those guidelines.

In accordance with the statutory assessment process, public comments on this draft EIS may be submitted to pitt&sherry, who will receive the comments on behalf of the proponent, Shree Minerals.

Comments may be submitted by post mail or by email.

The address for comment submission is:

Postal address:	Pitt & Sherry (Attention: Nelson Bay River Mine Project) GPO Box 94 Hobart, TAS 7001
Email address:	nelsonbayrivermine@pittsh.com.au

Following the closure of the public comment period, Shree Minerals will provide the Department with a Response to Submissions document and an updated EIS where appropriate. The Department will review the updated draft and direct Shree Minerals to publish a final EIS.

After assessing the final EIS, the Minister will make a determination on the proposal.

2. General information

For convenience, each major section of this document is prefaced with the relevant extract of the guideline requirements.

Guideline requirements for this section

The draft environmental impact statement must provide a description of the background of the proposed action including:

(a) the title of the proposed action
(b) the full name and postal address of the designated proponent
(c) a clear outline of the objective of the proposed action
(d) the location of the proposed action (including maps)
(e) the background to the development of the proposed action
(f) how the proposed action relates to any other actions (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved or proposed in the region affected by the proposed action
(g) the current status of the proposed action
(h) to the extent reasonably practicable, any feasible alternatives to the proposed action, including:
  - *i. if relevant, the alternative of taking no action*
  - *ii. a comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the proposed action; and*
  - *iii. sufficient detail to make clear why any alternative is preferred to another.*

2.1 Title of proposed action

The title of the proposed action is:

Nelson Bay River Magnetite and Hematite Mine.

2.2 Designated proponent

Name:	Mr Sanjay Loyalka
Title:	Chairman
Organisation:	Shree Minerals Limited
ACN / ABN:	130 618 683
Postal address:	Unit 4, The Pines Business Centre, 86 – 88 Forrest Street, Cottesloe, WA, 6011
Telephone:	08 61612068 (office); 0418166004 (mobile)
Email:	loyalka.sanjay@gmail.com

2.3 Objective of the proposed action

The objective of the proposed action is to develop a magnetite/hematite mine near Nelson Bay River in north western Tasmania. The site is located east of Couta Rocks and approximately 7 km northeast of Temma (see Figure 1).

For the first 1 to 2 years of the project, mining will involve the extraction of near-surface oxidised ore from an elongated shallow pit, to a down-dip depth of approximately 40 m (65 m RL). This ore will be transported without processing, other than crushing and screening, to Burnie on the north coast of Tasmania for shipping to markets (as Direct Shipping Ore, DSO). An alternative shipping port is Port Latta, to the west of Burnie.

After this initial period, ore will be extracted by open pit mining from a deeper, separate main pit using open cut mining. The main pit ultimately will be developed to a depth of approximately 225 m (-145 m RL). The ore from the main pit will be beneficiated in an onsite processing plant prior to road transport to the shipping port[1].

2.4 Location of proposed action

	Latitude			Longitude		
Location point	degrees	minutes	seconds	degrees	minutes	seconds
Northwest corner	-41	8	31	144	43	27
Northeast corner	-41	8	33	144	45	35
Southeast corner	-41	10	10	144	45	32
Southwest corner	-41	10	8	144	43	24

The location of the proposed project is shown in Figure 1.

The site has no street address. It is accessed via Wuthering Heights Road (a Forestry Tasmania road) from Rebecca Road.

`[1] Although an alternative possibility is the transport of ore to an existing licensed processing plant under a commercial arrangement with the owner of that plant

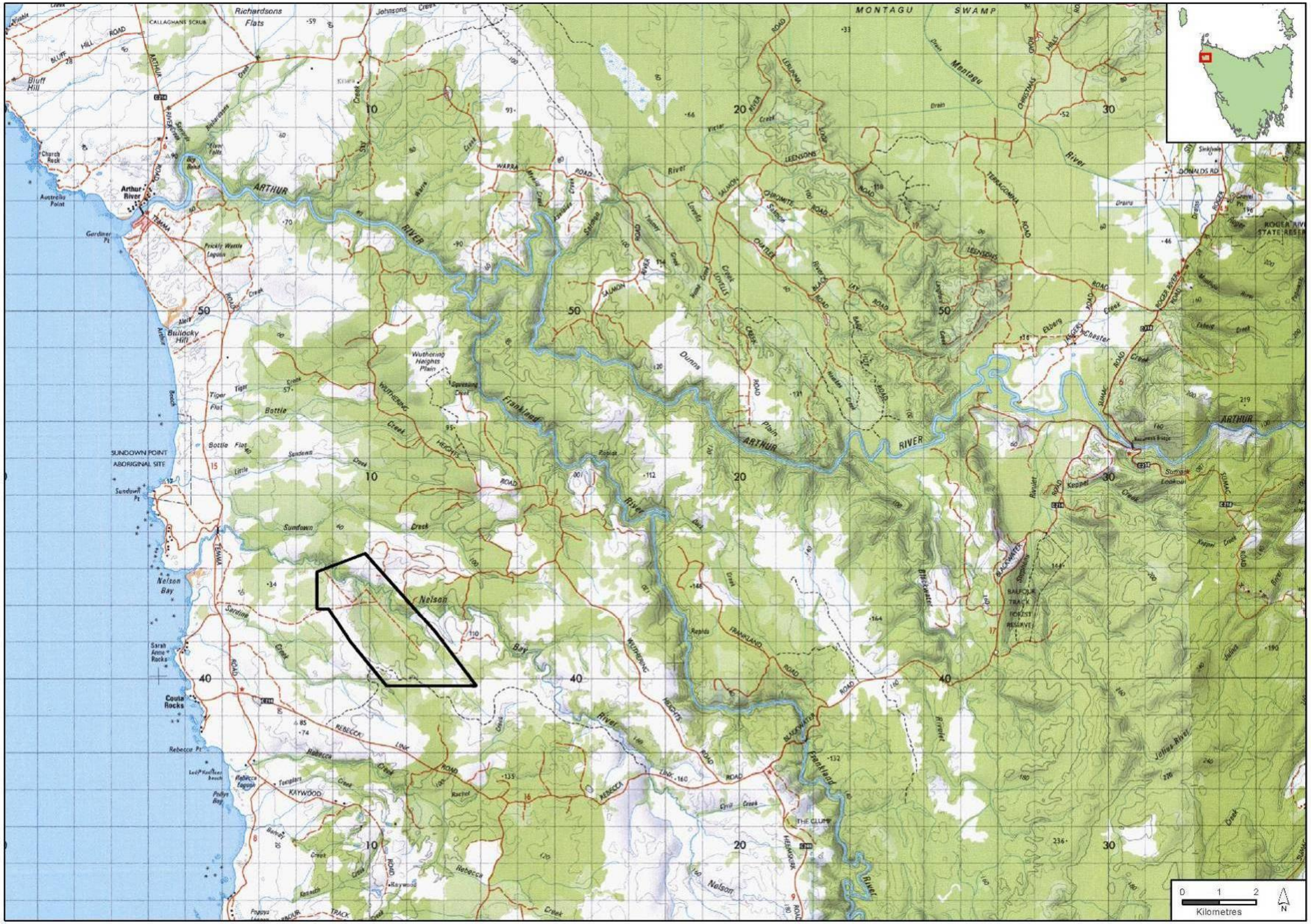


Figure 1: Local area map of proposed mine site (proposed lease boundary shown)

2.5 Background to the proposed development

Shree Minerals, an ASX listed mineral exploration company (ASX: SHH) has an interest in a diversified portfolio of exploration tenements located in Tasmania. Cornerstone investors in Shree include the ASX listed coal producer Gujarat NRE Coking Coal Limited (ASX: GNM) and China Alliance Holdings Group Limited, a Chinese investment group.

The Company's 100% owned Nelson Bay River Project, which is its most advanced exploration target, has significant iron resources, estimated as per the *Australasian Code for Reporting of Mineral Resources and Ore Reserves* (the 'JORC Code' or 'the Code') guidelines. The Company's other prospective exploration licences include Sulphide Creek (gold), Mt Bertha (iron, copper-gold, and magnesite) and Mt Sorell (base metals).

The Nelson Bay River resource is a magnetite (Fe_3O_4) deposit capable of producing a heavy media product suitable for coal washing and mineral separation (dense medium separation) or alternatively magnetite pellets for the iron and steel industry.

The present resource estimate, reported according to the JORC Code, is based on information from 24 diamond drill holes, with a combined length of 2,513 m. The global iron resource estimate is 12.6 Mt at 36.1% Fe, including magnetite resources and goethite-hematite resources.

The current mine plan is to target approximately 4 Mt (million tonnes) of the resource over a 10 year period. Targeting of the remainder of the resource will be developed while the initial 4 Mt is being mined. It is considered that the global resource could provide up to 30 years of mining at a production rate of 400,000 tpa (tonnes per annum).

Analyses indicate that the resource is ideally suited for the production of a marketable concentrate for either heavy media markets or pellet production.

2.6 Relationship to other actions

This project does not have any relationship to any other currently proposed actions.

2.7 Current status of proposed action

An application for a mining lease under the *Mineral Resources Development Act 1995* has been made to Mineral Resources Tasmania.

A Notice of Intent, under the *Environmental Management and Pollution Control Act 1994*, has been submitted to the Tasmanian EPA (23 March 2011). The EPA has provided guidelines for the preparation of the Development Proposal and Environmental Management Plan (DPEMP) for the project (18 May 2011). A draft DPEMP was submitted to the EPA for comment and a final DPEMP has been prepared following receipt of those comments. The DPEMP will be submitted to the EPA for assessment at approximately the same time that this EIS is submitted to the Commonwealth.

The State's assessment of the DPEMP and the Commonwealth's assessment of this EIS will be undertaken by each jurisdiction separately.

2.8 Feasible alternatives

The "no action" alternative would result in the benefits of the valuable resource being foregone. There are no economically feasible alternatives to how the mining could be undertaken.

There are feasible alternatives to how the mine infrastructure could be arranged. However, these alternatives would have a greater environmental impact. The proposed arrangement will have the least environmental impact of all the alternatives.

3. Description of the proposed action

Guideline requirements for this section

The draft environmental impact statement must contain enough information about the proposed action to allow the Minister for Sustainability, Environment, Water, Population and Communities (the Minister) to make an informed decision whether or not to approve under Part 9 of the EPBC Act (for the purposes of each controlling provision) the taking of the proposed action.

Provide a description of the proposed action, including:

(a) all the components of the proposed action

(b) the precise location of any works to be undertaken, structures to be built or elements of the proposed action that may have relevant impacts, including illustrations or maps

(c) how the works are to be undertaken, including design parameters for structures or elements of the proposed action that may have relevant impacts.

3.1 General

Shree Minerals Limited proposes to extract magnetite and hematite ore by open cut mining.

The main ore body for current targeting is located close to Nelson Bay River and will be extracted by developing a pit to a depth of approximately 225 m (-145 m RL). This ore will be beneficiated in an on-site processing plant prior to road transport to the port of Burnie (or Port Latta) on the north coast of Tasmania.

The processing plant will be constructed south of the main ore body, close to the access point to the mine site.

Processing of magnetite will involve crushing and grinding, followed by dry magnetic separation and regrinding, then wet magnetic separation and filtering and finally drying to the transportable product.

In addition to the main pit, there is also an extended near-surface oxidised ore body, comprising direct shipping quality (Direct Shipping Ore, DSO) goethitic hematite. This ore will be extracted by shallow excavation to an estimated depth of approximately 35 to 40 m down-dip (60 to 65 RL) and transported directly to the port, with the only beneficiation likely to be crushing and screening. The final depth of this pit will depend on further exploratory drilling that will be undertaken as the pit deepens.

The DSO will be the initial extraction target for the first 1 to 2 years, while the main pit is being developed and the processing plant is being constructed.

It is expected that the full DSO pit and the upper 20 m (oxidised layers) of the main pit will be free-dig mining, requiring no blasting. Blasting is only anticipated in the main pit, below the free-dig horizon.

Oxide ore (hematite) will be produced from the main pit in year 2 and the first three months of year 3. Thereafter, all production from the main pit will be magnetite ore. The expected mine life for the combined DSO/main pit operation is 10 years.

Anticipated ore and concentrate production rates are summarised in Table 1.

Table 1: Anticipated mine life ore and concentrate production rates

Year	Annual ore production	Cumulative ore mined	Oxide ore[1]	Magnetite ore	Concentrate	Product shipped out
	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
1	394,181	394,181	~355,000[2]	-	-	~355,000
2	384,372	778,553	~346,000[3]	-	~242,000	~242,000
3	407,034	1,185,588	~36,000	366,331	~156,000	~156,000
4	400,551	1,586,139	-	400,551	~150,000	~150,000
5	396,848	1,982,987	-	396,848	~150,000	~150,000
6	381,561	2,364,547	-	381,561	~150,000	~150,000
7	383,107	2,747,655	-	383,107	~150,000	~150,000
8	426,805	3,174,459	-	426,805	~150,000	~150,000
9	386,981	3,561,440	-	386,981	~150,000	~150,000
10	274,636	3,836,076	-	274,636	~150,000	~150,000

[1] ROM recovery rate is expected to be 90% of production rate
[2] Production from DSO pit
[3] Production from main pit (and thereafter for subsequent years)

The planned production rate from the main pit is an average of 150,000 tpa (product). During the first year, when the DSO pit, is operating the transport task would be approximately 350,000 tpa. The expected mine life for the combined DSO/main pit operation is 10 years.

Subject to further exploration work that will be undertaken as the mining proceeds, a second stage of the mine could extend this life by targeting additional parts of the resource. This would be the subject of a separate mine plan and environmental approval.

3.2 Mine setting

Resource

The resources at the site consist of approximately 1.0 km in strike length of hematite-goethite mineralisation within an ultramafic dyke with magnetite resources extending over approximately 400 m of this strike length. Recent ground magnetic surveys, however, indicate that the mineralised strike length may be in excess of 2.3 km. Mineralisation remains open along strike and at depth.

The magnetite ore, which occurs beneath the beneficiable oxide zone at the northern end of the deposit, lies within the ultramafic dyke that outcrops at the surface. The dyke strikes generally northwest-southeast, dips to the southwest at an angle around 65^o, and is typically 10 m to 40 m thick.

The northern limit to open pit mining is constrained by the proximity of the Nelson Bay River. The river is some 10 m wide and occurs to the east and north of the deposit. The deposit is interpreted to extend some 100 m to the north to the other side of the river but this extension has not been included in the ore body. In addition to imposing mining limits, the proximity of the river places constraints on the location of out-of-pit waste dumps.

The overburden consists of Proterozoic sediments dipping to the east at angles around 60° to 70°. The topography is gently undulating between 90 m to 100 m above sea level. A variable layer of peat generally occurs at the surface.

Depth to base of weathering for the waste sediments is typically 20 m to 25 m whereas the oxidized dyke base of weathering extends beyond 40 m.

The dipping hanging wall and footwall sediments observed at site and in the core appear to be very competent with no obvious problems for mining. The bedding, dipping into the footwall and the observed contact of the dyke with the sediments indicate a competent footwall rock unit which can contain a footwall ramp for the mining operations.

The hanging wall waste/ore zone boundary appears to be defined by a hanging wall shear which should provide a good physical and visual separation between the waste sediments and the dyke. A second hanging wall shear was observed within the dyke with the significant magnetite ore occurring between this second shear and the footwall of the dyke.

The dyke footwall waste sediment boundary appeared in the core to be indurated and this may require special attention during mining to minimise the occurrence of loss and dilution at the contact.

Some areas of significant pyrite were observed in the core that could lead to potential acid drainage problems in the waste rock dump. This material will require appropriate management, including encapsulation.

The proposed location of the mine pits and associated processing facilities has been identified as the most suitable location and no viable alternative sites have been identified.

Mine site

The proposed mine site has been selected because it will result in the most efficient exploitation of the known mineral resource in this particular area. Mining of the resource as proposed by Shree Minerals will result in the minimisation of mineral resource loss during mining operations and also any long term sterilisation of resource.

Mine layout

A conceptual mine layout is provided inFigure 2, which shows the end of mine (10 year) footprint. Staging footprints (1, 5 and 10 years) are provided in Appendix A. Cross sections of the mine pits are provided in Appendix B. The landscape of the mine site is shown in Figure 3.

The layout is aligned from southeast to northwest, reflecting the underlying resource lineaments. Two creeks cross the mine site and these also have a southeast to northwest alignment. The creeks are un-named and for convenience will be referred to as West Creek and East Creek. The mine pits lie between these creeks and the mine infrastructure has been designed to also lie between them, so avoiding any significant lost of riparian habitat.

The vegetation between the creeks is largely *Eucalyptus obliqua* and *nitida* forest and western wet scrub, none of which are threatened communities. This will need to be progressively cleared for the mine. Sensitive wet heathland lies to the west of West Creek. The confinement of the mine infrastructure between the creeks means that there will be no impacts on this heathland. There is a small, isolated fragment of wet heathland above the main pit, which will be lost. Site surveys found no threatened plant species in this fragment.

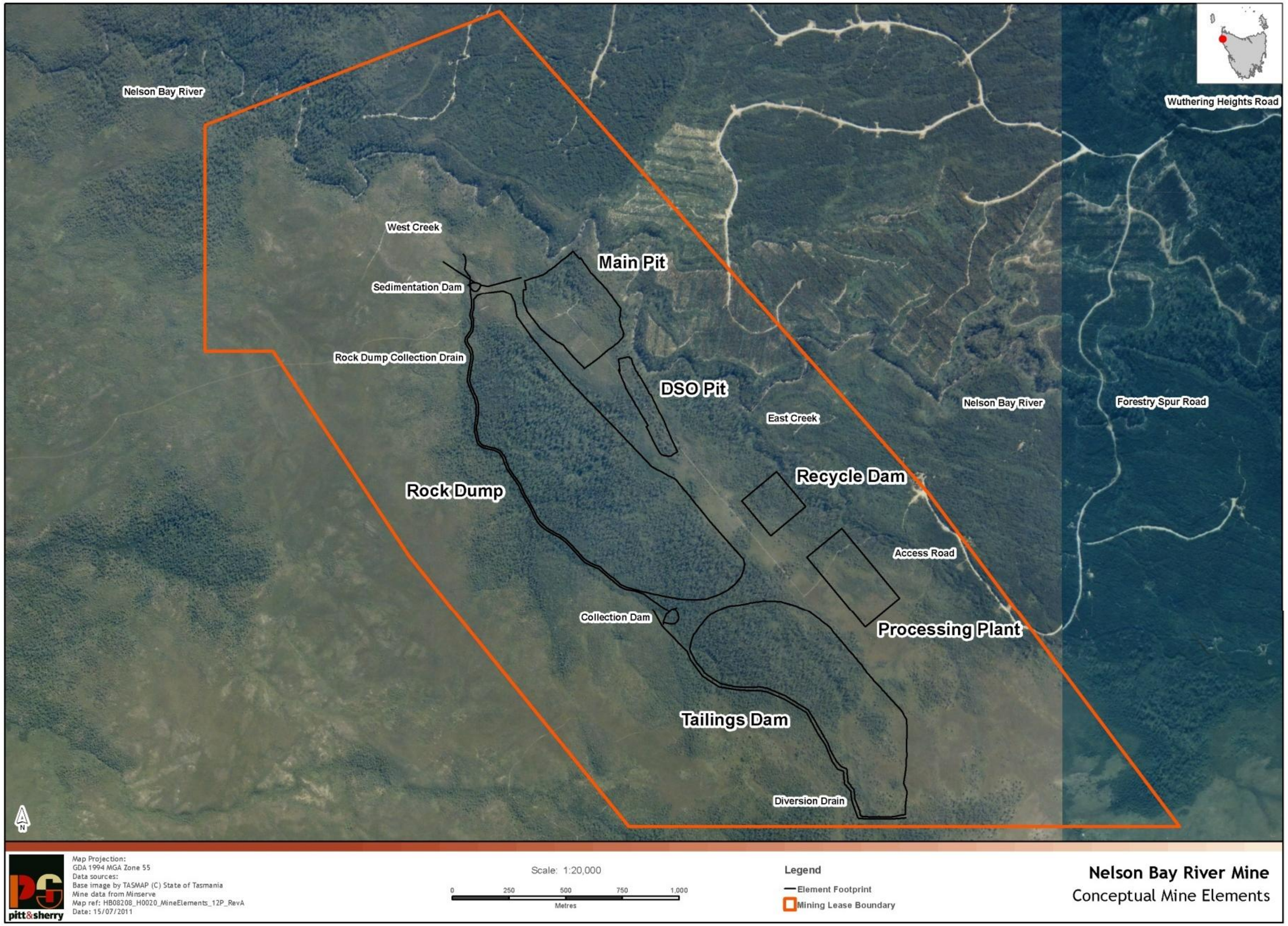


Figure 2: Principal mine elements (end-of-mine life footprint)

 Wuthering Heights Road approach to mine site (Photo: pitt&sherry)	 Vicinity of processing plant (Photo: pitt&sherry)	 Vicinity of the processing plant (Photo: NorthBarker)	 Central road along mine lease (Photo: pitt&sherry)
 Central road, vicinity of main pit (Photo: pitt&sherry)	 Exploration track commencement, vicinity main of pit (Photo: Wes Harder)	 Typical drill spur track, vicinity of main pit (Photo: pitt&sherry)	 Drill pad, vicinity of main pit (Photo: pitt&sherry)
 *Eucalyptus obliqua* forest, vicinity of waste dump (Photo: NorthBarker)	 *Eucalyptus nitida* woodland, vicinity of tailings dam (Photo: NorthBarker)	 Wet heathland in western part of lease (Photo: pitt&sherry)	 Wet heathland in western part of lease (Photo: NorthBarker)

Figure 3: Landscape of the mine site

The pits will be located at the northwestern end of the mine site. The waste rock dump will commence at the northwestern end and progressively grow to the southeast.

The proposed location of the ore processing facilities is approximately 1.2 km southeast of the pit, close to the access point to the mine site. A conceptual design of the processing plant is provided in Appendix C.

The proposed waste rock dump location has been chosen because it provides the most compact mine footprint, the shortest haul distances and it avoids incursion on significant vegetation to the west. In addition, a waste rock dump in this proposed location would be less visible from Rebecca and Temma Road than one located on the heathland to the west.

The tailings facility will be operated to recycle decant water into the beneficiation process via a recycle storage dam. Excess tailings dam water (from incident rainfall, will be sent to a central treatment plant, for neutralisation if necessary, prior to discharge to East Creek.

Both the tailings dam's overflow/seepage basin and the water recycle dam will need to have provisions for overflows, which will be to West Creek and East Creek respectively.

In the case of the basin, the West Creek runs for approximately 2 km before it reaches the river. In the case of the recycle dam, East Creek runs for approximately 500 m before it reaches the river. There would be no direct discharges to Nelson Bay River.

3.3 Hydrogeological conditions

A hydrogeological report[2] has been prepared by William C. Cromer Pty Ltd and is provided in Appendix D.

The mine site and environs are located on a coastal surface dissected by a dendritic drainage system. The surface is at elevations of about 80 – 100 m ASL near the proposed open pits, and on average slopes gently west at about 1^0.

Climatic data from the nearest meteorological stations are shown in Table 2. The mean annual rainfall at Temma (approximately 7 km southwest of the mine site) is 1300 mm. Annual evapotranspiration (ET) at Smithton Airport totalled 945 mm and 988 mm for 2009 and 2010 respectively, and exceeded mean monthly rain from November to March.

Effective annual rain (mean rain less ET for the period April to October) at the mine site is therefore estimated to be approximately 570 mm.

[2] Cromer, W. C. (2011) *Hydrogeological report, Proposed Nelson Bay River Magnetite Mine.* (Unpublished report for Shree Minerals Ltd. by William C. Cromer Pty. Ltd.).

Table 2: Climatic summary for Temma and Smithton airport Bureau of Meteorology stations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temma rainfall (mm)													
Mean	57	58	74	106	135	152	166	152	123	100	85	81	1300
Highest	134	186	221	219	283	238	278	266	217	213	166	245	1745
Lowest	8	7	14	31	50	60	56	39	48	34	14	3	929
Smithton airport evapotranspiration (ET; mm)													
2009	160	111	80	62	43	24	30	55	69	102	73	136	945
2010	154	127	105	63	44	29	27	44	64	91	109	131	988
Effective rain (mean rain less ET)													
2010	-97	-69	-31	43	91	123	139	108	59	9	-24	-50	572

The surface streams include Nelson Bay River and its tributaries West Creek and East Creek, and, in separate catchments to the southwest and north, Sardine Creek and Sundown Creek respectively.

Near the mine site, Nelson Bay River has cut through the coastal surface to base levels between 40 and 50 m ASL, so the local relief is up to 50 m and hillsides are steep.

Catchments (and groundwater and surface water sampling stations) are shown in Figure 4.

The approximate surface water catchment areas of West and East Creeks are 320 ha and 270 ha respectively. The estimated mean annual discharges of West and East Creeks to Nelson Bay River are about 1650 ML and 1400 ML respectively, based on effective rainfall.

Based on general hydrogeological principles, the geology of the district, and a review of drill core photographs, the rocks and ores of the mine site and environs are regarded as fractured, hard-rock, unconfined aquifers. In such an environment, effective rain (precipitation less evapotranspiration) flows overland to surface streams, or infiltrates through the unsaturated zone to the water table.

Shallow water less than a metre or so from the ground surface was recorded from bores GW5 and GW7 (see Figure 4 for locations). The former is in the lower reaches of West Creek, and the latter on almost flat, poorly drained ground. The remaining bores recorded water tables between about 5 and 10 m below ground.

A conceptual hydrogeological model for the mine site is shown in Figure 5.

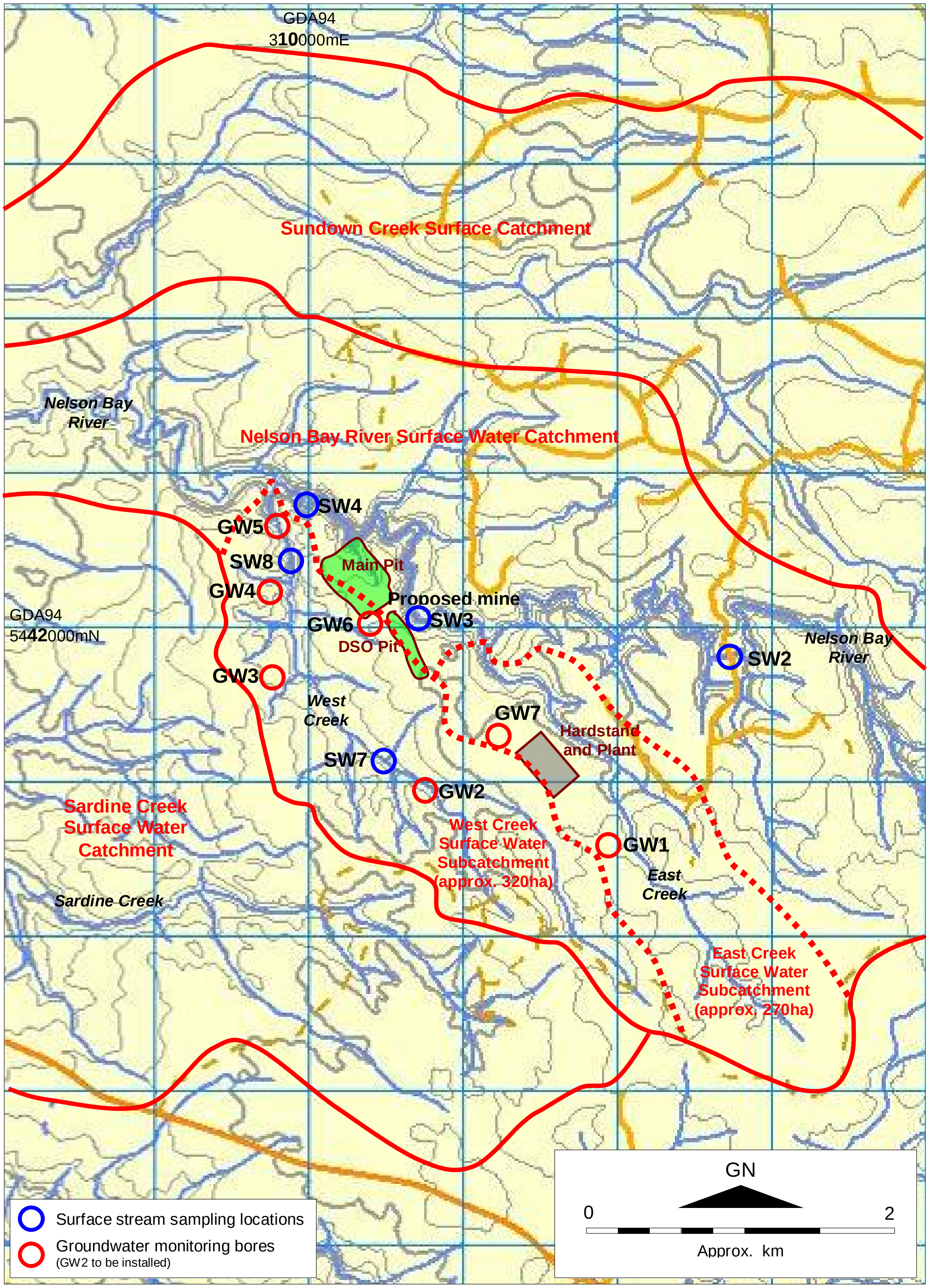


Figure 4: Surface water catchments near the proposed Nelson Bay River Mine. Mining operations will be contained within the Nelson Bay River catchment. Source: wwthelist.tas.gocv.au

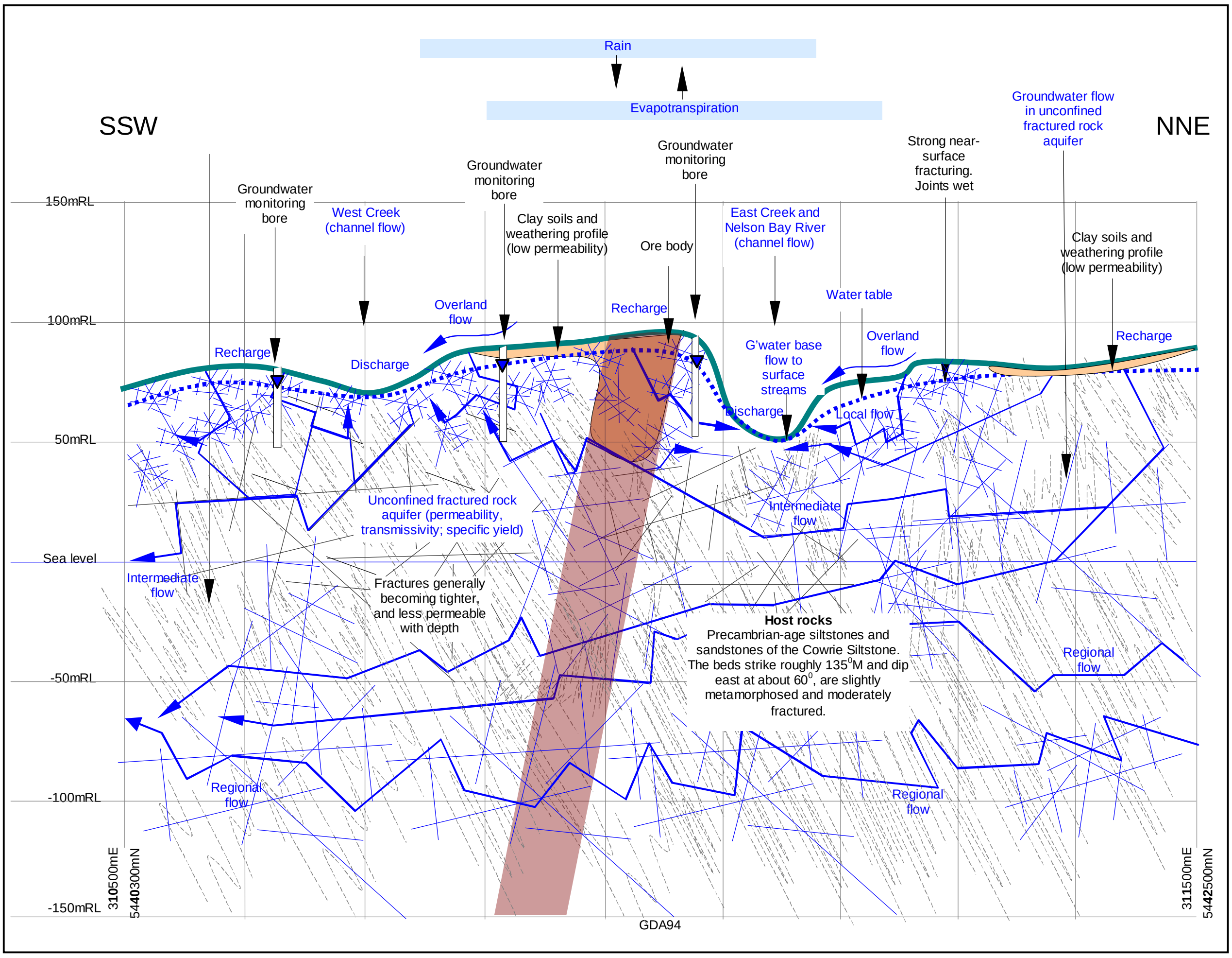


Figure 5: Conceptual hydrogeological model for the mine site (vertical exaggeration approximately 5)

The key features of the model are:

- No distinctive basement rocks but at depth overburden pressure will increasingly tend to close joints and other openings and at an intermediate-scale or regional-scale constitute a lower boundary to the groundwater system.

- The steeply easterly-dipping Cowrie Siltstone which constitutes a fractured rock aquifer. Fracturing is expected to be relatively intense at and near the surface, becoming less intense with depth. Permeability and specific yield are expected to be variable, but generally decreasing with depth. Groundwater moves only through the fractures, which separate essentially dry rock. (Other secondary porosity development might include vuggy dissolution `zones in carbonates within the Cowrie Formation).

- The steeply-west dipping mineralised zone, which is locally oxidised and weathered, and probably of lower permeability, near the surface.

- Fault zones, where present, may be more permeable than the country rock and the ore bodies.

- A regional water table is expected to be a subdued replica of the land surface, and intersects the land surface along drainage lines, at least in wet periods.

Near-surface groundwater flow is controlled by local systems, where flow lines are steep (equipotential lines are gently inclined) and recharge and discharge occur on hills and intervening valleys respectively. Such conditions are likely to extend beneath the level of West and East Creeks.

At increasing depths, flow becomes intermediate and then regional in scale, with equipotential lines steepening to near-vertical, and flow lines almost horizontal.

Figure 6 is a variation of Figure 5 showing conceptual effects of mine pit dewatering on the water table towards the end of open cut operations.

Conceptual groundwater inflows (using the Theis equation) to the mine pits are provided in Table 3.

Dewatering the Main Pit, and to a lesser extent the shallower DSO Pit, will lower ("drawdown") the water table in their vicinity, and if pumping is continued for a sufficiently long period, a near steady state condition will emerge where the lowering of the water table will cease. If pumping is stopped, the water table will rise.

Drawdown is greatest at pit and decreases radially away from it. The area of influence of a pumped bore or pit is contained within the radial distance to the point beyond which groundwater levels are unaffected by pumping.

Estimates for area of influence are provided in Table 4, based on assumed aquifer hydraulic conductivity and storativity and the final drawdown in the pit or bore.

An overlay of the distribution of wet heathland[3] on the surface drainage system in the area west of West Creek shows the habitat to be almost wholly located on a broad, gently-sloping interfluve in a groundwater recharge area. In this area groundwater beneath the heathland flows away from the heathland, not towards it, and groundwater therefore makes no contribution to the soil water of the heathland.

The heathland plants are shallow rooted species in peaty soil. Their soil water will be fed from above by rainfall, not from the water table below.

Dewatering of the pits during mining will lead to a drawdown of the water table in areas surrounding the pits. The effect diminishes with increasing distance from the pits.

Depending on the period and extent of dewatering the area of influence of the pit drawdowns may extend beneath the margins of the wet heathland west of West Creek.

[3] See Figure 2 of *Flora and Fauna Habitat Assessment: Nelson River – Shree Minerals Mine & Infrastructure Proposal*. Unpublished report for Shree Minerals by North Barker Ecosystem Services, 22 March 2001. (Appendix K)

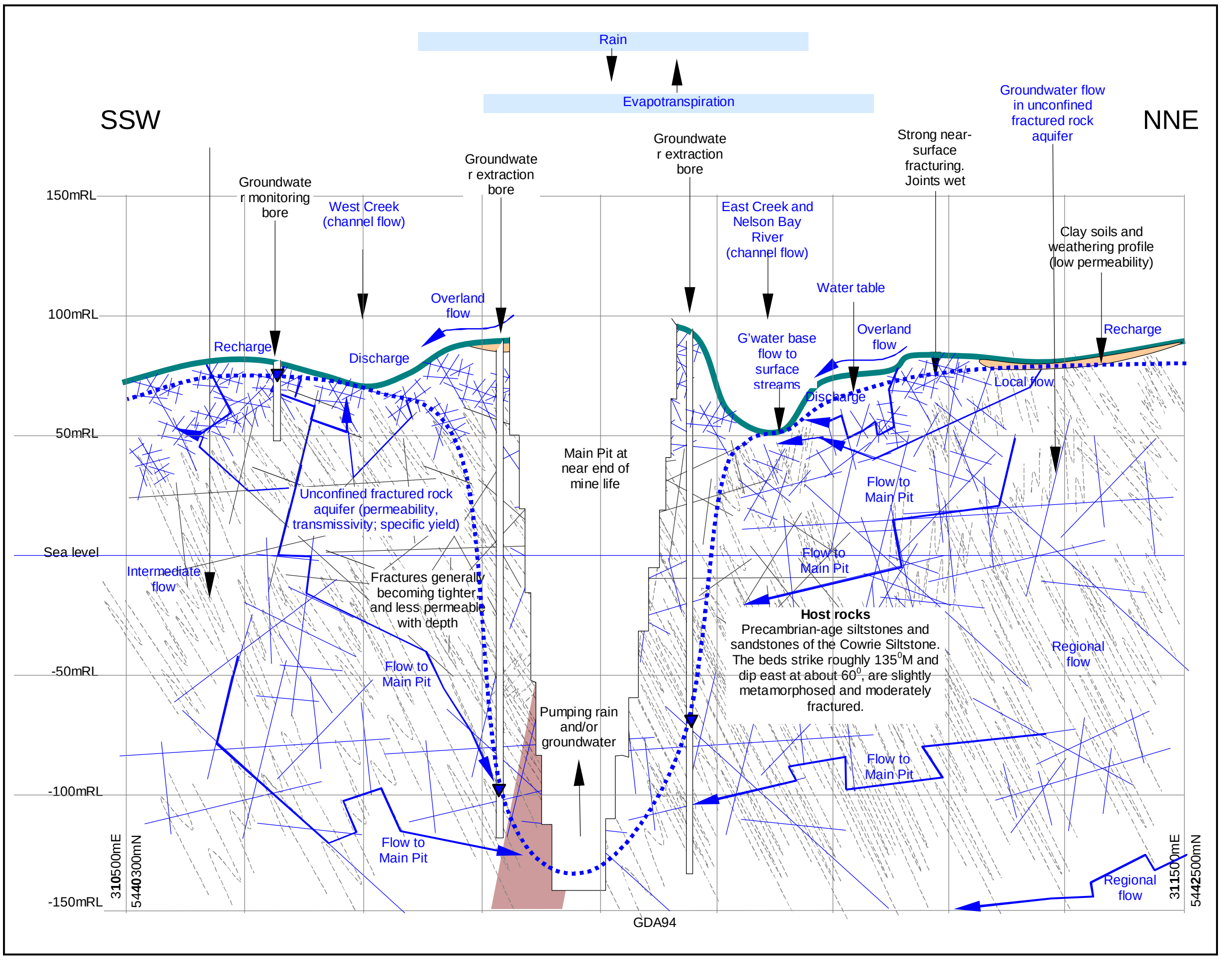


Figure 6: Conceptual hydrogeological model for the effects of pit dewatering (vertical exaggeration approximately 5)

Table 3: Estimates of groundwater inflow to the main and DSO pits assuming two values of hydraulic conductivity (Hy)

	Inflow (L/s)	Inflow (ML/yr)
Main pit (Hy = 0.1)	25	800 +/- 50%
Main pit (Hy = 0.05)	14	400 +/- 50%
DSO pit (Hy = 0.1)	8	300 +/- 50%
DSO pit (Hy = 0.05)	4	100 +/- 50%

Table 4: Estimates of groundwater areas of influence for near steady state dewatering of the Main and DSO pits assuming two values of hydraulic conductivity (Hy)

	Inflow (L/s)	Radius of influence (m)
Main pit (Hy = 0.1)	25	1200 +/- 20%
Main pit (Hy = 0.05)	14	800 +/- 20%
DSO pit (Hy = 0.1)	8	800 +/- 20%
DSO pit (Hy = 0.05)	4	350 +/- 20%

However, as stated, the wet heathland is in a groundwater recharge area, not a discharge area, and its soil water is therefore not dependent on the underlying water table. The heathland plants are shallow rooted species reliant on soil water from infiltrating rainfall, not from the underlying water table.

There is therefore no significant likelihood of the wet heathland soil water, and hence the ecosystems dependent on it, including threatened orchid species[4], being affected by the dewatering of the mine pits.

Although dewatering of the pits will remove groundwater that otherwise would have flowed into Nelson Bay River, all but the 0.1 Mm^3/a that will used as process make-up water will be returned to Nelson Bay River upstream of the pits (see Figure 7 in section 3.6). The mean annual flow of Nelson Bay River is 46 Mm^3 (Figure 7), so the make-up water lost from the river is only 0.2% of the river's mean annual flow. There will therefore be no significant impact on river flows downstream from the mine.

3.4 Mining methods

Mining will be from two pits: the DSO (shallow) pit and the main (deep) pit (see Appendices A and B).

DSO extraction will be by shovel and truck open cut mining. After removal of overburden, the DSO will be stripped in approximately 5 m flitches over lengths of a few hundred metres. Overburden will go to the waste rock dump (non-acid forming rock) or the DSO pit (potentially acid forming rock).

DSO will be hauled to the crushing and screening plant, which will be constructed at the processing plant site.

Ore extraction from the main pit will be by drill and blast, shovel and truck open cut mining. The upper 20 m of the resource is expected to be amenable to free-dig extraction; blasting is likely to be required at lower depths.

The ore will be removed in horizontal slices with a hydraulic excavator in backhoe mode loading rear dump trucks situated on the bench below. Pit ramps will be at 1 in 10 grade. At a nominal pit depth of 225 m, this means that more than 2 km of ramps will be required to access the bottom of the pit, which will preclude in-pit dumping of waste rock. All waste rock (apart perhaps from the final flitch) will therefore need to go to a separate out-of-pit waste rock dump.

Estimated mining quantities for the DSO and main pits are shown in Table 5, and annual waste rock material and ore production figures are shown in Table 7.

Based on the current resource information, a mine life of 10 years is anticipated.

[4] Mine dewatering is expected to have no impact on soil water conditions at and in the vicinity of the recorded location for the pretty leek orchid (*Prasophyllum pulchellum*) because the location is not only in a groundwater recharge area but is also outside the estimated area of influence of pumping.

Table 5: Mining quantities

Item	Total volume m^3	Specific gravity t/m^3	Tonnes	Strip ratio m^3/t	Strip ratio t/t	Years of production
DSO pit						
Total pit volume	857,895					
Ore volume	131,394	3.0	394,181	1.44	3.74	1
Waste	726,512	2.6	1,888,931			
Magnetite pit						
Total pit volume	11,904,082					
Oxide ore	141,692	3.0	425,075			1.25
Magnetite ore	815,357	3.7	3,016,820			7.75
Total ore	957,049		3,441,895	3.15	8.52	
Waste	10,947,033	2.6	28,462,286			
Both pits						
Total volume	12,761,977					
Total ore	1,278,692	3.0	3,836,076	2.97	8.00	10.0
Total waste	11,666,866	2.6	30,333,852			

NOTE: It is not possible to get these figures to exactly balance because they are based, in part, on assumptions (%'s, etc)

Table 6: Annual waste rock material and ore production

Year	Cumulative material movement (bcm)	Annual movement (bcm)	Cumulative waste mined (bcm)	Annual waste (bcm)	Cumulative ore mined (tonnes)	Annual ore mined (tonnes)
1	857,895	857,895	726,512	726,512	394,181	394,181
2	2,745,686	1,887,791	2,486,237	1,759,726	778,553	384,372
3	4,795,962	2,050,276	4,415,268	1,929,031	1,185,588	407,034
4	7,342,161	2,546,199	6,853,503	2,438,234	1,586,139	400,551
5	9,140,369	1,798,208	8,544,743	1,691,241	1,982,987	396,848
6	10,334,245	1,193,876	9,635,772	1,091,029	2,364,547	381,561
7	11,794,887	1,460,643	10,993,152	1,357,379	2,747,655	383,107
8	12,372,891	578,004	11,456,114	462,963	3,174,459	426,805
9	12,665,436	292,544	11,644,351	188,237	3,561,440	386,981
10	12,761,977	96,541	11,666,866	22,515	3,836,076	274,636

3.5 Haulage of ore and waste rock

Ore and waste rock will be hauled out of the pits to the natural ground surface along ramped roads. Haulage will be by 30–35 t rear dumps or articulated trucks.

Ramps for the shallow DSO pit will be simple and will move along the DSO resource as excavation proceeds along the DSO resource. Ramps for the main pit will move down as the pit deepens.

Ore will be taken to the processing plant via a haul road to be constructed. The out-of-pit haulage distance from the DSO pit to the crushing and screening plant will be approximately 1 km.

The out-of-pit haulage distance from the main pit to the processing plant will be approximately 2 km. The within-pit haulage distance will progressively increase to about 2 km when the main pit reaches maximum depth.

PAF waste rock will be taken to the DSO pit for encapsulated disposal. In the event that the DSO pit has insufficient capacity, excess PAF rock will be stored in encapsulation cells above the DSO pit. This excess material will be disposed of in the main pit on mine closure.

The majority of the NAF waste rock will be taken to the NAF waste rock dump. Potential other uses for NAF waste rock are discussed in section 3.7.

3.6 Ore processing

The conceptual design for the processing plant is provided in Appendix C.

Hematite

There are two distinct grade areas contained within the Nelson Bay River hematite deposit. Higher grade material occurs in the DSO pit and lower grade material occurs above the magnetite ore in the main pit.

The higher grade material will be prepared as a direct shipping ore (DSO). Processing of this product will simply be: mine, crush, screen and ship.

The lower grade hematite above the main pit is too low in iron and high in silica to be blendable with the higher grade for direct shipping. This material will require beneficiation.

The preliminary flowsheets for high and low grade hematite are provided in Appendices E and F.

Magnetite

Magnetite (and low grade hematite) ore will be processed at a plant to be located approximately 1.2 km southeast of the pit (see Appendix A).

Metallurgical test work has shown that the ore is readily able to be concentrated using simple processing. Coarse dry magnetic separation followed by wet magnetic separation has demonstrated an Fe grade greater than 69.0% and SiO_2<1.6%, Al_2O_3<0.05%, S<0.1% and P<0.01%.

A preliminary magnetite processing plant flow sheet is provided in Appendix G.

420,000 tpa of ROM ore will be crushed in the primary jaw crusher. The primary crushed ore is conveyed to the secondary screens for screening. Typically the material would be screened at 40 mm; however, this needs to be confirmed with test work to be undertaken during detailed design.

The oversize (+40 mm) ore from the secondary screen is conveyed to the secondary cone crushers. The crushed product is conveyed back to the secondary screens.

The secondary screen undersize (-40.0 mm) ore is conveyed to a buffer stockpile ahead of the high pressure grinding rolls (HPGRs). The purpose of the stockpile is to disengage the crushing and grinding sections, which have different operating availabilities.

Ore is removed from the stockpile by under ore feeders and conveyed to a series of bins to feed the three lines of HPGRs.

The HPGR ground ore is screened at 3 mm. This size is to be confirmed with further test work. The oversize is recycled to combine with the fresh feed and reprocessed through the HPGRs. The undersize (-3 mm) is slurried with water and pumped to the first stage of magnetic separation, the rougher wet low intensity magnetic separators (RW LIMS).

The RW LIMS separate the -3 mm ground product into magnetic concentrates (cons) and non-magnetic tailings (tails) streams. The tails are pumped to the tails thickener, reducing the amount to be further ground by ball mills. The rougher cons are reslurried with water and pumped to the ball mills. Grinding balls are added on an as need basis.

The ground material discharged from the ball mills is screened to remove ball scats and other oversize detritus with the undersize pumped (with additional process water added if required) to derrick screens for screening at 106 µm. This yields an estimated screen undersize product, P80 of ~75 µm. The oversize (+106 µm) is recycled to the ball mills for regrinding.

The -106 µm pulp is pumped to the secondary LIMS for further magnetic concentration and then is reslurried and pumped to the cleaner wet LIMS for final magnetic concentration. The secondary wet LIMS units separate the -106 µm ground product into mags (cons) and non-mags (tails) streams.

The cleaner wet LIMS concentrate, analysing ~68% Fe with other specified materials being within the required concentrate product specification, are repulped with process water and pumped to the concentrate thickener for partial dewatering.

The thickener underflow at 65%w/w solids is pumped to the concentrate filter. Filtered concentrate is stored in the concentrate storage shed before transporting to the shipping port via road.

The secondary wet LIMS and cleaner wet LIMS non-mag tails are pumped to the tailings thickener, combining with the rougher LIMS non-mag tails, and thickened and pumped to the tailings storage facility.

The tailings thickener overflow and concentrate thickener overflow flow by gravity to the recycle water dam for use in the operations.

Flocculent concentrations in the tailings are not expected to be significant because the flocculent molecules are tied up with the solids, making floccs. Any concentration of the flocculate, being fed to the thickeners, once it is diluted with the ore slurry, is expected to be of the order of grams per tonne of solution (including the material used to form the floccs). The vast majority of this material will remain with the solids in the tailings dam.

The mass balance of the magnetite processing plant indicates that there will be a significant loss of water to the tailings dam (22.7 tph to the dam and 11.4 tph returning), and a recovery of about 50% of this water from the tailings facility back to the recycle dam. Although this figure is high, it is considered to be reasonable, given the high rainfall and low evaporation rates of western Tasmania.

The basic mass balance for the magnetite process is summarised in Table 7.

Table 7: Basic mass balance summary for magnetite flowsheet

Stream data	Feed	After rougher magnetic separation	After secondary magnetic separation	After cleaner magnetic separation
Solid (tph)	53.3	32.2	22.6	19.2
Water (tph)	1.4	21.5	15.0	2.1
% solids (w/w)	97.5	60	60.0	90
Fe %	40.9	54.1	60.8	68.2
SiO_2 %	22.6	18.7	10.7	4.7

Water requirements

The concentrator is expected to be available for 7,884 hours per year. The process flowsheet (Appendix G) shows a process water requirement of 219.6 tph (tonnes per hour), giving a maximum annual requirement of approximately 1.8 Mt of process water, i.e. 1.8 Mm^3. This water will be a combination of recycled water and fresh make-up water.

As shown in the flowsheet, the water balance is 207.5 tph of return process water and 12.1 tph of fresh make-up water, i.e. 1,636,000 m^3 of recirculated water and 95,000 m^3 of fresh make-up water per year.

The estimated mine water budget is shown in Figure 7.

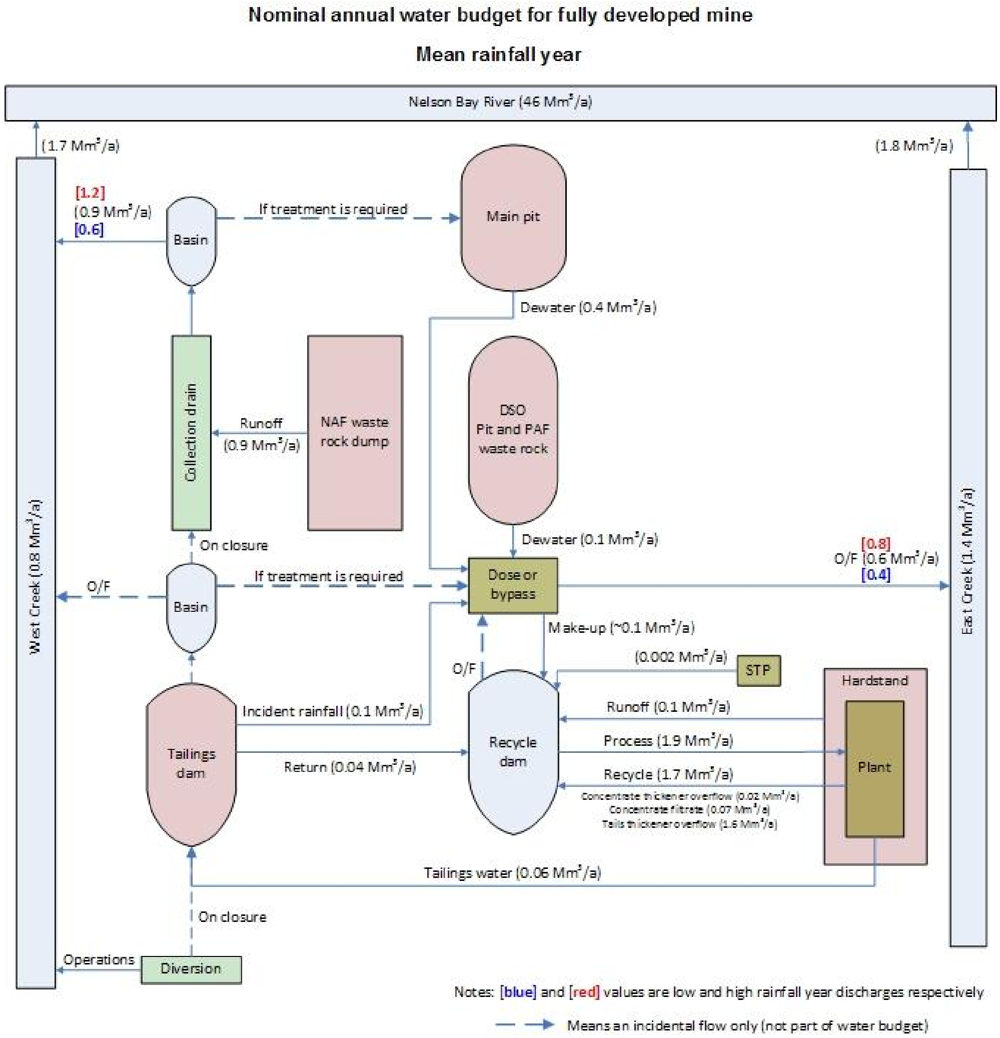


Figure 7: Nominal annual water budget for fully developed mine (mean rainfall year)

Normal practice is to have dam storage capacity for 2-4 weeks of the annual requirement. This equates to 136,500 m^3 of recirculated water and 8,000 m^3 of fresh water for one month's capacity.

The recycle water will be held in a dedicated dam, to be constructed near the processing plant. This dam will receive the decant from the tailings dam and its sedimentation basin. Make-up water will be supplied to the recycle dam from the DSO pit, which will accumulate its own water after the completion of mining, and from the main pit dewatering.

The DSO pit is expected to make at least approximately 100,000 m^3 of water per mean rainfall year, which will be enough to supply the make-up water needs, obviating the need for any extraction from Nelson Bay River.

Additional makeup water will also be available from dewatering of the main pit. The available amount will progressively increase as the main pit deepens, up to at least an estimated 400,000 m^3 per mean rainfall year at full pit development.

Assuming a 5 m deep dam the recirculation dam footprint area would be 165 m x 165 m. The proposed location of this dam will be to the north of the processing plant (see Appendix A).

Water management will evolve through various stages as the mine develops. This staging is shown in Appendix H.

3.7 Waste rock management

3.7.1 Disposal requirements

The ore body has a steep dip (65°) and a limited strike length (600 m). As a result, it will not be possible to undertake any backfilling of mined areas with waste rock whilst the main pit is operational. All waste rock from the main pit and DSO pit must therefore be transferred to out-of-pit dumps.

Based on current mine plans, approximately 0.7 and 11.0 Mm^3 of waste rock will be removed from the DSO and main pits respectively. This total waste rock volume of 11.7 Mm^3 will require approximately 13.9 Mm^3 of dump space, based on an assumed waste rock bulking factor of 1.2.

The approximate anticipated production of waste rock material over the proposed mine life is shown in Table 8.

Table 8: Waste rock production (estimated)

Year	DSO pit waste rock (m^3)	Main pit waste rock (m^3)	Cumulative waste rock (m^3)
1	726,512	-	726,512
2	-	1,759,726	2,486,237
3	-	1,929,031	4,415,268
4	-	2,438,234	6,853,503
5	-	1,691,241	8,544,743
6	-	1,091,029	9,635,772
7	-	1,357,379	10,993,152
8	-	462,963	11,456,114
9	-	188,237	11,644,351
10	-	22,515	11,666,866
Total	726,512	11,020,903	11,666,866

It is anticipated that the majority of the waste rock will be transferred to the waste rock dump but a significant amount may be used for construction of the following, subject to acceptable chemical and/or geotechnical properties:

- Tailings dam; use would be spread over the life of the mine
- Collection drain along the western side of the waste rock dump
- Sedimentation/collection dams
- Mine roads and standing areas
- Recirculation and make-up dams
- Construction pads for the process plant.

3.7.2 Waste rock material

Waste rock material will consist of:

- The country rock: predominantly quartz sandstone with lesser amounts of grey laminar bedded siltstone, of the Proterozoic Rocky Cape Group
- Some oxidised ore that is not of sufficiently high iron concentration for direct shipment
- Ultramafic dyke material
- Thermally metamorphosed sediments: dyke-country rock contact material (skarn).

Although early indications were that there was no significant pyrite or other sulphides in the ore and waste rock, subsequent analyses have indicated that the waste rock material will contain some pyritic material.

3.7.3 Waste rock dump location

The proximity of the pit to the Nelson Bay River limits the availability of adjacent areas for waste rock dumps.

The proposed location of the waste rock dump, which has an approximate footprint of 70 ha, is shown in Appendix A. This location provides for the most compact mine footprint and the shortest waste rock haul distances. It also avoids any impact on significant vegetation further to the west, including the extensive population of the rare (TSPA) heath *Epacris curtisiae* and a discrete population of the critically endangered (EPBCA) orchid *Prasophyllum pulchellum*.

A dump in this location would lie to the immediate west of both the main pit and the DSO pit, and would take advantage of natural drainage gullies, minimising visibility from the Rebecca and Temma Roads.

The alternative location for the rock dump, which would need to be on the wet heathland further to the west, is problematic. That location is on a broad, flat ridge lying between the Nelson Bay River and the Sardine Creek catchments and contains an extensive population of the rare (TSPA) heath *Epacris curtisiae* and a discrete population of the critically endangered (EPBCA) orchid *Prasophyllum pulchellum*.

3.7.4 Rock dump and drainage design rationale

Waste rock will be separated into potentially acid forming (PAF) and non-acid forming (NAF).
PAF waste rock will be encapsulated in clay inside the DSO pit. In the event that the DSO pit has insufficient capacity, excess PAF rock will be stored in encapsulation cells above the DSO pit. This material will be disposed of in the main pit on mine closure.

NAF waste rock not required for tailings dam and other mine site construction purposes will be disposed of in a separate waste rock dump situated on natural ground.

The initial concept design described in the Project Description and EPBC referral, and used to scope the project’s flora and fauna surveys, included a waste rock dump that straddled West Creek that runs through the proposed lease area into Nelson Bay River. The tailings dam would be located near the head of this creek.

The initial design also included a site cut-off drain that ran along the full length of the western edge of the mine site. In its northern half, the location of this drain largely followed the boundary between wet heathland to the west and the *Eucalyptus nitida* and *obliqua* forest to the east (where the dump would be located). The flora studies found that the wet heathland was suitable habitat for *Epacris curtisiae* and threatened orchids (*Prasophyllum pulchellum*). A design objective for the project therefore became to protect that wet heathland habitat. With this objective established, further orchid surveys were unwarranted because the orchid habitat itself will be protected and the precise locations of individual populations of orchids are therefore of no consequence.

The key potential risks to orchid habitat are direct physical impact from ground disturbance and changes to the hydrology of the wet heathland. With the original dump and cut-off drain layout, there would have been some marginal physical disturbance to the fringes of the habitat near the northern end of the cut-off drain. This disturbance would not be a significant impact on the habitat as a whole but it would nevertheless be contrary to the design objective.

The cut-off drain lay down-gradient from the heathland. Surface water would have run from the heathland to the drain (not the other way around) and the presence of the drain could therefore not have affected heathland soil water unless it was very close. For most of the length of the cut-off drain, the drain lay well away from the heathland and it could not have impacted on the heathland's hydrology. However, in the northernmost sections of the drain, where it intersected with the fringes of the heathland, the presence of the drain could have lead to a local sharp draw-down of soil water from the adjacent heathland because of its vertical excision into the soil horizons. Like the marginal direct physical disturbance, this local impact would not have been significant for the *Epacris* and orchid habitat as a whole but it would nevertheless be contrary to the design objective.

The initial concept design for the rock dump to straddle West Creek would also have had the obvious direct impact of the loss of the creek's riparian habitat. On the other hand, by taking advantage of the gully topography, the final height of the dump could be lower, so reducing its potential visibility from tourist roads at its full volume. In addition to these competing concerns, covering the creek with a rock dump would have required a flow-through rock dump or a creek diversion, both of which raise engineering and management complexities.

To avoid these impacts and complexities, the location of the NAF rock dump has therefore been shifted from its original concept position to now be located entirely on the eastern side of West Creek. This revised location avoids the loss of the creek's riparian habitat. The move also negates the requirement for the full site cut-off drain on the western side of the creek and therefore removes the potential impacts of the drain on *Epacris* and orchid habitat. The disadvantage of the move is that it reduces the available area of the dump's footprint and therefore increases the final height of the dump. However, much of the NAF waste rock appears to the suitable to be crushed and sold for beneficial reuse as, for example, commercial road base and the final volume of the rock dump is therefore unlikely to be as large as the theoretical maximum volume, meaning that the potential visibility concerns are diminished.

PAF waste rock will be identified at the mine working face and will be directed for disposal in the DSO pit where it will be encapsulated in clay. This will minimise the risk of acid formation and the in-pit location will provide a secondary security should any acid leakage occur. On mine closure, the DSO pit will be flooded, so providing permanent protection against acid formation. Excess PAF rock stored in encapsulation cells above the main pit will be disposed of in the main pit on mine closure. This pit will also be flooded on mine closure, also providing permanent protection against acid formation.

NAF waste rock will be stored in a separate dump to the west of the DSO pit. Drainage from the rock dump will flow westwards towards West Creek. This drainage will be intercepted before it reaches the creek by a collection drain that will be constructed parallel to the creek and at least 30 m away from it (so protecting the riparian habitat). The dump will grow southwards as mining proceeds and the collection drain will grow with it. The final length of the collection drain will therefore only need to be as long as is required by the size of the dump. The more waste rock that is taken off site for beneficial reuse (eg. for road base), the smaller the dump and the shorter the drain. The collection drain will terminate at its northern (downstream) end in a sediment settling basin, which will be off-stream. The basin overflow will discharge into the adjacent creek.

Although no PAF waste rock will knowingly be taken to this dump, the dump design with its collection drain directing seepage to a collection dam provides a mechanism to collect and treat for any acid drainage that unexpectedly does emerge.

As an additional security measure against unexpected acid drainage, appropriate sections of the collection drain could if necessary be lined with acid neutralising rock, such as dolomite or limestone, which could be brought onto site for that purpose. Existing dolomite supplies are available along the product transport route and dolomite could be brought back to the site economically by back filling ore transport trucks. This would only need to be a temporary neutralisation measure because any acid generation in the NAF dump would be incidental and short term. Lined drains are effective over the short term but become armoured and ineffective over the longer term.

To complement the modifications to the initial concepts of the rock dump and cut-off drain, the location of the tailings dam has also been modified by extending its southern boundary to the natural contours (rather than having a headwall). The tailings dam will be located near the head of West Creek. Location on the creek line reduces the volume of the dam wall but, more importantly, facilitates permanent flooding of the dam following mine closure. The headwaters of the creek above the tailings dam will be diverted around the dam using a cut-off drain. The drain will be constructed with a top-up flow weir to allow creek water to flow into the tailings dam to maintain a constant water cover over the tailings, during both operations and after mine closure. A permanent water cover over the tailings dam will prevent oxidation of pyritic material in the tailings and hence prevent acid formation.

Free tailings water will be recycled by decant into the process plant's recycle dam and tailings water alone would not lead to the tailings dam overflowing. However, if rainwater fills the dam to overflowing, that overflow will discharge to an off-stream sediment settling basin, which will also have a return to the recycle dam. If the recycle dam itself fills to overflowing, excess water will be discharged to East Creek, via the acid neutralisation treatment plant if the pH is below the treatment threshold of pH 7. Both the tailings dam collection basin and the recycle dam will need to have provision for emergency overflows (to West and East creeks respectively) but such overflows would only occur in extreme weather events.

Depending on the rate of growth of the rock dump and hence its collection drain, either before or at mine closure the overflow from the tailings dam collection basin will be redirected to the rock dump collection drain.

3.7.5 Waste rock management

Inert material

The majority of NAF waste rock material will be disposed of in the NAF waste rock dump but variable amounts, subject to suitability of lithology and mineral content, will be used for the following:

- Construction of the tailings dam, including the various lifts in the dam wall that will be required over the life of the mine
- Mine site road construction
- Construction of the berm wall around the waste rock dump.

There is also the potential for NAF waste rock to be crushed and sold off-site for road base material.

Potential acid forming material

At DSO break-ground (within the first 6 months into the project), further exploratory drilling of the DSO and oxidised ore in the main pit will be undertaken and samples will be subjected to kinetic testing, including free draining column leach or humidity cell tests.

In year two, further exploration drilling of the main pit magnetite resource will be undertaken (while the overlying oxidised ore is being mined) and these samples will also be subjected to static and kinetic testing.

Throughout the mine's life, regular static and kinetic testing will be undertaken of pit wall material and in advance of mining if exploration drilling of new areas is conducted.

The existing block model for PAF material in both the DSO and main pits will be progressively refined as mining proceeds and this, together with regular geological inspections and active grade control at the mine face, will allow PAF material to be identified and separately managed to NAF material.

All PAF (and UC) waste rock will be disposed of within special encapsulation cell(s) within the DSO pit. In the event that the DSO pit has insufficient capacity, excess PAF rock will be stored in encapsulation cells adjoining the main pit. This material will be disposed of in the main pit on mine closure.

No PAF or UC material will be disposed of to the NAF rock dump.

3.7.6 Waste rock dump drainage control

Design of the waste rock dump will include a drainage collection and management system.

An appropriately designed collection drain will be constructed along the western side of the waste rock dump to collect all drainage off the dump surface and any seepage from within the dump.

All the drainage and seepage collected by drain will be directed to a sedimentation dam, as shown in the mine layout in Appendix A.

Construction of this drainage collection and control system will ensure that there is no movement of surface drainage or seepage from the waste rock dump area to West Creek.

Operational controls will ensure that no PAF or UC material will be disposed of in the NAF dump, so acid drainage from this dump is unlikely. If signs of acid runoff occur, however, water from the sedimentation dam will be pumped back into the main pit, from where it will in turn be pumped with the main pit's dewater to the acid neutralisation treatment plant.

Closeout rehabilitation of the dump could establish low vegetation commensurate with the wet scrub of surrounding areas.

While the location of the dump will require the clearing of *Eucalyptus nitida* and *obliqua* forest, this community is not of high significance and it has been subject to fire damage in the recent past. An alternative location for the rock dump, which would need to be on the heathlands further to the west, is problematic. That location is on a broad, flat ridge lying between the Nelson Bay River and the Sardine Creek catchments.

The heathlands have a high probability of containing threatened orchid and heath species (see section 6.1).

The vegetation community in the preferred location of the dump is not of conservation significance and surveys have found no threatened species in this area (section 6.1). Also, the drainage catchment is relatively small and the tailings dam and the rock dump will be in the same catchment, whereas the alternative location for the dump would split these two over two catchments. A single catchment means that tailings dam and rock dump water management can be an integrated system, as shown in Appendix H.

3.8 Acid generation potential

3.8.1 Pyrite content

The resource contains pyrite in varying proportions, as shown in Figure 8.

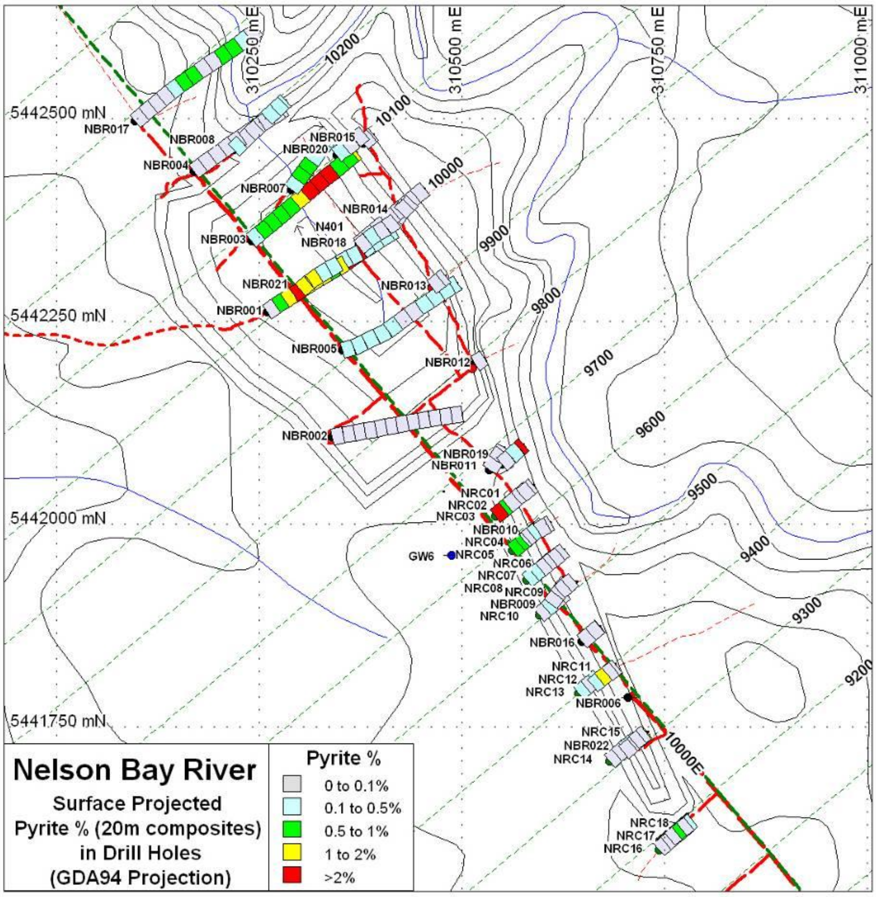


Figure 8: Pyrite content observed in drill holes

The core samples indicate that the occurrence of pyrite is not strata bound but occurs along fractures, joints and faults, with encrustations and veins having pinch and swell of varying size.

The waste rock is quartz sandstone with lesser amounts of grey laminar bedded siltstone. The occurrence of pyrite in the bulk of the waste rock is most commonly <0.5%, occurring in disseminated and to a lesser extent veinlet form.

As shown in the cored distributions in Figure 8, pyrite content varies considerably. It has a relatively high concentration near the 10100 m grid line (hole NBR003) but is more typically <1%. Strong pyrite zones will be readily visually identified and set aside for encapsulation.

Pyrite in waste rock, which is mostly quartz sandstone with lesser amounts of grey laminar bedded siltstone, is more commonly <0.5% as disseminated and, to a lesser extent, veinlet form. Strong (to ~15% in spots by visual assessment although only ~3% by sample analysis) disseminated pyrite is evident in association with pervasive silica alteration locally, being most prevalent west of the magnetite ore on sections 10000 & 10100N (hole NBR003). Disseminated and veined sulphide is also evident within skarn in both the footwall and hanging wall. This illustrates the variability in the distribution of pyrite, which is more likely to be found in discrete localised occurrences.

Skarn also often bears significant chalcopyrite, which can also be visually delineated and separated for disposal as PAF material.

The key sulphide mineralisation styles are:

- Disseminated most commonly within pervasive silica zones (eg. hanging wall in deposit centre)
- Sulphide veinlets and fracture fill
- Quartz – sulphide veining
- Disseminated sulphide in skarn
- Overall, pyrite is noted from 29% of the total metres drilled at NBR.

The principal lithologies are:

- Siltstones
- Sandstones
- Skarn
- Goethite hematite
- Magnetite.

3.8.2 Potential acid drainage

In order to determine the potential for acid drainage to occur at the mine site, as a result of mining operations, it is necessary to clarify / understand the following:

- How much of the waste rock will be:
  - Potentially acid forming (PAF)
  - Non acid forming (NAF)
  - Acid consuming (ACM)
- Where each of these types of rock is likely to occur (in relation to the mining plan)
- When each of these types is likely to be produced over the mine life (eg continuously, specific periods in the mining operation, etc)
- How readily / easily these materials will be able to be identified in the pits
- The likely timing and exposure of potentially acid forming materials
- The likely pyritic content of the tailings.

3.8.3 Geochemical sampling program

Detailed sampling and analysis has been undertaken to investigate the acid generation potential of the waste rock material. This has consisted of three programs:

- Composite sampling on holes NBR018 and NBR22, undertaken in 2010
- A more detailed program, undertaken in June 2011, on geological drill hole logs from the whole drill hole dataset, excluding the recent NBR012A to 014A metallurgical holes; appropriate samples were selected from these holes
- A round of K-NAG kinetic testing, undertaken in September 2011, on representative samples (holes NRC08, NRC13 and NRC17) from the DSO pit.

Analytical results have been interpreted in accordance with the AMIRA International ARD Test Handbook[5].

The AMIRA decision tree is shown in Figure 9.

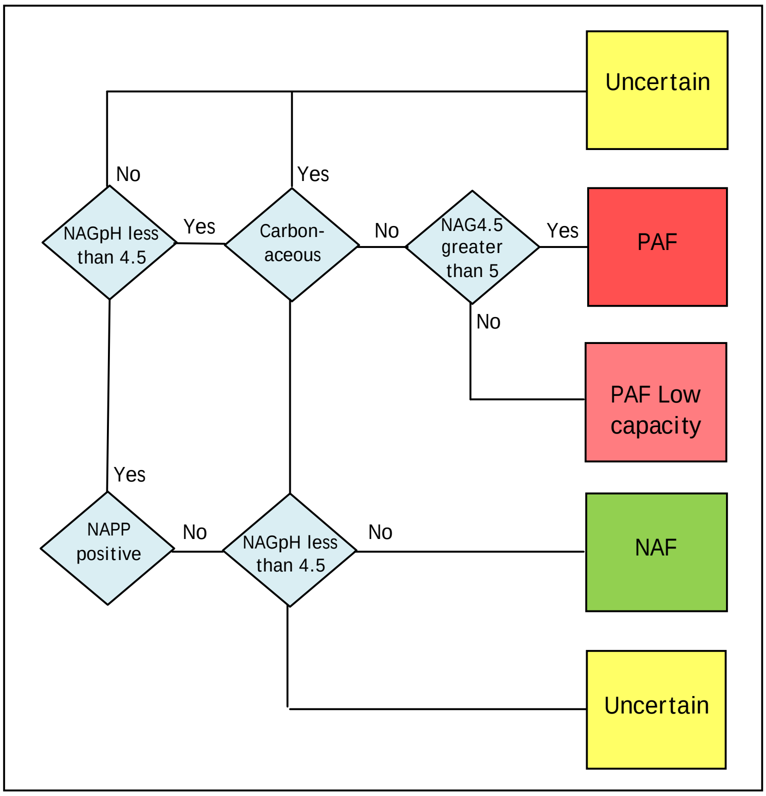


Figure 9: Sample acid classification decision tree (AMIRA)

[5] AMIRA International (May 2002) *ARD Test Handbook Project P387A Prediction & Kinetic Control of Acid Mine Drainage*.

2010 program

Sample intervals and rock type are shown in Table 9.

Table 9: Sample intervals for composite pyrite sample

Sample Number	Sample Interval (m)	Lithology
Drill hole NBR018		
367048	3.0 – 3.5	Laminated siltstone / minor sandstone
367049	6.6 – 7.1	
367050	10.0 – 10.5	
367051	16.0 – 16.5	Quartz vein
367052	23.0 – 23.5	Fine grained sandstone
367053	26.0 – 26.5	Fine grained sandstone
367054	32.9 – 33.4	Siltstone and fine grained sandstone
367055	36.8 – 37.3	Fine grained sandstone and siltstone
367056	45.3 – 45.8	Sandstone with minor siltstone
367057	49.0 – 49.5	Siltstone with minor sandstone
Drill hole NBR022		
367058	5.2 – 5.7	Siltstone
367059	9.0 – 9.5	Quartz sand
367060	13.7 – 14.2	Fault breccia; clay; sandstone, siltstone, skarn clasts
367061	20.0 – 20.5	Fault breccia zone; siltstone, sandstone, gossanous ironstone, pervasive silica
367062	21.7 – 22.2	
367063	26.3 – 26.8	
367064	28.5 – 29.0	

A composite sample for analysis was made, consisting of ten samples from NBR018 (from 3.0 – 49.5 m) and seven samples from NBR0222 (from 5.2 – 29.0 m). Borehole NBR018 was chosen because it is located in the region of highest pyrite content (the area between 10000 and 10100N) compared with the lower levels experienced elsewhere. The analytical report, summarised below, is contained in Appendix I.

2011 program

This program sampled drill holes from four key sections along the strike of the magnetite resource zone, to a depth within the confines of the modelled open cut, and three drill holes within the DSO resource vicinity. The sampling aimed to assess the spectrum of key lithologies and alteration types.

Core samples of 0.5 m were collected from various lithologies and alteration types and a photo and brief description were recorded for each sample. Each sample was at least 0.5 kg, the minimum sample weight required to undertake the required analyses. Details of the samples are shown in Table 10.

Table 10: Sample information for detailed acid accounting analysis

Sample Number	Net Mass (g)	Drill Hole	Sample Depth (m)	Lithology
45398	703.7	NRC08	28.0 – 29.0	Siltstone
45410	678.7	NRC08	39.0 – 40.0	Skarn
45524	720.0	NRC10	32.0 – 33.0	Quartz vein
45692	677.1	NRC13	42.0 – 43.0	Quartz vein
45694	586.7	NRC13	44.0 – 45.0	Medium grained sandstone
45764	721.7	NRC14	50.0 – 51.0	Siltstone
45769	719.4	NRC14	55.0 – 56.0	Siltstone
45760	483.5	NRC14	46.0 – 47.0	Siltstone
45949	463.0	NRC17	39.0 – 40.0	Skarn
520901	1125.1	NBR007	21.63 – 22.13	Siltstone
520902	1977.9	NBR007	85.5 – 86	Siltstone/sandstone
520903	1845.0	NBR003	22 – 22.5	Siltstone
520904	1528.8	NBR003	58.5 – 59	Siltstone
520905	1508.8	NBR003	79.5 – 80	Siltstone
520906	1043.8	NBR003	110.1 – 110.6	Siltstone
520907	1552.9	NBR021	7.6 – 8.1	Sandstone
520908	1378.5	NBR021	27.7 – 28.2	Sandstone
520909	1751.0	NBR021	45.2 – 45.7	Sandstone
520910	1517.7	NBR021	63 – 63.5	Siltstone
520911	1635.8	NBR021	84.95 – 85.45	Siltstone/fine grained sandstone
520912	860.1	NBR021	105.2 – 105.7	Siltstone
520913	845.7	NBR021	181.85 – 182.35	Sandstone
520914	1376.3	NBR005	35.5 – 36	Siltstone
520915	776.9	NBR005	95.9 – 96.4	Siltstone
520916	914.8	NBR005	137.9 – 138.4	Fine grained sandstone
520917	747.5	NBR021	53.9 – 54.4	Siltstone
520918	1503.3	NBR002	14.9 – 15.4	Siltstone
520919	1582.8	NBR002	50.3 – 50.8	Siltstone
520920	621.4	NBR002	77 – 77.5	Sandstone
520921	889.5	NBR002	93.6 – 94.1	Siltstone
520922	857.1	NBR002	124.5 – 125	Siltstone
520923	819.1	NBR002	169.5 – 170	Siltstone
520924	1010.1	NBR002	180.8 – 181.3	Siltstone
520925	769.0	NBR009	31.8 – 32.3	Siltstone
520926	914.4	NBR016	35 – 35.5	Sandstone
520927	880.3	NBR022	46.2 – 46.7	Sandstone
520928	844.1	NBR001	41 – 41.5	Siltstone
520929	936.0	NBR001	115.5 – 116	Siltstone

Sample Number	Net Mass (g)	Drill Hole	Sample Depth (m)	Lithology
520930	823.4	NBR001	161 – 161.5	Siltstone
520931	575.3	NBR001	189.3 – 190	Skarn

The representative samples were selected, logged and photographed. Most samples are from within relatively little weathered core, with sparse samples from partially oxidised near surface sampling. Sample selection was based partly on the basis of mineralogy and character and partly considering the variation down each hole. Sampling primarily focused on encompassing areas that would be included within the modelled pit. This included some sampling from the immediate footwall to the magnetite within shallower level holes.

Core overall was in good condition and had not experienced more than superficial surface oxidation.

The strongest pyrite alteration is associated with pervasive silicification in fine to medium grained sandstone in the hanging wall on section 10000N. Within the laminated bedded fine grained sandstone and siltstones, pyrite is disseminated within chlorite flecks / patches and is significantly weaker when compared to the more strongly silicified zones. Here pyrite reaches up to 1% but mostly <0.5%. Further SE on section 9900 (hole NBR005), similar disseminated pyrite on fine grained sandstone interbeds is significantly reduced, comprising trace overall in the top 115 m of NBR005, but locally forming concentrations to 1% over short intervals (<5m).

Skarn intervals worth sampling were sparse, with widths being narrow and the core commonly faulted and broken.

Carbonate acid neutralisation potential

There is no specific mention of carbonaceous sediment in the drill logs. A few zones of recognised carbonate veining were identified during the sampling program but overall quartz–carbonate veins (eg. NBR007 from 17.3 to 17.8 m) form a very small volume that is unlikely to contribute significantly to acid neutralisation potential. Furthermore, the NBR007 interval cited above is narrower than a likely minimum mining unit size.

Although extensive HCL (10%) testing of various lithologies was undertaken, no carbonate was identified.

Analytical program

The aim of the analytical program was to enable the determination of (as required by the Project Specific Guidelines):

- The occurrence and quantities of the acid and non acid forming materials and acid consuming materials
- The acid generating capacity of the ore
- The extent of element enrichment and leaching potential in waste rock and the potential for enrichment and leaching in tailings
- The identification of elements and concentrations that may be of concern based on background levels.

The analytical program consisted of the following:

1. TCLP (Toxicity Characteristic Leaching Procedure)
2. Acid Base Accounting & Net Acid Producing Potential, including:
   - Sulphur Suite (Total S, Sulphide)
   - MPA (Maximum Potential Acidity)
   - ANC (Acid Neutralising Capacity)
   - NAP (Net Acid Production)
   - NAG/NAGpH (Net Acid Generation)
   - K-NAG (24 hour kinetic Net Acid Generation)
   - pH / EC Test
   - Standard Metals Suite (incl. As, Cd, Cu, Cr, Hg, Pb, Ni, Sb & Zn).

All analytical work associated with this program was undertaken by SGS Metallurgical Services, a NATA registered laboratory based in Perth.

Static net acid generating potential tests

The results of the static tests for acid generation potential are provided in Error! Reference source not found..

Element enrichment and leaching potential in waste rock

TCLP analysis results are shown in Table 12.

No detectable levels of mercury, arsenic or cadmium were found in the waste rock samples analysed. There were variable levels of chromium (<0.005 - 0.22 mg/L), copper (<0.005 - 2.3 mg/L), lead (<0.005 – 4.4 mg/L), nickel (0.005 – 0.16 mg/L and zinc (<0.01 – 1.5 mg/L).

Table 11: Acid accounting analytical results

Sample	Drill Hole	Total S (%)	MPA (kg/tH_2SO_4)	ANC (kg/t H_2SO_4)	NAPP (kg/t H_2SO_4)	NAGpH	$NAG_{4.5}$ (kg/t H_2SO_4)	Geochem Class
2010 Analytical Program								
10638 Composite	NBR018	0.7	21	3	18	3.0	9.7	PAF
10638 / MB – 74198 Tailings composite*		0.121	3.5	11	<0	6.4	<0.5	NAF
2011 Analytical Program								
NBR07 non-mags (tailings)	NBR007	1.36	42	77	-36	5.8	<0.5	NAF
NBR08 non-mags (tailings)	NBR008	1.98	61	70	-11	4.8	<0.5	NAF
NBR021 non-mags (tailings)	NBR021	1.06	32	75	-43	6.3	<0.5	NAF
45398	NRC08	0.044	1.3	<1.0	0	5.6	<0.5	NAF
45410	NRC08	0.275	8.4	<1.0	8	3.6	2.2	PAF Low Capacity
45524	NRC10	0.116	3.6	<1.0	4	4.3	<0.5	PAF Low Capacity
45692	NRC13	1.98	61	3.5	56	2.5	27	PAF
45694	NRC13	0.331	10	1.4	8	5.2	<0.5	UC
45764	NRC14	0.266	8.1	<1.0	7	3.6	2.0	PAF Low Capacity
45769	NRC14	0.402	12	<1.0	12	3.3	3.7	PAF Low Capacity
45760	NRC14	0.16	4.9	1.6	3	4.1	<0.5	PAF Low Capacity
45949	NRC17	1.03	32	<1.0	30	2.9	10	PAF
520901	NBR007	0.04	0.96	3.2	-2	4.2	<0.5	UC
520902	NBR007	0.02	0.56	4.3	-4	6.6	<0.5	NAF
520903	NBR003	3.09	93	<1.0	92	2.3	49	PAF
520904	NBR003	0.65	18	1.9	16	2.8	13	PAF
520905	NBR003	0.67	19	2.0	17	2.8	14	PAF
520906	NBR003	0.78	24	2.2	22	2.7	17	PAF
520907	NBR021	0.07	2.1	1.2	1	3.8	1.0	PAF Low Capacity
520908	NBR021	0.71	21	<1.0	20	2.7	17	PAF
520909	NBR021	0.08	2.4	1.4	1	4.0	1.0	PAF Low Capacity

Sample	Drill Hole	Total S (%)	MPA (kg/tH_2SO_4)	ANC (kg/t H_2SO_4)	NAPP (kg/t H_2SO_4)	NAGpH	$NAG_{4.5}$ (kg/t H_2SO_4)	Geochem Class
520910	NBR021	0.28	8.4	1.2	7	3.2	5.0	PAF
520911	NBR021	0.52	14	<1.0	14	3.0	10	PAF
520912	NBR021	0.03	0.87	2.0	-1	5.4	<0.5	NAF
520913	NBR021	<0.005	<0.25	2.3	-2	4.5	<0.5	NAF
520914	NBR005	0.13	3.2	1.7	1	3.6	2.1	PAF Low Capacity
520915	NBR005	0.43	12	1.6	10	3.0	9.1	PAF
520916	NBR005	0.09	2.5	4.3	-2	4.7	<0.5	NAF
520917	NBR021	0.75	21	<1.0	20	2.7	17	PAF
520918	NBR002	<0.005	<0.25	3.2	-3	5.6	<0.5	NAF
520919	NBR021	0.09	2.5	4.7	-2	4.3	<0.5	UC
520920	NBR021	<0.005	<0.25	4.4	-4	6.2	<0.5	NAF
520921	NBR021	0.85	25	5.4	19	2.8	16	PAF
520922	NBR021	0.03	0.54	3.8	-3	5.4	<0.5	NAF
520923	NBR021	0.1	2.9	3.8	-1	5.2	<0.5	NAF
520924	NBR021	0.21	6.3	3.4	3	3.6	2.3	PAF
520925	NBR009	<0.005	<0.25	1.0	-1	6.5	<0.5	NAF
520926	NBR016	0.02	0.51	1.8	-1	6.4	<0.5	NAF
520927	NBR022	0.11	3.3	3.8	0	4.3	<0.5	PAF Low Capacity
520928	NBR001	0.46	11	<1.0	10	3.1	7.6	PAF
520929	NBR001	0.09	2.6	3.0	0	4.5	<0.5	PAF Low Capacity
520930	NBR001	0.14	3.6	5.2	-2	4.2	0.5	UC
520931	NBR001	0.56	17	11	6	5.0	<0.5	UC

*The tailings composite comprised all non-magnetics (non-ore) from the Davis tube testing program for samples between depths 51.6 and 77.4 m from NBR018

Table 12: Toxicity characteristic leaching procedure – metals

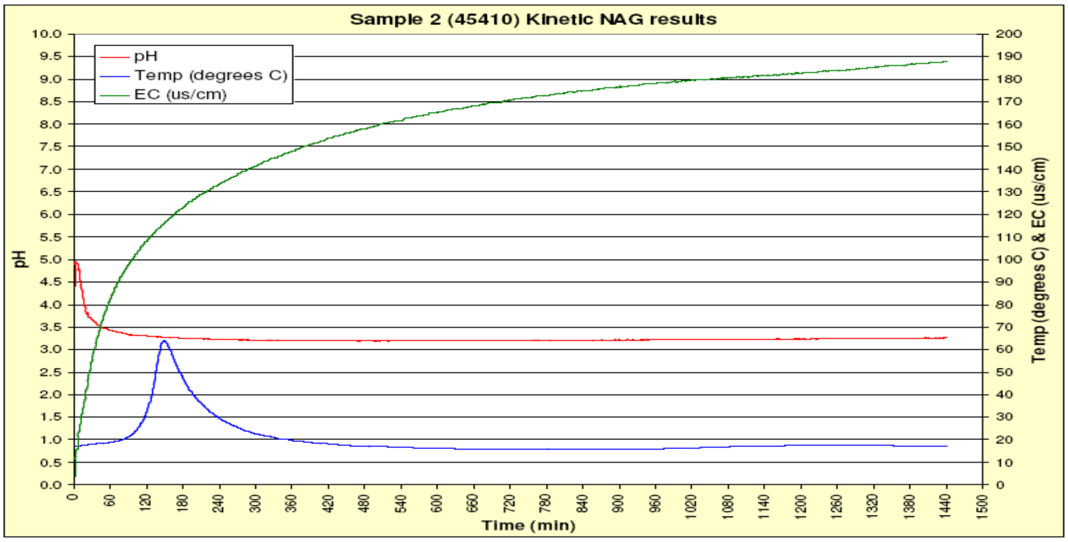
Sample	Drill Hole	pH TCLP (after 18 hrs)	Hg (mg/L)	As (mg/L)	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Ni (mg/L)	Zn (mg/L)
LOR			0.0005	0.02	0.001	0.005	0.005	0.02	0.005	0.005	0.005	0.01
2010 Analytical Program												
10638 Composite	NBR018	5.1	<0.0005	<0.020	0.001	<0.005	0.15	nd	0.088	nd	0.065	0.06
10638 / MB – 74198 Tailings composite		5.0	<0.0005	0.036	0.001	<0.005	0.69	2.6	<0.005	13	0.058	0.87
2011 Analytical Program												
NBR07 non-mags (tailings)	NBR007	5.0	<0.0005	<0.020	<0.001	<0.005	0.15		<0.005		0.16	0.26
NBR08 non-mags (tailings)	NBR008	5.1	<0.0005	<0.020	<0.001	<0.005	0.078		<0.005		0.028	0.16
NBR021 non-mags (tailings)	NBR021	5.0	<0.0005	<0.020	<0.001	<0.005	0.10		<0.005		0.062	0.23
45398	NRC08	4.9	<0.0005	<0.020	<0.001	0.13	0.014		<0.005		0.032	0.11
45410	NRC08	4.9	<0.0005	<0.020	0.001	0.051	0.014		<0.005		0.14	0.45
45524	NRC10	4.9	<0.0005	<0.020	0.001	0.022	2.3		0.007		0.071	0.22
45692	NRC13	5.0	<0.0005	<0.020	<0.001	0.14	<0.005		0.015		0.051	0.21
45694	NRC13	4.9	<0.0005	<0.020	<0.001	0.036	0.008		0.005		0.028	0.20
45764	NRC14	4.9	<0.0005	<0.020	<0.001	0.013	<0.005		0.010		0.030	0.21
45769	NRC14	5.0	<0.0005	<0.020	<0.001	0.025	0.092		0.23		0.051	0.20
45760	NRC14	4.9	<0.0005	<0.020	<0.001	0.0185	0.007		0.016		0.024	0.22
45949	NRC17	4.9	<0.0005	<0.020	0.001	0.054	0.25		0.11		0.16	0.88
520901	NBR007	5.0	<0.0005	<0.020	<0.001	0.007	0.005		<0.005		0.046	0.01
520902	NBR007	5.0	<0.0005	<0.020	<0.001	0.037	<0.005		0.16		0.008	0.02
520903	NBR003	4.9	<0.0005	<0.020	<0.001	0.010	0.079		0.009		0.13	0.06
520904	NBR003	4.9	<0.0005	<0.020	<0.001	<0.005	<0.005		<0.005		0.066	0.01
520905	NBR003	5.0	<0.0005	<0.020	<0.001	0.008	0.096		<0.005		0.047	0.03
520906	NBR003	5.0	<0.0005	<0.020	<0.001	0.009	0.008		0.040		0.022	0.01

Sample	Drill Hole	pH TCLP (after 18 hrs)	Hg (mg/L)	As (mg/L)	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Ni (mg/L)	Zn (mg/L)
LOR			0.0005	0.02	0.001	0.005	0.005	0.02	0.005	0.005	0.005	0.01
520907	NBR021	4.9	<0.0005	<0.020	<0.001	0.043	0.032		0.028		0.018	0.03
520908	NBR021	4.9	<0.0005	<0.020	0.001	0.089	0.021		0.019		0.14	1.5
520909	NBR021	4.9	<0.0005	<0.020	<0.001	0.14	0.021		0.024		0.012	0.03
520910	NBR021	4.9	<0.0005	<0.020	<0.001	0.005	0.026		0.034		0.031	0.05
520911	NBR021	4.9	<0.0005	<0.020	<0.001	0.013	0.016		0.017		0.10	0.02
520912	NBR021	4.9	<0.0005	<0.020	<0.001	0.008	0.007		0.008		0.007	0.01
520913	NBR021	5.0	<0.0005	<0.020	<0.001	0.22	<0.005		0.050		0.015	0.02
520914	NBR005	4.9	<0.0005	<0.020	<0.001	<0.005	0.011		0.12		0.031	0.02
520915	NBR005	4.9	<0.0005	<0.020	<0.001	<0.005	0.036		0.025		0.080	0.05
520916	NBR005	5.0	<0.0005	<0.020	0.001	0.035	<0.005		4.4		0.012	0.02
520917	NBR021	4.9	<0.0005	<0.020	<0.001	0.007	0.020		<0.005		0.085	0.02
520918	NBR002	4.9	<0.0005	<0.020	<0.001	0.006	<0.005		<0.005		0.009	0.04
520919	NBR021	5.0	<0.0005	<0.020	<0.001	0.011	<0.005		0.034		0.018	0.03
520920	NBR021	5.0	<0.0005	<0.020	<0.001	0.070	0.025		0.017		0.015	0.03
520921	NBR021	5.0	<0.0005	<0.020	<0.001	0.015	0.10		0.035		0.072	0.05
520922	NBR021	5.0	<0.0005	<0.020	<0.001	0.007	0.054		<0.005		0.021	0.02
520923	NBR021	5.0	<0.0005	<0.020	<0.001	0.005	0.051		0.027		0.028	0.02
520924	NBR021	5.0	<0.0005	<0.020	<0.001	0.010	0.006		0.010		0.023	0.01
520925	NBR009	5.0	<0.0005	<0.020	<0.001	0.027	0.009		0.035		0.005	<0.01
520926	NBR016	5.0	<0.0005	<0.020	<0.001	<0.005	0.37		0.87		0.027	0.03
520927	NBR022	5.0	<0.0005	<0.020	<0.001	0.019	0.005		0.036		0.060	0.02
520928	NBR001	4.9	<0.0005	<0.020	<0.001	0.016	0.062		<0.005		0.16	0.04
520929	NBR001	5.0	<0.0005	<0.020	<0.001	0.008	0.011		0.028		0.027	0.01
520930	NBR001	5.0	<0.0005	<0.020	<0.001	0.010	0.016		0.021		0.010	0.02
520931	NBR001	5.0	<0.0005	<0.020	0.001	<0.005	0.017		<0.005		0.011	0.13

LOR = Level of Reporting

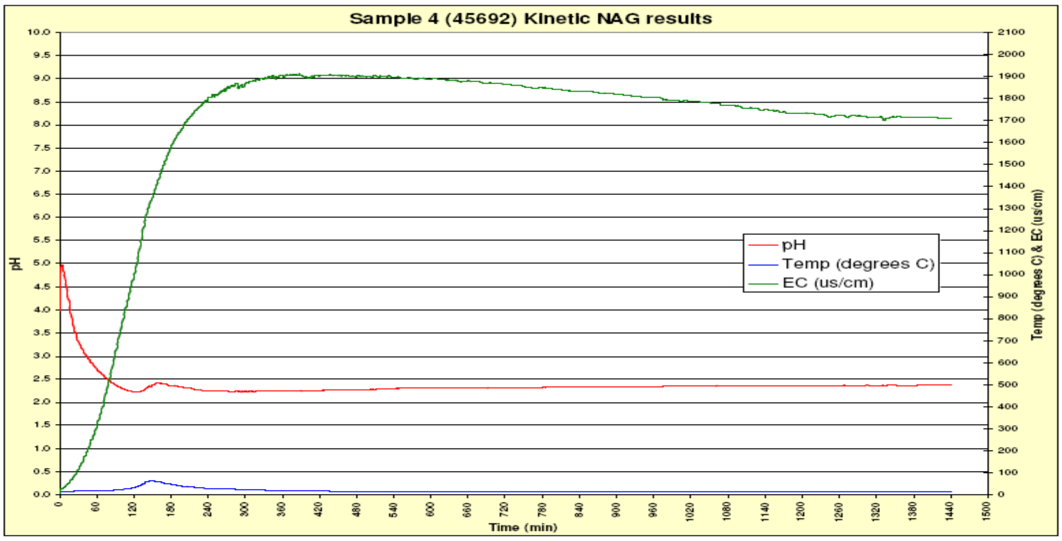
Kinetic net acid generating potential tests

K-NAG tests were conducted on samples 45410, 45692 and 45949, which are from the DSO pit. The K-NAG profiles for these samples are shown in Figure 10, Figure 11 and Figure 12 respectively.



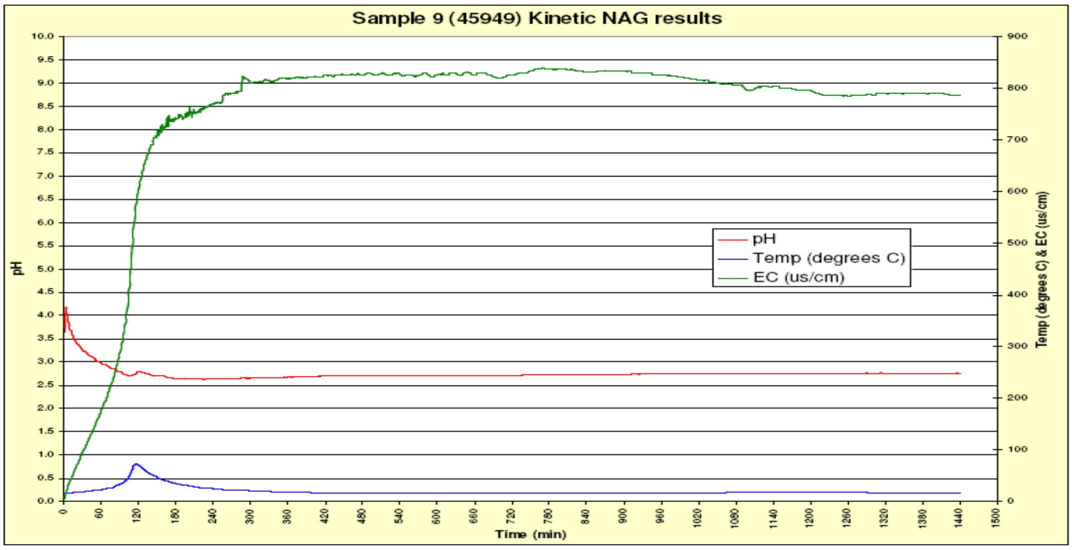
KNAG Time to pH 4 = 17 minutes
Predicted Lag Time to pH 4 in a column test = 8 to 16 weeks (9 weeks calculated)
Final KNAG pH = 3.26
Indicated Sample Type: Potentially Acid Forming (PAF)

Figure 10: Kinetic NAG profile for sample 45410



KNAG Time to pH 4 = 17 minutes
Predicted Lag Time to pH 4 in a column test = 8 to 16 weeks (9 weeks calculated)
Final KNAG pH = 2.38
Indicated Sample Type: Potentially Acid Forming (PAF)

Figure 11: Kinetic NAG profile for sample 45692



KNAG Time to pH 4 = 6 minutes
Predicted Lag Time to pH 4 in a column test = 4 to 8 weeks (3 weeks calculated)
Final KNAG pH = 2.76
Indicated Sample Type: Potentially Acid Forming (PAF)

Figure 12: Kinetic NAG profile for sample 45949

The K-NAG test is qualitative rather than quantitative but it nevertheless provides an indication of the likely rate at which waste rock may produce acid conditions when exposed to air. This will guide the management of waste rock, particularly the frequency at which the PAF waste rock dump should be covered with a sealing layer to minimise air and water ingress.

The K-NAG tests were conducted on samples taken near the ore body, at depths of approximately 40 m below the surface. The DSO ore is hematite, which is oxidised, and the overburden above it is therefore likely to be even more highly oxidised. The K-NAG test results can nevertheless be conservatively applied to determine appropriate management approaches for PAF material found in the DSO pit.

The SGS interpretive report on the K-NAG tests is provided in Appendix J.

The K-NAG profiles for all three samples show a sharp temperature spike indicative of oxidation. Coincident with these temperature spikes are reductions in pH and these reductions show no signs of recovery, which is consistent with the lack of significant neutralising capacity within the water rock.

All the tested samples indicated significant potential to generate acid drainage, with rapid onset of acid production predicted. The predicted lag time to the onset of acid conditions was 8 to 16 weeks for samples 45410 and 45692 and 4 to 8 weeks for sample 45949.

The K-NAG tests show that PAF rock from the DSO pit will need to be regularly covered with low permeability, clayey soil to minimise the risks of acidification. An initial cover frequency of fortnightly will be adopted but this will be adjusted if and as necessary based on the results of regular monitoring of dump run-off, which will pick up early signs of emerging acidity.

3.9 Tailings

All tailings samples were classified as NAF (non-acid forming).

The acid and neutralising potentials of the tailings samples are shown in Table 13.

Siderite and carbonate (calcite) are considered to be the sources of alkalinity in the test samples. In practice, however, siderite does not provide a neutralising role due to secondary reactions that negate its net neutralising capacity.

Table 13: Acid accounting results for tailings samples

Sample	Total S %	$CaCO_3$ %	ANC/NP kg H_2SO_4/t	NAG Total oxidisable sulphur kg H_2SO_4/t
NBR07	1.36	7.9	77	41
NBR08	1.98	7.1	70	59
NBR018	0.121	1.1	11	3.5
NBR021	1.06	7.6	75	32

Under the AMIRA protocol, NAF samples with a total sulphur content of more than 2% and an ANC/MPA ratio of less than 1.5 should be subjected to further evaluation. However, none of the tailings samples exceed these criteria.

The tailings are unlikely to be a source of acid drainage but they will nevertheless be managed on the conservative assumption that they do contain PAF material.

Comparison of TCLP results (Table 12) for the tailings samples against those of the waste rock and ore samples show no suggestion of significant element enrichment in the tailings.

3.10 Estimated amounts of pyritic waste material

The amount of PAF material in the main and DSO pits was estimated by Shree Minerals' consulting geologist (Robert Reid) as follows. This estimation was then supplemented with block modelling by Hellman & Schofield PL, as described in later in this section.

The accuracy of the estimation of pyritic waste material is constrained by the fact that exploratory drilling targets the resource rather than the non-resource material surrounding it. Drill directions are oriented relative to the resource and the areal coverage of drilling follows the apparent areal extent of the resource.

In addition to these biases, for practical and economic reasons analytical testing needs to be restricted to representative samples from the drill cores and cannot test every section of every core.

Despite these constraints and limitations, the information from the analysed samples can be used to build a model of the pyrite distribution as if it was a "resource", using the same principles and procedures as are used for resource modelling, as described below.

Main (magnetite) pit

Pyrite distribution was modelled on a sectional basis, generating shells to define polygons for >0.5% pyrite. This was undertaken with reference to PAF classified rocks and, to a lesser extent, the distribution of lithology and pervasive silica alteration. The latter is a key control on disseminated pyrite distribution, which is commonly better developed within more porous coarser grained sandstone beds and interbeds within siltstone.

Bedding is known to have a consistent strike of approximately 130TN / -45 to 55E dip within outcrop and orientated core, particularly in the north of the prospect area. This orientation is notably sub-parallel to drill hole dip in many cases, making interpretation of pyrite distribution controlled by stratabound pervasive silicification difficult. In the proposed pit area, sectional interpretation shows dip of strata to be a little shallower; for example, on section 10000N an apparent dip of -35 degrees is indicated (Appendix K).

An approximate outline and contours for the final planned pit was generated from mine plans, with a pit digital terrain model (DTM) subsequently created allowing approximate pit profiles to be overlain on the sections, enabling clearer interpretation.

A consistent geological interpretation across all sections extending from 9800 to 10100 mN was generated considering down-hole lithologies, long core axis angles and surface mapping.

Acid rock classification was displayed in conjunction with visually estimated pyrite (%) to aid sectional interpretation with >0.5% pyrite (PAF) zones extended to the pit boundary and stopped at the approximately 12 to 15 m base of oxidation. The boundaries for PAF rock are approximate.

The PAF outlines are partly based upon the premise that pervasive silica and disseminated pyrite alteration emanates from the mineralisation hosting fault zone and pervades along permeable zones in the enclosing sediments. This appears to be primarily within the siltstone dominated units with less acid generation potential from the coarser more silicified sandstone beds.

A basic sectional "pre-resource" was calculated using a two dimensional inverse distance weighted interpolator (power 2) for PAF rock (>0.5% pyrite). This was based upon 100 m spaced sections (+/-50 m section envelope), assuming an average specific gravity of 2.7 g/cm^3 from 21 drill core determinations.

Samples were classified (section 2.8.1) as NAF, PAF, PAF Low Capacity and UC (Table 15). Comparison of this classification to the logged pyrite portions shows a consistent relationship between pyrite presence (>=0.5%) and PAF classification.

Table 14: Specific gravity determinations for Nelson Bay River drill core

Rock type	Specific gravity (SG) (g/cm^3)
Hornfels	2.82
Fine grained sandstone	2.63
Sandstone undifferentiated	2.72
Siltstone	2.70
Average (20) samples	2.71

Table 15: Relationship of lithology and geochemical classification

Sample Number	Drill Hole	Sample Depth (m)	Description	Class
45398	NRC08	28.0 – 29.0	lht bn & gn, semi-trans qvn(25), sil fg sst & slst, FeO(w)	NAF
45410	NRC08	39.0 – 40.0	gn msv skarn(60) - perv sil(40) overprint, dss cg py(1%)-cpy(?)	PAF Low Capacity
45524	NRC10	32.0 – 33.0	crm & lht bn, st & milky qvn(90), sil sed(10)	PAF Low Capacity
45692	NRC13	42.0 – 43.0	gn & crm, milky qvn(40), dgn skarn(30, m), sil-serp(30), dss cg py	PAF
45694	NRC13	44.0 – 45.0	AA, qvn(10)	UC
45760	NRC14	46.0 – 47.0	lht gn, perv sil(m) over fg qsst(80), relict lam bdd slst & fg sst(20)	PAF Low Capacity
45764	NRC14	50.0 – 51.0	gn, skarn(m) over sil(m) lam bdd slst & fg sst	PAF Low Capacity
45769	NRC14	55.0 – 56.0	gn & red/bn, AA sil(m/s) lam bdd seds, milky qvn(20)	PAF Low Capacity
45949	NRC17	39.0 – 40.0	dgn, skarn(90, s) dss cg py(5%) cpy(tr), sil(w) but strong in few siliceous frags	PAF
520901	NBR007	21.63 – 22.13	thin bedded grey slst	UC
520902	NBR007	85.5 – 86	lam bedded slst & fg q-sst	NAF
520903	NBR003	22 – 22.5	weakly weathered grey / cream irregular lam bedded slst, ch(w, flecks), dss py (0.5%)	PAF
520904	NBR003	58.5 – 59	grey lam bdd slst with oxidised bn flecks after chlorite / sulphide?, minor straight sil veinlets on fractures with perv sil(vw)	PAF
520905	NBR003	79.5 – 80	lam bedded slst, very weak FeOxidised exterior	PAF
520906	NBR003	110.1 – 110.6	grey lam bdd slst, py(1% overall)-ch blebs / flecks (w, ~1% overall), perv sil(w/m)	PAF
520907	NBR021	7.6 – 8.1	cream perv sil(m/s) - dss fg py(0.5%) sandstone	PAF low capacity
520908	NBR021	27.7 – 28.2	cream strongly leached and pitted likely after pyrite, perv sil(m/s) relict sst	PAF

Sample Number	Drill Hole	Sample Depth (m)	Description	Class
520909	NBR021	45.2 – 45.7	cream perv sil(m/s) - dss fg py(0.5%), sparse ch flecks(vw) sandstone; sil-vnlets(w) on straight fractures	PAF low capacity
520910	NBR021	63 – 63.5	grey lam bdd slst with py dss(0.5%) within ch(vw) patches/flecks, with sil-py-ch veining on straight fracs(w, <0.5%)	PAF
520911	NBR021	84.95 – 85.45	grey lam bedded fg sst and slst, dss py(1%) with ch(vw) flecks on silicified crm fg sst interbeds. Perv sil(w)	PAF
520912	NBR021	105.2 – 105.7	grey lam bdd fg sst and slst	NAF
520913	NBR021	181.85 – 182.35	grey mottled sil(w/m) - ch(w) pervassive alteration within thin bdd fg/mg sst.	NAF
520914	NBR005	35.5 – 36	grey lam bdd fg sst & slst	PAF low capacity
520915	NBR005	95.9 – 96.4	grey lam bdd slst & fg sst	PAF
520916	NBR005	137.9 – 138.4	grey perv sil(w/m) - ch(vw) altered fg sst with slst interbeds	NAF
520917	NBR021	53.9 – 54.4	grey lam bdd slst & fg sst, py(0.5%) dss within ch(vw) flecks	PAF
520918	NBR002	14.9 – 15.4	grey lam bdd slst and fg sst, weathered(w)	NAF
520919	NBR002	50.3 – 50.8	grey lam bdd slst and fg sst, weathered(w)	UC
520920	NBR002	77 – 77.5	crm / grey perv sil(w/m) over fg q-sst with minor laminar beds bearing weak slst.	NAF
520921	NBR002	93.6 – 94.1	grey lam bdd fg sst and minor slst, perv sil(w/m), ch (w) flecks, dss Py?	PAF
520922	NBR002	124.5 – 125	grey lam bdd fg sst and minor slst; ox dss py?(0.5%)	NAF
520923	NBR002	169.5 – 170	lht bn lam bdd fg sst and minor slst, perv sil(m), brown FeOxidised surface(w)	NAF
520924	NBR002	180.8 – 181.3	grey mostly fg q-sst with sparse slst lam interbeds, perv sil(w/m)	PAF
520925	NBR009	31.8 – 32.3	grey thin bdd slst and fg q-sst, sparse pits after py?(0.5%)	NAF

Sample Number	Drill Hole	Sample Depth (m)	Description	Class
520926	NBR016	35 – 35.5	crm / grey perv sil(w/m) over fg/mg q-sst	NAF
520927	NBR022	46.2 – 46.7	pale green perv sil(m) with speckled chlorite(w/m) overprinting fg/mg q-sst, sparse relict surface pits after py?	PAF low capacity
520928	NBR001	41 – 41.5	grey and pgn lam bdd slst and minor fg q-sst. Weak pgn FeO stained exterior. Sparse ch flecks(vw) and relict cubic Py pits(0.5%)	PAF
520929	NBR001	115.5 – 116	grey lam bdd slst and minor fg q-sst. Dss py(1%) mostly in fg sst interbeds and locally weakly framboidal / rounded appearing. Perv sil(vw), Fresh no oxidn	PAF low capacity
520930	NBR001	161 – 161.5	grey lam bdd slst and minor fg q-sst. Dss py(<1%), perv sil(w) Fresh no oxidn	UC
520931	NBR001	189.3 – 190	brown oxidised (m) silicified(m) dgn skarn; half core sample,	UC

There was minor overlap between pyrite bearing and NAF classified samples. ARD classification from the 2010 and 2011 sampling is plotted on sections (Appendix K). Strong silicification with 0.5% disseminated pyrite (NBR021), interestingly returned a PAF Low capacity classification (Table 15).

This result is low regardless of sulphide content presumably because the stronger pervasive silicification protects the pyrite from oxidation. It appears that more siltstone dominated pyrite bearing samples are PAF classified when compared to sandstone and pervasive silica altered samples. This may simply be a relict of lesser availability of sandstone samples, related to drill hole distribution.

The pyrite within siltstone appears to be more readily oxidisable by comparison to that of often higher concentrations encapsulated within pervasive silicification, a result seemingly at odds intuitively. This relationship appears to hold in the central 10000N to 10100N area (holes NBR001, NBR003, NBR021), whereas both principal lithologies are variably classified outside this zone, particularly on 9800N (hole NBR002).

The majority of the significant PAF rock is in the northern half of the pit (e.g. hole NBR003) on sections 10000 and 10100mN (Table 15). The volume and tonnes of PAF within each section are shown later in Table 16.

Twenty five percent of the tonnage calculated for 10100mN was removed from the waste rock estimation calculations as an approximation to account for what will not be mined from the 100 m wide modelled zone that intersects the NE pit wall. The same consideration was not applied to 9800mN, at the south eastern pit end, since expansion of the inferred PAF zone toward 9900mN will approximately accommodate a tonnage equivalent to that not planned for mining.

DSO pit

The acid rock drainage potential of the proposed DSO pit area was investigated through 12 samples, taken from drill holes NRC08, NRC10, NRC13, NRC14, NRC17, NBR009, NBR 022 and NBR 016.

Silicified sandstone from the hanging wall in NBR009 and NBR016 were classified as NAF, while siltstone in the footwall in NBR022 returned PAF Low Capacity. Considering that these holes are relatively short and near-surface, a large proportion of the upper part of the holes was oxidised and weathered and therefore not appropriate for sampling. This is generally in line with the observed zonation of PAF to NAF classified samples extending from the main pit to the south west.

At greater depths, PAF Low capacity material was found in the hanging wall in holes NRC08, NRC10, NRC13, NRC 14 and NRC17, principally in association with quartz veins,which form a zone of ~5 to 7 m in thickness but which locally reaches 13 m on 9400mN. Pyrite distribution in the quartz veins is, not unexpectedly, sporadic and unpredictable. Quartz veining is often pyrite barren but also commonly bears variable pyrite of up to 5% tenor but reaching 60% in one example (see below). The sulphidic portions of quartz veining should be readily visually selected for encapsulation.

The DSO pit area was modelled to encompass >55% FeO material, with the pit outline being based upon -65 to -70^0 north eastern and -45 to -50^0 (bedding parallel) south western pit walls planned for the magnetite pit. Consequently some elevated pyrite zones did not require evaluation since they were found to lie outside the pit margins. Some examples follow. Immediately north of the proposed pit, section 9650N bears significant coarse grained aggregated pyrite in quartz veining visually amounting to ~60% over 1 m, within a zone of 4 m @ ~20% pyrite in NRC03. Similarly, on 9600mN some potentially pyrite bearing quartz veining lies outside the potential pit boundary and extends to surface within the oxidised – pyrite depleted zone. Neither of these high pyrite areas will be mined.

Comparatively small sulphidic zones of potential importance with regard to ARD potential were identified on sections 9550, 9400 and 9200 mN. Pyrite contained within these zones is shown in Table 16. Sectional envelopes were defined as +/- 12.5 m on 50 m (9550mN) and +/-50 m on 100 m (9200 & 9300mN) spaced sections, which likely provides a generous tonnage assessment given the observed erratic pyrite distribution in quartz veins. An SG of 2.7 g/cm^3, similar to the sediments, was considered valid (quartz = 2.65 g/cm^3).

Sampling outcomes summary

The outcomes of the sampling were as follows:

- A poorly constrained "pre-resource" of ~4.5 Mt @ 1.01% pyrite was inferred for (>0.5% pyrite) PAF rock in the main pit, with a comparatively small ~40 kt @ 2.99% pyrite modelled for the DSO Pit.
- The majority of the significant PAF rock is shown to be in the northern half of the main pit on sections 10000 and 10100 mN. Pervasive silica, primarily located within more porous sandstone appears to encapsulate elevated pyrite concentrations, resulting in some NAF classifications for this material, whereas the disseminated pyrite within the less altered siltstones is more often classified as PAF.
- PAF distribution and character is uncertain, partly since most drilling is sub-parallel to hole dip and actual distribution will become evident during mining.
- Pyrite is mostly erratically distributed within hanging wall quartz veins in the DSO pit area but should be readily visually identified during mining.

Anticipated quantities of acid forming materials

The potential amounts of pyritic waste rock material have been estimated on the basis of the analytical results and the estimated percentages of the various lithologies. The approximate anticipated quantities of pyritic material are shown in Table 16.

Table 16: Estimated amounts of potentially acid forming rock (PAF)

Section (mN)	Pyrite %	Estimated pyritic volume m^3	PAF (tonnes)
Main (magnetite) Pit			
10100	1.00	407,500	1,100,250
10000[1]	1.27	812,600	2,194,000
incl. Zone 1	*1.37*	*750,741*	*2,026,750*
incl. Zone 2	*0.08*	*61,852*	*167,000*
9900	0.05	321,850	869,000
9800	(<0.05)	120,000	324,000
Total PAF	1.01*	1,661,950	4,487,250
DSO Pit			
9550	2.97	2,724	7,355
incl. Zone 1	*6.00*	*1,005*	*2,713*
incl. Zone 2	*1.20*	*1,719*	*4,642*
9400	3.47	10,299	27,807
9300	0.60	1,074	2,900
9200	2.06	2,356	6,360
Total PAF	2.99*	13,729	37,067
Both pits			
Main pit	1.01*	1,661,950	4,487,250
DSO pit	2.99*	13,729	37,067
	Total PAF	1,675,679	4,524,317
		PAF rock as % of total material mined[3]	
	Main pit	14.0%	
	DSO pit	1.6%	

*Weighted average
[1] Section 1000N comprises two zones, zone 1 and zone 2 of 2,026,750 and 167,000 tonnes respectively.
[2] Section 9550N comprises two zones, zone 1 and zone 2 of 2,713 and 4,642 tonnes respectively.
[3] Total mining quantities are given in Table 5

Block modelling of PAF rock

Shree Minerals commissioned Hellman & Schofield PL to undertake block modelling estimations of PAF waste rock. The Hellman & Schofield report is provided in Appendix L.

Hellman & Schofield created a block model with a minimum block size of 5 x 20 x 10 m (X, Y, Z) from which they estimated pyrite volumes. The block model was consistent with the current resource model. Hellman & Schofield's model was based on the actual pit design shape whereas Reid's model used a simplified pit shape.

Hellman & Schofield's estimates for pyrite volumes in the main and DSO pits are provided in Table 17 and Table 18 respectively.

Table 17: Estimates of pyritic material in the main pit (0.5% pyrite cut-off)

Lode	Volume (m^3)	Pyrite %
Siltstone	1,507,020	1.5
Skarn	164,729	2.68
Total	1,671,749	1.64

Table 18: Estimates of pyritic material in the DSO pit (0.5% pyrite cut-off)

Lode	Volume (m^3)	Pyrite %
Quartz vein	12,951	2.15
Total	12,951	2.15

The Hellman & Schofield estimates of pyritic material are slightly higher than the Reid estimates for the main pit and slightly lower than the Reid estimates for the DSO pit. The differences are attributed to the more accurate pit shape model used by Hellman & Schofield and are not considered to be significant.

The Hellman & Schofield review supports the PAF waste rock estimates described in Table 16.

Anticipated timing and exposure of potentially acid forming materials

The potential amounts of pyritic waste material and anticipated periods of removal over the first half (5 years) of the mine's life are summarised in Table 19. As described in section 0, at that time the remaining available volume for PAF disposal into the DSO pit will be reviewed.

Table 19: Pyritic waste rock - anticipated volumes and likely removal times during the first half of mine operations

Year	DSO Pit m^3	Main Pit m^3	Both Pits m^3	Cumulative m^3
1	14,000	-	14,000	14,000
2	-	24,000	24,000	38,000
3	-	135,000	135,000	173,000
4	-	346,000	346,000	519,000
5	-	309,000	309,000	828,000

The above estimates were calculated through conservative interpretations of available drilling data. However, because the pyrite is predominantly associated with quartz veins, which by nature are sporadic and irregular, the estimates are unavoidably uncertain. The estimates will be progressively refined during mining as more exploratory holes are drilled and the pits are opened up. This additional refinement work will begin with the commencement of operations.

3.11 Management of pyritic material

The waste rock from the high pyrite areas of the resource (both for the main pit and for the DSO pit) will be managed to minimise acid generation. This management will involve identification, appropriate emplacement, encapsulation and drainage control and monitoring.

It is anticipated that the high pyrite zones will be readily visually identified in the pit walls. These zones will be marked out for separate removal from the pit, and the material will be set aside for encapsulation within a specifically designed cell(s) within a section of the completed DSO pit.

In addition to this visual separation of high pyrite material, regular acid accounting analysis in accordance with the AMIRA procedures will be undertaken of all samples taken as part of routine grade control, including from blasting drill holes. Any material not classified as NAF (ie. classified as PAF, PAF Low capacity or UC) will be separated for encapsulation in the DSO pit. Regular routine testing of samples prior to blasting and/or material removal will be critical to the beneficiation process, which will rely on precise grade control for optimal efficiency. The incorporation of acid accounting testing with the routine grade control testing will ensure that no significant quantities of non-NAF material go to the NAF dump.

As described in section 3.8.3, K-NAG testing predicted that reactive PAF material could generate acid conditions within 4 to 8 weeks. This material will therefore be covered on a fortnightly basis to preclude these conditions forming. Depending on the results of routine K-NAG tests, for particularly reactive material this may be supplemented by mixing alkaline material (brought onto site from a commercial supplier) with highly reactive PAF material.

The DSO pit is the preferred location for disposal of any potentially acid forming material as it would provide the most secure location, precluding any long term acid drainage from the site. Flooding of the pit on mine closure would provide the added security of a water cover.

The proposed PAF rock disposal method is shown schematically in Figure 13.

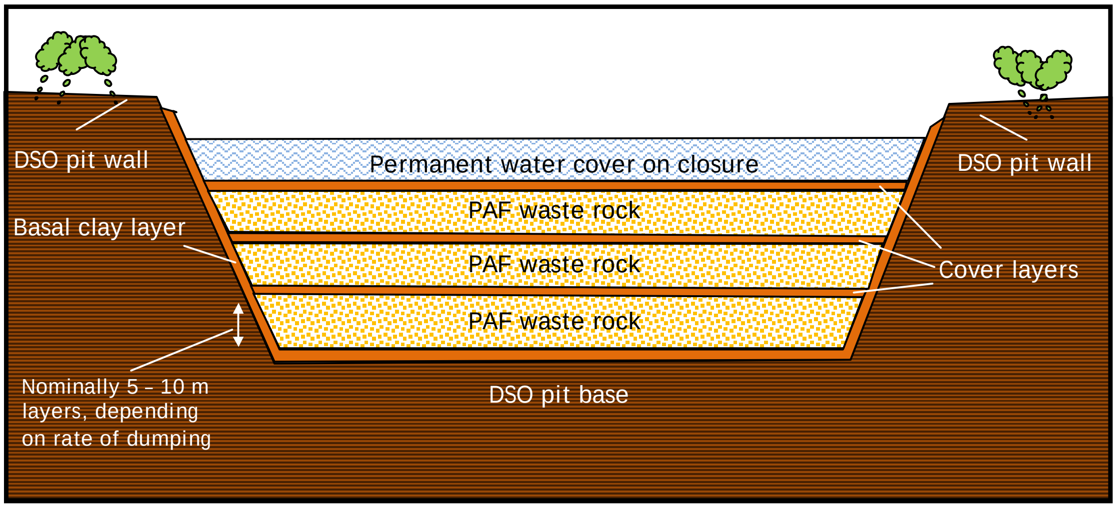


Figure 13: Schematic arrangement for disposal of potentially acid forming waste rock in DSO pit

Magnetite mining in the main pit will not commence until the DSO pit mining has been completed. However, the oxidised ore overlying the main pit magnetite will be mined prior to DSO completion because that may need blending with DSO ore to satisfy market requirements. Because only oxidised ore would be mined from the main pit during this overlap period, there would be minimal PAF waste rock generated. What little there may be during this brief period would be stored in the DSO pit.

ALL DSO pit PAF material will be managed inside the DSO pit from the outset. There will be no requirement for temporary storage of DSO PAF material outside the pit as it is being opened up. In the unlikely event that DSO material is uncovered early in the life of the pit, when it has only a limited void volume available, a bench will be left within the pit on which to temporarily store this early material (in an encapsulated cell) until the void has been expanded sufficiently to allow that material to be moved to its permanent location in the pit.

DSO and main pit PAF rock material will be encapsulated within cell(s) specially designed and constructed so that oxidation of the pyritic material will be slowed down, water ingress to the material reduced (preferably prevented if possible), and any drainage from the material readily controlled and treated.

The basic cell design for the disposal of pyritic material will consist of cells with clay lined floors and walls (clay lined containment bunds. Periodically the material within the cells will be capped with clay or compacted crushed NAF rock that will act as a barrier to air and water ingress, before the introduction of additional pyritic material. This will produce a ‘sandwich type’ structure, as shown above in the conceptual cell design (Figure 13).

These cover layers will be successively replaced by overlying layers and are not intended to be a final impermeable capping – the final ‘capping’ will be a permanent water cover. The cover layers therefore will not be engineered clay caps designed to achieve a particular impermeability criterion but rather covers in the order of 0.5 to 1 m thick to inhibit oxygen and rainfall penetration while the next layer of material is being laid above.

Clay for covering will be sourced from within the mine disturbance footprint in the first instance but will be supplemented if and as required by clay sourced from approved commercial clay pits in the surrounding region.

The proposed management measures for potential acid forming material will ensure that any oxidation of pyritic material will be minimised and any acid drainage produced will be controlled to the maximum possible extent.

If acid is formed due to rain runoff from the exposed rock in the operating PAF cell, it will safely accumulate in the DSO pit before being pumped to the recycle dam (via the neutralisation plant) for process make-up water.

Flooding the PAF rock dump inside the DSO pit on mine closure will provide permanent protection against oxidation and hence acid generation. This flooding will be passive and would commence naturally when pit dewatering ends.

The current JORC confirmed DSO resource provides a 40 m deep DSO pit with an approximate volume of 0.9 Mm^3 (Table 5). Based on the current estimates of PAF rock volumes (Table 16), the DSO could take approximately 50% of the estimated 1.7 PAF Mm^3 of PAF rock volumes over the life of the mine, allowing for clay linings and final water cover. However, strong exploration indications are that the ultimate DSO pit will extend to approximately 60 m deep, which has the potential to provide a DSO pit volume of approximately 1.1 to 1.2 Mm^3, which could take about 65 to 70% of the anticipated PAF rock.

Because of the generally veinlet nature of the pyrite dissemination and because the drill holes are biased toward schist material, which is more likely to contain pyrite, the amount of PAF rock may be less than current estimates, meaning that the DSO pit volume may in fact be sufficient for all PAF waste. The actual PAF quantities will become evident as mining proceeds and projections of the likely total amount will become progressively more refined over the first several years of operations.

If the actual PAF rock production rates and the actual DSO pit volume lead to a mid-mine-life (year 5) projection that the pit volume will not be sufficient for the last few years of mining then the PAF storage will be raised above the DSO pit as a temporary dump.

The basic structure of the cell will be similar to that shown in Figure 13 but, rather than making use of the pit walls, the raised cell will be constructed within a wall constructed from NAF rock. Drainage off the dump will be directed into a sump void that will be retained and water collected in this sump will continue to be pumped out as before.

Because these temporary cells will be above ground, they would not be accessible to the rising phreatic zone within the DSO pit and could therefore not become enveloped within a saturated zone like the deeper cells. The risk of oxidation of PAF material within the above ground cells is therefore greater and because of this these cells will be covered with clay rather than NAF rock. The risk of oxidation of PAF material in these cells having commenced before the material is relocated into the main pit for flooding will therefore be minimised.

This same approach would be adopted as a contingency response for the unlikely situation that a significantly greater amount of PAF rock is found than is expected, which could lead to the DSO pit's PAF storage capacity being filled earlier in the mine life than anticipated.

This temporary above-pit dump will be managed until mining finishes, at which time it will be demolished, with the rock being trucked to the edge of the main pit where a safe chute arrangement will be constructed. The PAF rock will be pushed through the chute into the pit. The excess PAF rock will therefore become flooded with a permanent cover of water as the main pit fills because of the cessation of dewatering.

With the above strategies, all PAF rock will be managed throughout the mine's operations to minimise the potential for acid generation and on mine closure all PAF rock will be submerged under a permanent cover of water (whether in the DSO pit or in the main pit), thereby providing permanent protection against acid generation.

If acid is formed due to rain runoff from the exposed rock in the operating PAF cell, it will safely accumulate in the DSO pit before being pumped to the recycle dam via the central treatment plant, where it can be alkalinity dosed if required, for process make-up water.

Flooding the PAF rock dump inside the DSO pit on mine closure will provide permanent protection against oxidation and hence acid generation. This generation will be passive and would commence naturally when pit dewatering ends.

3.12 Acidic water management

The primary management approach (described above) will be to prevent the generation of acid drainage by encapsulation of PAF material during operations and permanent flooding on mine closure.

During operations, however, it is possible that highly reactive PAF rock, if it occurs, could generate acidic water before there has been time for that rock to be encapsulated. This is an unlikely scenario, because regular testing of waste rock samples will be routinely conducted to alert operators to the uncovering of highly reactive material, thereby enabling them to encapsulate it quickly. Nevertheless, contingency plans include the provision for treating acidic water.

All water from the main and DSO pits, which will include runoff from the PAF water rock dumps, and from the tailings dam will be pumped to the recycle dam via an acid neutralising treatment plant (see the schematic arrangement provided earlier in Figure 7) where it can be neutralised if necessary before being discharged to East Creek or being sent to the recycle dam for process make-up water. Treatment will occur if the water's pH is less than a quality threshold (pH of 7).

Regular monitoring of the discharges to East Creek will be used to confirm that pH levels of at least 7 are also accompanied by dissolved metal concentrations that are not significantly greater than their respective Nelson Bay River Water Quality Objectives. If this monitoring suggests a higher threshold pH is more appropriate, that will be adopted.

The neutralisation plant will be a proprietary system, which will be selected as part of detailed design.

The discharge from the plant will be via a sludge settling pond or thickener tank(s), designed to suit the chosen treatment plant's configuration.

The sludge pond/tank(s) will be used to detain the treated water to ensure complete oxidation (so that precipitation does not occur subsequent to discharge) and to settle out unstable metal hydroxide precipitates from the supernatant, so that precipitates are not discharged with the treated water.

Periodically, the pond/tank(s) will be desludged and the sludge will deposited within the PAF rock dump inside the DSO pit immediately prior to the addition of a dump cover layer. The PAF cell will therefore retain the sludges *in situ* and they, together with the rock within the PAF dump, will be permanently flooded on mine closure.

By design, the NAF dump should receive no PAF material. However, as discussed in section 3.7.6, if signs of acid runoff occur water from that dump's sedimentation dam will be pumped back into the main pit, from where it will in turn be pumped with the main pit's dewater to the acid neutralisation treatment plant.

3.13 Tailings management

Production rate

The weighted average recovery of saleable product for the mine is expected to be 36% across the resource.

The DSO ore will generate no tailings.

Processing of the magnetite ore and the lower quality hematite ore from the main pit will generate tailings.

At the planned production rate of 150,000 tpa of concentrate, 400,000 tpa of ore will be processed, generating 250,000 tpa of dry tailings, equivalent to a volume of approximately 140,000 m^3pa or 1.4 Mm^3 over the mine life.

As the tailings discharged from the process plant will be approximately 70% solids, the total settled wet volume of tailings will be approximately 1,400,000 m^3/0.7 = 2,000,000 m^3 over the life of the mine or 200,000 m^3pa (140,000 m^3/0.7).

Testing on tailings derived from exploration cores shows that they are likely to be non-acid forming (see section 0). However, the sporadic occurrence of pyrite in quartz veins means that there is some potential for potentially acid forming material to be discharged in the tailings stream. As a conservative protection measure, surplus neutralising capacity will be added to the tailings stream prior to deposition in the tailings dam.

The amount of acid neutralising material to be added will be initially determined by detailed static and kinetic laboratory testing once tailings production commences. Thereafter, the tailings stream will be tested daily for pH and acid generating potential as it emerges from the processing plant. For this in-stream testing it is planned to use calcium as a surrogate for neutralising potential and total sulphur as a surrogate for acid potential but these details will be further informed by the laboratory testing. The relative amounts of the surrogates will be used to determine the amount of alkalinity to be added to the tailings prior to their deposition in the tailings dam so that the deposited tailings have a surplus alkalinity. Periodically, further laboratory testing of the tailings will be undertaken to check (and adjust if necessary) the calibration of the surrogates.

The addition of surplus alkalinity to the tailings stream means that the tailings could not become acidic and they will also hold a residual alkalinity.

Tailings storage

The process tailings will be permanently stored and managed using a dedicated tailings dam (see Appendix A).

Tailings will be discharged from the processing plant (also shown in Appendix A) and deposited onto the dam water using an open pipe or spigots, until a beach is formed. The water level will be controlled using a decant tower or overflow channel weir, installed in or near the dam wall, to keep the level low enough to give optimum beaching and hence consolidation of the tailings.

The water level will be controlled to optimise detention time to ensure adequate solids/liquid separation.

The decant from the tailings dam will be pumped back to the recycled water dam (via the neutralisation plant) and hence to the processing plant.

Tailings storage dam requirements

The tailings dam will need to have at least an annual volume availability of 200,000 m^3 plus freeboard at full production to allow for the settling and dewatering of the tailings. The total required volume for tailings over the life of the mine is 2 Mm^3. The volume of the conceptual design is 3 Mm^3, which is more than adequate for the tailings and water cover freeboard. The conceptual footprint area of the tailings dam is approximately 25 ha.

Tailings storage dam design

The tailings storage dam wall will be constructed in compacted 2 m lifts of graded crushed material sourced from pit overburden material, based on current understanding of the potential nature of this overburden material. The toe of the dam is expected to be at 90 m RL, with a final height of 115 m RL.

The dam wall will have an external slope of 1 in 2.5, an internal slope of 1 in 2 and a width at the top of 6 m. The internal slope of the wall may be steepened to a slope up to 1 in 1.5, subject to detailed design.

The dam wall will require approximately 1 Mm^3 of material, based on the current design, and will be constructed of selected graded crushed NAF material sourced from pit overburden material, based on current understanding of the potential nature of this overburden material. It will be constructed in stages of compacted lifts, which would be undertaken as demand requires.

The ore processing does not include chemical processing and the tailings will not have high toxicity that might otherwise require a synthetic liner.

The tailings dam will be clay-lined. Clay is available on site but the resource has not been quantified. Clay requirements for the lining and wall core are in the order of 0.5 Mm^3. If on site resources prove to be inadequate, supplementary clay will be imported from a licensed commercial clay pit. Clay will be compacted to achieve a permeability of less than 1×10^{-9} m/s. The tailings will provide additional sealing as they consolidate over time.

The principal environmental concern is unoxidised pyritic residues. These have the potential to generate acid on oxidation. This risk will be mitigated by dosing the tailings with alkalinity as they emerge from the processing plant and by maintaining a water cover over the tailings (apart from the tailings beach) during operations and after mine closure.

A collection dam will be constructed below the dam to collect any seepage and provide a water sampling point for any such seepage. Collected water will be returned to the recycle dam (via the neutralisation plant).

The design of the tailings dam will require approval from the Tasmanian Assessment Committee on Dam Construction and will need to satisfy the design standards of the Australian National Committee on Large Dams (ANCOLD)[6]. As part of the detailed dam design process, a societal risk assessment will be undertaken to examine the risk of human fatalities from a catastrophic dam failure. Because of the absence of human habitation in the Nelson Bay River catchment, the exposed population would be very low, and would probably be confined to road traffic on Temma Road, several kilometres downstream from the mine site. Nevertheless, the ANCOLD standards are likely to require a design failure probability of 1 in 10,000 years or less.

Catastrophic failure of the tailings dam will therefore be a very low (1 in 10,000 year) probability. If, despite this, failure did nevertheless happen to occur during operations, tailings would flow and be deposited in West Creek and remedial action would be undertaken. On mine closure, the tailings dam overflow would be connected to the waste rock dump collection drain. A post-closure tailings dam failure would result in tailings being deposited in the collection drain. Given the design standard for the dam, both of these scenarios are extremely unlikely events.

Decant water

The decant from the tailings dam will be pumped into the recycling dam and then pumped back to the processing plant as recycled process water.

Because of the shortfall of recycling water relative to the total process water needs (requiring makeup water), there is not expected to be a need for any routine discharge of tailings dam decant. However, if rainfall onto the tailings dam leads to an excess, this will be discharged either to the collection basin below the tailings dam or to the recycled water dam. Any overflow from these dams would discharge to West Creek and East Creek respectively. Because of the tailings alkalinity dosing (see section 3.13), the tailings decant water, and hence any overflow to West Creek) would not be acidic. The discharge to East Creek, which could be subject to acidic inputs from pit water, which be via the acid neutralisation treatment plant, where it would be neutralised if the pH falls below the treatment threshold of pH 7.

If, for some unlikely reason, the decant water is temporarily not suitable or available for recycling back to the process plant, there is more than sufficient pit water to make up the shortfall. As shown in Figure 7, even in a dry year the expected excess of pit water is 0.4 Mm^3/a, which exceeds the 0.04 Mm^3/a expected from decant recycling by an order of magnitude.

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[6] ANCOLD (November 2010) *Guidelines on Planning, Design, Construction, Operation and closure of Tailings Dams*.

Water cover

The tailings dam will be constructed towards the head of West Creek. West Creek will be diverted around the dam. However, a top-up weir will be constructed at the diversion point allow creek water to be redirected into the dam in order to maintain a permanent water cover. This arrangement will remain in place after mine closure.

The total catchment area of the tailings dam and its upstream feed from West Creek is approximately 70 ha. The surface area of the tailings dam itself is approximately 40 ha. The mean annual effective rainfall (rainfall minus evaporation) at the mine site is 570 mm (see Table 2 in section 3.3). With a catchment to dam area ratio of approximately 70:40, i.e. 1.75:1, the mean effective rainfall onto and into the tailings dam is therefore approximately 1 m, which will ensure a mean depth of permanent water cover of at least 1 m.

The lowest annual rainfall likely to be experience at the mine site is approximately 900 mm, equivalent to the annual evapotranspiration rate (Table 2 again). Even in drought years, there will therefore be no net evaporation from the tailings dam, and a permanent water cover depth of at least 1 m is therefore readily attainable.

A permanent water cover will prevent the tailings dam water becoming acidic and hence prevent the dissolution of metals contained within the tailings material. Tailings discharge water is therefore not expected to have any significant toxicity.

3.14 Mine infrastructure

A number of stockpiles will be maintained on site (in addition to the waste rock dump), namely:

- Topsoil stockpiles (for rehabilitation)
- Crushed material stockpile (eg. for road surfacing)
- Waste rock stockpile (eg. for building tailings dam walls)
- The ROM and Finish stockpiles.

Topsoil will be recovered during the construction of the open pit, the waste dump areas and the access roads and will be stockpiled for future rehabilitation works.

The mine will have basic support infrastructure including parking, workshops, ablutions and change rooms, a first aid room, a crib room, an office and security room, a diesel powered generator, communications, storage buildings and areas and domestic wastewater treatment facilities. All entrances, car ports and access paths between buildings will be covered.

The workshop will include provision for welding, vehicle maintenance, fitting and machining.

One or more sea containers will be used as lockup tool and parts stores.

The compound will include storage for chemicals, paints and fuel oils. An explosive magazine will be located at an appropriate distance from the plant area.

Potable water will be sourced from rainfall and stored in rainwater tanks.

Sewage will be collected for treatment in an on-site Aerated Wastewater Treatment System (AWTP) or similar. Treated effluent will be discharged into the recycle dam.

Power will be supplied by diesel powered generators. It is estimated that the total energy demand for the site, excluding mine dewatering pumps, will be approximately 2 MW. Mine dewatering pumps will be trailer mounted mobile units powered by diesel engines. By separating the power requirements of the pumps from the rest of the mine's infrastructure, the need for unnecessary oversizing of the diesel generator will be obviated, along with the need to connect an electrical supply from the surface substation to the pit floor.

The diesel generator station will be located centrally to all operations. To handle high starting loads of high inertia equipment such as the crusher and conveyor systems, the power capacity will need to be 500 KVA to be provided by two parallel 250 KVA units.

Power will be fed from the diesel alternator sets by a cable to a low voltage motor control centre in a substation building adjacent to the generator shed, which will be an open-sided, flat roofed steel structure.

3.15 Disturbance footprint

Key features of the project include:

- DSO pit: a shallow excavation to a depth of approximately 40 m down-dip (60 to 65 m RL)
- Main pit: an open cut pit to an ultimate depth of approximately 225 m (-145 m RL)
- Processing plant: an on-site processing plant with ROM pad
- Waste dump: an out of pit storage area for NAF waste rock
- Tailings storage dam: a process tailings storage area
- Support infrastructure: a range of facilities essential for mine operation and management.

The total disturbance footprint for the principal elements of the mine is approximately 152 ha. The footprint areas of the various components are shown in Table 20.

Table 20: Disturbance footprint of principal mine elements

Component	Area (ha)
DSO pit	3.6
Main pit	13.5
Waste dump	70.1
Processing plant and ROM pad	8.0
Process water dams	4.0
Tailings dam	41.7
Sediment dams	1.0
Cut-off drains and bunds	2.1
Access and haul roads	9.0
Total	152

3.16 Pit water, stormwater and site drainage

Mine water management will ensure that no contaminated surface water or groundwater is discharged to Nelson Bay River.

Surface water diversions

Cut-off drains and bunds will be constructed to divert water away from the pits (both the DSO pit and main pit), waste rock dump, tailings dam and processing plant site. This diverted water will not be subject to contamination and therefore will be directed into natural drainage lines, through energy dissipation structures as necessary to minimise erosion risk.

Pit water

Water from pit dewatering will be pumped to the acid neutralisation plant and then to the recycle dam or to the East Creek discharge. The expected DSO dewatering rate is approximately equal to the process water make-up needs. Dewatering from the main pit would be excess to this, and the excess would be discharged to East Creek (see earlier Figure 7). In an average year at full pit development, the main pit dewatering rate is estimated to be 0.4 Mm^3/a. The average annual flow of Nelson Bay River is in the order of 40 Mm^3.

The additional contribution to the Nelson Bay River flow from the main pit dewatering will therefore be less than 1% in an average year. However, in a dry year the discharge of mine water would be more significant. As the pit deepens, pit water inflows will become more driven by the deeper regional aquifer, which will largely be independent of short term fluctuations in rainfall. Surface waters, including Nelson Bay River, on the other hand will respond to day to day changes in rainfall and the river flow could be very low during particularly dry periods. If pit water continued to be discharged at a relatively constant rate, during dry times the discharge could dominate the flow in the river. For this reason, a variable flow discharge regime that adjusts to creeks and river conditions will be implemented.

If acid is formed due to rain runoff from the exposed rock in the operating PAF cell inside the DSO pit, it will safely accumulate in the DSO pit before being pumped to the neutralisation plant.

It is possible that any exposed PAF rock in the main pit wall will oxidise and generate acid through rain runoff or groundwater discharge over that part of the pit face. Pit water will be pumped to the central treatment plant, where it can be alkalinity dosed if necessary, prior to discharge to East Creek (or to the recycle dam as make-up water).

East Creek is ephemeral and there will be times of the year when the creek is dry.

If there was a constant discharge to East Creek throughout the year, an additional impact would be to change the nature of the creek's biota downstream of the discharge. The biota of ephemeral streams is adapted to survive extended periods of no flow. If the creek was changed to a permanent stream by the ongoing discharge of mine water during otherwise dry periods, it is likely that this biota would become at least partially displaced by biota characteristic of permanent streams.

To avoid these impacts, it would be desirable for the discharges to East Creek to mimic the natural flow patterns of the creek to the extent practicable. When the creek is dry, discharges should ideally be avoided. When the creek is flowing, discharges could increase proportionally to the creek flow. While these objectives may not always be achievable in practice, provided that the creek can be left dry for extended periods the creek biota would retain the characteristics of an ephemeral stream.

A key objective for the discharge to East Creek will therefore be to maintain it as an ephemeral creek, with extended periods of no discharge when East Creek is dry. Shree will work to this objective by using the recycle dam to buffer discharges. The recycle dam has been sized to store a nominal 4 week supply (28 days) of water for the process plant and this provides ample buffering capacity.

Processing plant

Site runoff from the processing plant hardstand, which may be subject to hydrocarbon contamination, will be diverted into an oil and grease separator, prior to pumping to the recycle dam. Treated effluent from the facility's wastewater (sewage) treatment plant will also be sent to the recycling dam.

Tailings dam

A discharge to West Creek could occur from any overflow from the tailing dam's collection dam.

An overflow is unlikely because water from this dam will be recycled to the process plant. If there was nevertheless an overflow, the alkalinity dosing of the tailings and the permanent water cover of the tailings dam (apart from the tailings beach) would prevent the overflow from becoming acidic or high in dissolved metals.

Rock dump

NAF material will be separated at source from PAF material, as described in section 0. NAF rock will be taken to the NAF waste rock dump; PAF rock will be stored in the DSO pit and ultimately flooded in the DSO and main pits.

A discharge to West Creek could occur from the NAF rock dump's collection drain sedimentation basin.

Runoff from the rock dump into its collection drain would be at low risk of acidification and hence metal dissolution because the rock dump will comprise NAF material.

If there was nevertheless some incidental acid formation, water would be pumped from the basin to the main pit and hence to the neutralisation plant for treatment.

3.17 Product transport

Product will be transport to the Port of Burnie or Port Latta via the following roads (Figure 14):

1. Wuthering Heights Road (responsible authority: Forestry Tasmania)
2. Rebecca Road (DIER)
3. Blackwater Road (Forestry Tasmania)
4. Sumac Road (Forestry Tasmania)
5. Roger River Road (Forestry Tasmania/Circular Head Council)
6. Trowutta Road (Circular Head Council)
7. Grooms Cross Road (Circular Head Council)
8. Irishtown Road (Circular Head Council)
9. Bass Highway (DIER) to either Port Latta or the port of Burnie.

All processing infrastructure will be on-site and the only off-site infrastructure used will be the State road network for product transport to Burnie port (or Port Latta), although it is possible that unprocessed ore could alternatively be sold to an existing licensed processor for processing, subject to commercial agreements.

Product transport will be up to 7 days a week but for conservative impact assessment purposes in this DPEMP, a 5 day week has been assumed (with consequential higher daily truck movements).

Product transport from the 150,000 tonnes pa operating mine will require approximately 40 truck movements a day (i.e. 20 loads per day). This is based on a nominal five day week but, subject to the transport contract, trucking may occur 7 days a week. During year 1, while the DSO pit is operating, the transport task will be approximately 350,000 tonnes pa (assuming a ROM recovery rate of 90%).

Product transport estimates are shown in Table 21 (based on ore quantities shown in Table 1).

Table 21: Product transport estimates

Component	Year 1	Years 2 - 10
Cartage period	7 days a week but assumed 5 days per week for assessment purposes; average 12 hour day	
Product production (tonnes per annum)	350,000	150,000
Truck capacity (tonnes)	33	33
Approximate average number of loads per day	41	20
Trips on route (vehicle movements per day)	92	40

There will also be traffic associated with worker movement to and from the mine. However, as a mitigation measure against potential wildlife roadkill, Shree will provide a bus to transport workers to and from Smithton (some may need to use their own cars if they live away from that transport route).

A Traffic Impact Assessment (TIA)[7] has been prepared in accordance with the Department of Infrastructure, Energy and Resources (DIER) publication *Traffic Impact Assessments (TIA) Guidelines* September 2007. The TIA is provided in Appendix M.

The objective of the TIA was to assess the proposed cartage routes and to determine the traffic impact of the cartage of product to the Port of Burnie and/or Port Latta.

The results of the TIA, which included an examination of parking, sight distances from junctions, traffic operations and road safety, were as follows:

- The Safe Intersection Sight Distances from the mine access must be in accordance with the requirements of the *Circular Head S.46 Planning Scheme No.1, 1995*.
- There were no crashes in the vicinity of the mine in the last 5 years.
- The increased traffic generated by the proposed development will have minimal impact, for both 24 hour and daylight only carting operations. The traffic operations of the surrounding road network will, therefore, continue to operate at an acceptable level of service.

[7] Pitt & Sherry (July 2011) *Nelson Bay River Proposed Magnetite/Hematite Mine Traffic Impact Assessment*. Report prepared for Shree Minerals.

- The Circular Head Planning Scheme requires that five parking spaces be provided for employees at the extractive pit sites. Dimensions for car spaces and associated turning areas must comply with the Australian Standard for off-street parking AS2890.1.

Figure 14: Product transport route

3.18 Construction

A Construction Environmental Management Plan (CEMP) will be prepared prior to mine development and construction work commencing.

Site preparation works

Initial site preparation works will involve the following:

- Preparation of the CEMP
- Construction of access roads to the site
- Clearance and disposal of vegetation in areas required
- Removal of DSO overburden
- Levelling and grading of sites in preparation for establishment of crusher and generators, and the erection of buildings and other infrastructure
- Establishment of drainage lines, settlement ponds, etc.

Erosion mitigation measures

In accordance with Section 35.1 of the *State Policy on Water Quality Management 1997*, all construction works must employ measures consistent with best practice environmental management to prevent erosion and the pollution of streams and waterways by runoff from sites of road construction.

All construction works will be undertaken in accordance with the DPIW Wetlands and Waterways Works Manual. A variety of erosion and sedimentation controls, particular to specific construction areas, will be utilised throughout the project and will include the following measures:

- The areas disturbed will be kept to the minimum practicable level required for construction.
- Disturbed areas will be rehabilitated and revegetated as soon as practicable after disturbance in order to minimise erosion and sedimentation.
- Temporary rehabilitation of sites will be undertaken in areas where final rehabilitation will be delayed for various reasons. This may include measures such as the installation of temporary erosion matting covers, etc.
- Overland drainage flow will be diverted away from disturbed areas and bare soil to outfalls with sediment traps to reduce the potential for erosion.
- Sedimentation controls will be used, where required, to reduce particulates in surface water run-off from entering local waterways:
  - Silt stop fencing will be used to prevent any disturbed sediment from reaching local creeks and waterways
  - All drainage from site drains will be directed to outfalls with sediment traps
  - The materials or sediments collected in these sediment traps will be disposed of within the site, if practicable, or will be disposed of in accordance with EPA requirements.
- The access road's crossing of East Creek will be constructed with an open-bottomed culvert, designed and sited in accordance with the Manual;
- Where any river/drainage line crossings require construction activities to be undertaken within the waterway:
  - Silt stop netting will be established at an appropriate distance downstream from the construction site to collect any disturbed sediment
  - If feasible, temporary measures will be undertaken immediately upstream of the site to control the rate of water flow (e.g. measures to divert the water around part of the site to enable construction)
  - All river/drainage line crossing construction work that requires any instream activities will be undertaken at times of low flow to minimise the potential for sediment generation.
- All erosion and sedimentation controls will be established prior to the commencement of the works and will only be removed following completion of the earthworks and other construction activities, once disturbed soil has stabilised.
- Erosion and sedimentation controls will be inspected at least weekly and also following heavy rainfall events throughout the construction period. If inspections reveal any damage, they will be repaired as soon as practicable.
- All stockpiled materials will be controlled to ensure that dust is minimised and potential runoff from these stockpiles does not enter watercourses.
- All mitigation measures will be outlined in detail in the Construction Environmental Management Plan.

Following construction, there is potential for impact to local waterways and drainage lines as a result of runoff from the road surfaces and mining activities. Environmentally sensitive drainage design that allows sufficient treatment of this runoff prior to release into the environment will be utilised.

Plant hygiene measures

The botanical survey observed no symptomatic evidence of *Phytophthora* anywhere within the study area but the vegetation type would be susceptible to infection.

Hygiene measures for *Phytophthora* management have been implemented at entry points to the site during the exploration phase.

Appropriate hygiene protocols, including wash down procedures, will be maintained on the site during the development and operation of the mine. These protocols, which will be consistent with the recommendations of the DPIW Biodiversity Conservation Branch report titled: "Interim *Phytophthora cinnamomi* Management Guidelines", will include maintenance of current hygiene treatment stations at entry points to the area and ensuring that personnel observe strict protocols in treating boots, equipment, vehicles and machinery before entering any potentially infected area.

Construction materials

The major requirements for construction materials will relate to construction of new roads and upgrading of existing roads, construction of the tailings storage facility and aggregate for concrete construction.

It is anticipated that all construction materials required will be sourced from on site, apart from some road materials and concrete aggregate. At this stage, the local materials appear to be suitable for road base and/or concrete aggregate after crushing.

NAF waste rock will be used to construct the tailings storage facility dam wall and locally derived clay will be used to provide an impermeable lining. Local clay will be used to construct the PAF waste rock cell in the DSO pit.

Commissioning

Commissioning is expected to consist of two main phases:

- Development of an initial, short-term operation based on mining and shipping of the near-surface oxidised ore (hematite) – the Direct Shipping Ore (DSO)
- Development of the main operation - the mining and processing of the lower grade hematite ore and then the underlying magnetite ore.

The initial short-term DSO operation is expected to last 1 – 2 years. It will require the installation of plant to crush and screen the DSO, the development of a shallow mining operation based on this ore and the establishment of infrastructure to load the crushed and screened ore. Port infrastructure to stockpile and load the ore will also be developed in this initial phase.

During this initial mining operation phase the main pit will be developed, together with the waste rock dump, the process plant and the tailings storage facility.

Commissioning of the main pit and process facilities is expected to occur in the second year after the commencement of DSO production.

3.19 Off-site infrastructure

All processing infrastructure will be on-site. The only off-site infrastructure used will be the State road network for product transport to Burnie port (or Port Latta).

Product transport from the 150,000 tonnes pa operating mine will require approximately 40 truck movements a day (i.e. 20 loads per day). This is based on a nominal five day week but, subject to the transport contract, trucking may occur 7 days a week. During the first year, when the DSO pit, is operating the transport task would be approximately 350,000 tpa.

4. Matters of National Environmental Significance

Guideline requirements for this section

The draft environmental impact statement must identify threatened species and communities and migratory species listed under the EPBC Act that are likely to be impacted, directly or indirectly, as a consequence of the proposed action (this may include species or communities that do not occur on site). For each of these species or communities, the following information must be provided:

a) information on the abundance, distribution, ecology, and habitat preferences of the species or community

b) discussion of known threats to the species or community, with reference to threats posed by the proposed action

c) maps identifying at both site and regional (at a minimum including the Nelson Bay River catchment) levels:

i. all known occurrences of the species or community

ii. all potential habitat for the species (differentiating where relevant on the basis of use (e.g. breeding habitat, migration pathways, feeding habitat, etc)

d) discussion of any surveys used to detect the species or community, including the following:

i. methods, including timing, equipment and qualifications of personnel

ii. results, including reliability and limitations

iii. where relevant, justification for not conducting surveys or deviating from best practice methodology

e) for all species or communities that are considered unlikely to be impacted by the action, but for which apparently suitable habitat is present and could be impacted by the proposed action, detailed information to demonstrate that impacts on the species are unlikely to occur.

Consideration of each species or community must have regard to any recovery plan prepared by a Commonwealth or state government, in relation to the species or community, and any publicly available policy statement prepared by the Department of Sustainability, Environment, Water, Population and Communities in relation to the species or community.

At a minimum, potential impacts on species and communities listed in Appendix 1 must be addressed. Targeted surveys within suitable habitat likely to be impacted by project activities are required for all species in Appendix 1.

Appendix 1 – Species and communities of particular interest

Species/community and status	*Specific issues for consideration (if any)*
Mammals	
Sarcophilus harrisii *Tasmanian devil* *Endangered*	*The single biggest threat to the survival of this species is the highly contagious Devil Facial Tumour Disease. The relatively disease free north-western populations consequently hold particular conservation value. In this context the department notes that while habitat loss is not generally a key threat to this species, it is more significant where the population is of inherently high conservation significance. Information on the likely impacts of the proposed action in this respect is required; in particular:* • *rates of infection amongst the local population of this species;* • *discussion of whether the proposed action might facilitate the intermixing of populations of this species, leading to increased rates of infection; and* • *any measures proposed to mitigate and/or compensate for any increased infection.*

Species/community and status	*Specific issues for consideration (if any)*
	The impact of roadkills arising from increased traffic and availability of road killed carrion must also be addressed. Baseline data collected from the Arthur River Road and Blackwater Road must be used in the assessment of impacts. *The draft environmental impact statement must assess impacts from project activities on this species and its habitat in accordance with guideline 4. Given the area of apparently high quality habitat for this species that will be disturbed by the proposed action, it is currently assumed that a healthy population of this species exists at the site of the proposed action. Given the area of apparently high quality habitat for this species that will be disturbed by the proposed action, it is currently assumed that a healthy population of this species exists at the site of the proposed action.*
Dasyurus maculatus subsp. maculatus (Tasmanian population) spot-tailed quoll *Vulnerable*	*Impacts on this species other than loss of habitat have not yet been addressed, and must be in the draft environmental impact statement. Such impacts may include road kills arising from increased traffic and availability of road killed carrion.* *The draft environmental impact statement must assess impacts from project activities on this species and its habitat in accordance with guideline 4. Given the area of apparently high quality habitat for this species that will be disturbed by the proposed action, it is currently assumed that a healthy population of this species exists at the site of the proposed action.* *The draft environmental impact statement must include strategies to mitigate and / or compensate for likely and potential impacts on this species.*
Amphibians	
Litoria raniformis Green and Golden Bell Frog *vulnerable*	*The draft environmental impact statement must assess impacts to this species.*
Birds	
Aquila audax subsp. fleayi Wedge-tailed eagle (Tasmanian) *Endangered*	*Information provided by the proponent indicates that further aerial searches in areas of potential habitat are required to establish the degree of utilisation of the site of the proposed action by this species.* *Impacts on this species other than loss of nesting habitat have not yet been addressed, and must be addressed in the draft environmental impact statement. Such impacts include visual and noise impacts, and road kills arising from increased traffic and availability of road killed carrion.* *If found to be present at the site of the proposed action and likely to be significantly impacted, strategies to mitigate and/or compensate for impacts on this species are required.*

Species/community and status	*Specific issues for consideration (if any)*
Alcedo azurea diemenensis *Azure Kingfisher (Tasmanian)* *Endangered* [Note that this species has been renamed to *Ceyx azurea diemenensis* and is referred to by its new name in this EIS]	*The draft environmental impact statement must assess impacts to this species.*
Lathumus discolor *Swift parrot* *Endangered*	*Migratory habitat is of particular interest.*
Neophema chrysogaster *Orange-bellied parrot* *Critically Endangered*	*Migratory habitat is of particular interest.*
Tyto novaehollandiae castanops *Tasmanian Masked Owl* *vulnerable*	*The draft environmental impact statement must assess impacts to this species.*
Fish	
Prototroctes maraena *Australian grayling* *Vulnerable*	*Further detail on migratory barriers is required.* *Potential for contamination of groundwater and surface water must be addressed. The Nelson Bay River, upstream of proposed activities is known to support individuals.*
Crustaceans	
Astacopsis gouldi *Tasmanian giant freshwater crayfish* *Vulnerable*	*This species was not addressed in referral documentation and must be addressed in the draft environmental impact statement.*
Plants	
Caladenia dienema *Windswept spider-orchid* *Critically Endangered*	*Hydrological impacts are of particular interest, noting that the extent of likely hydrological impacts is not clear from the referral documentation.* *1. Targeted surveys. The proponent must conduct seasonal targeted surveys both inside and adjacent to the site impacted by the development before and during development. These surveys need to be assessed against existing population records to determine the significance of the development impact. Surveys 1- 3 years after fire are highly recommended in this region given the nature of the fire regimes and orchid's response to fire. These surveys must be conducted between late October and early November (a month later for D. lanceolata).* *2. The proponent must conduct baseline research into the mycorrhizal requirements of impacted orchids. It is widely accepted that mycorrhizal distribution directly influences orchid distribution. Currently, little is known about orchid mycorrhizal distribution patterns other than being patchy across the landscape and sensitive to changes in hydrology and soil organic content. Orchids maintain a mycorrhizal association throughout their life but may survive on tuber storage reserves for up to two years if the mycorrhizal association is lost.*
Prasophyllum secutum *Northern leek-orchid* *Endangered*	
Pterostylis rubenachii *Arthur River greenhood* *Endangered*	

Species/community and status	*Specific issues for consideration (if any)*
	Research required to mitigate against this impact is mycorrhizal distribution assessment studies using orchid seed as 'baits' for mycorrhizal presence. This allows the testing for mycorrhizal presence/absence along transects across the landscape for a variety of orchids and habitats. This can also be used to detect potential sites for reintroduction post development. Seed 'baits' are placed in the soil in May (start of the growing season) and retrieved in October for scoring and assessment. *3. The proponent must conduct baseline research into pollinator requirements of impacted orchids. Orchids have a variety of pollination mechanisms some more elaborate than others. The Prasophyllum sp. here are self-pollinated and the development in unlikely to impact on fruit set. The pollination mechanism for Caladenia dianeama is considerably more complex as they require a specific native wasp for pollination. Wasp presence can be surveyed through recording fruit set rates and by pollinator 'baiting' studies where flowers are used (during Oct and Nov) as 'baits' to attract wasps. Although these species were not located within the immediate impact zone, this work is highly recommended to determine if the habitat may contain suitable pollinator populations.*
Diuris lanceolata *Snake orchid* *Endangered*	*These species were not addressed in referral documentation and must be addressed in the draft environmental impact statement.* *Hydrological impacts are of particular interest, noting that the extent of likely hydrological impacts is not clear from the referral documentation.*
Genoplesium brachystachyum *Short-spiked midge-orchid* *Endangered* [Note that this species has been renamed to *Corunastylis brachystachya* and is referred to by its new name in this EIS]	
Pterostylis ziegeleri *Grassland greenhood* *Vulnerable*	
Prasophyllum pulchellum *Pretty leek-orchid* *Critically Endangered*	*Further targeted surveys are recommended to ensure that the likely impacts of the proposed action on this species are better understood.* *Hydrological impacts are of particular interest, noting that the extent of likely hydrological impacts is not clear from the referral documentation.*
Prasophyllum favonium *Western leek-orchid* *Critically Endangered*	

A flora and flora survey[8] has been undertaken and the survey report is provided in Appendix N.

The mapped vegetation communities and threatened species flora and fauna observations from the survey are shown in Figure 15.[9]

[8] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[9] This map includes a small extension outside the surveyed area, an extension that resulted from design changes to the tailings dam in response to matters raised in the EIS guidelines. For that extension, Tasveg mapping is used. The vegetation communities of this extension are not habitats suited to likely threatened flora (such as orchids).

A survey[10] for the giant freshwater crayfish (*Astacopsis gouldi*) has also been undertaken and this is provided in Appendix O.

The results of a roadkill and headlight observation survey[11] of regional roads commissioned by the Department of Infrastructure, Energy and Resources for a separate project are provided in Appendix P.

A survey of Nelson Bay River for the Australian grayling (*Prototroctes maraena*) was not undertaken because a hydraulic barrier near the mouth of the river (see Figure 34) would prevent the grayling from swimming upstream. Instead, a general fish survey will be undertaken downstream of the mine at an appropriate time of year during the first year of operations. Similar surveys will be repeated in 3 year intervals, in years 4, 7 and 10. The survey will be undertaken in accordance with the Tasmanian River Condition Index protocol.

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[10] Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River*. Report prepared for Pitt & Sherry.

[11] Data (by Wildspot Consulting) and mapping (by Northbarker Ecosystem Services) provided courtesy of the Department of Infrastructure, Energy & Resources.

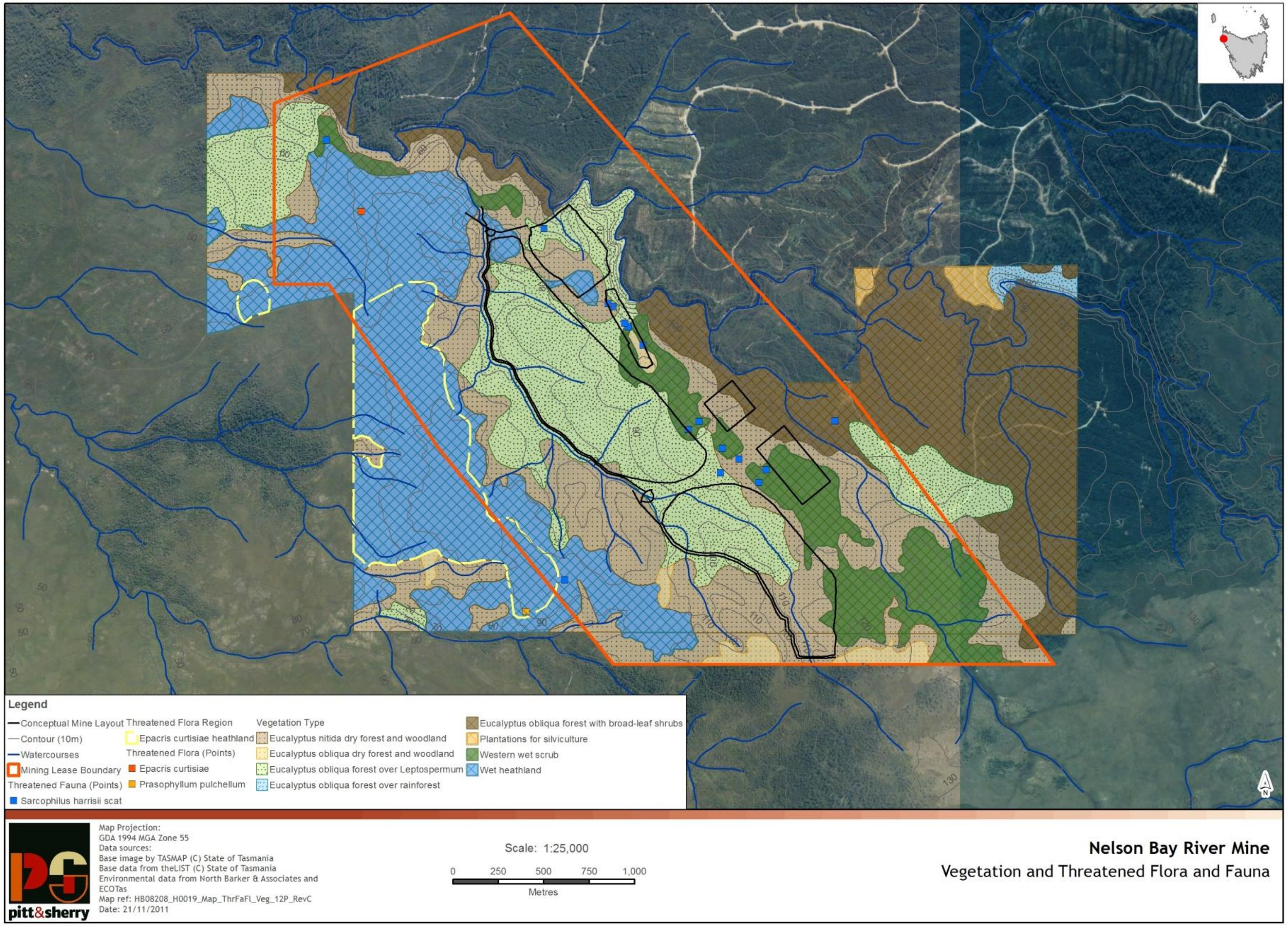

Figure 15: Vegetation communities and threatened species observations

4.1 Flora

Table 22 lists threatened flora species listed under both the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Tasmanian *Threatened Species Act 1995* (TSP Act) previously recorded within a 5 km radius of the proposed mine site.

Figure 16 **shows the EPBC Act listed flora species in relation to the proposed mine layout. The preferred habitats of these species, together with comments on the occurrences of suitable habitat in relation to the mine site are described later in**

Table 26 in section 6.2.2.

Table 22: Threatened flora recorded from within 5 km of the proposed mine site[12]

Species	EPBC Act listing	TSP Act listing	Potential to occur[13]	Closest distance of known populations to the mine lease boundary (km)[14]
Caladenia dienema windswept spider orchid	Critically Endangered	Endangered	low	0.1
Caladenia pusilla tiny fingers	-	Rare	low	-
Corunastylis brachystachya short-spiked midge orchid [Referred to by its old name of *Genoplesium brachystachyum* in the EIS guidelines]	Endangered	Endangered	low	3.0
Cullen microcephalum dusky scurfpea	-	Rare	none	-
Diuris lanceolata large golden moths	Endangered	Endangered	none	3.4
Epacris curtisiae northwest heath	-	Rare	present	-
Lotus australis Australian trefoil	-	Rare	none	-
Phyllangium divergens wiry mitrewort	-	Vulnerable	none	-
Prasophyllum favonium western leek orchid	Critically Endangered	Endangered	moderate	3.3
Prasophyllum pulchellum pretty leek orchid	Critically Endangered	Endangered	present	0.2
Prasophyllum secutum northern leek orchid	Endangered	Endangered	none	4.8
Pterostylis rubenachii Arthur River greenhood	Endangered	Endangered	none	4.8
Spyridium vexilliferum var. *vexilliferum* helicopter bush	-	Rare	low	-
Xerochrysum bicolor eastcoast everlasting	-	Rare	low	-

[12] Natural Values Report, 15/11/2010, DPIPWE, Report Number: 40737
[13] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[14] Natural Values Atlas data (Download on 3/05/2011) and field survey data from Northbarker Ecosystem Services

Figure 16: Distribution of EPBC Act listed threatened flora in relation to the Mine Lease Boundary[15]

[15] This map has been compiled from the Natural Values Atlas data (Download on 3/05/2011) and field survey data from Northbarker Ecosystem Services. Species shown on the map are only EPBC Act listed species. The extent of the map is a 6 km buffer from the Mining Lease extent in the northern and southern direction but not in an inland easterly direction due to the fact that no data exists for this region. The map excludes the species *Pterostylis ziegeleri* as the closest known location of this species is 10.5 km away to the north near Gardiner Point. This species is required to be addressed as per the EIS Guidelines.

4.1.1 *Caladenia dienema* - windswept spider orchid (Critically Endangered)

Abundance

The estimated total population of *Caladenia dienema* is less than 250 mature individuals with most subpopulations comprising less than 20 mature individuals usually occurring as scattered plants over a relatively small area. The species has a patchy distribution along the west coast, comprising 16 subpopulations spread over approximately 90 km.[16]

Potential flowering is all of October and November[17].

Distribution and habitat

Caladenia dienema is endemic to western and northwestern Tasmania with the core part of its range in the Temma to Marrawah region (see Figure 17). Its historical recording from the north coast indicates a potentially much wider distribution including the whole northwestern tip of the State. The potential habitat for the species is widespread on the west coast and is identified as coastal heathland within 1 km of the coastline.[18] There are several recent records for this species from late 2008 and 2009 between Tiger Creek and Sundown Creek and near Couta Rocks.[19]

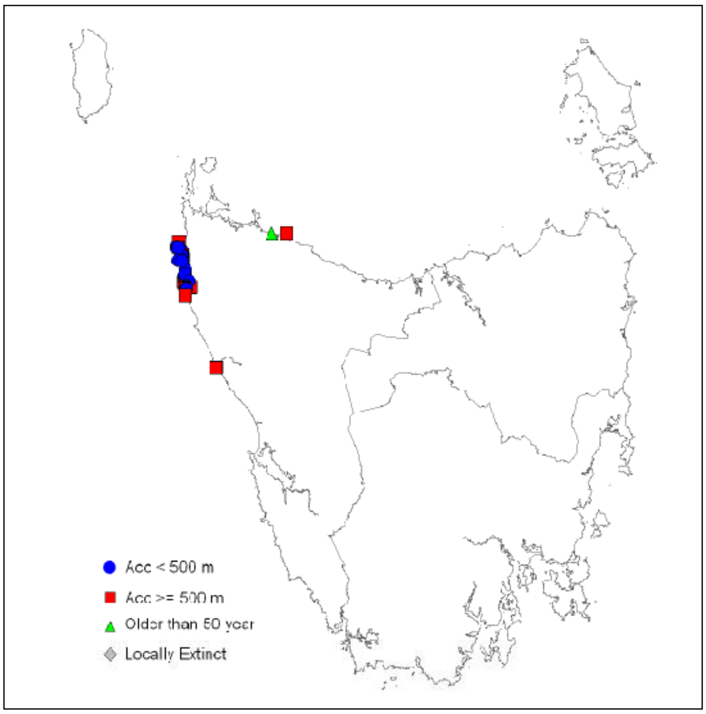

Figure 17: Distribution of *Caladenia dienema* (Source: Threatened Species Section (2010) *Listing Statement for* Caladenia dienema *(windswept spider-orchid).* Department of Primary Industries, Parks, Water and Environment, Tasmania.)

[16] Threatened Species Section (2010) *Listing Statement for* Caladenia dienema *(windswept spider-orchid).* Department of Primary Industries, Parks, Water and Environment, Tasmania.
[17] Wapstra, M. N. Roberts, H. Wapstra and A. Wapstra (2010) *Flowering times of Tasmanian orchids: a practical guide for field botanists*.
[18] Threatened Species Section (2010) *Listing Statement for* Caladenia dienema *(windswept spider-orchid).* Department of Primary Industries, Parks, Water and Environment, Tasmania.
[19] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

The species is known from coastal scrub and windswept coastal grassland and heaths amongst stunted shrubs and sedges on moist to well-drained sand and clay loams.[20]

Known threats

The key threat to *Caladenia dienema* is clearance of habitat in the near–coastal areas of the west and northwest coasts. Recently, the key threat has included inappropriate fire regimes which have resulted in changes to the vegetation types supporting the species. In summary, the threats to the species include the following[21]:

- Land clearance (including agricultural and coastal development)
- Development on public land (many populations of the species are within the Arthur–Pieman Conservation Area)
- Inappropriate fire regime (greater abundance at sites subject to higher intensity summer fires)
- Recreational activities (further development of recreational activities within the Arthur–Pieman Conservation Area)
- Cattle agistment (Arthur–Pieman Conservation Area is subject to cattle grazing through agistment licences)
- *Phytophthora cinnamomi* (no populations are currently effected; however, there is a potential to introduce or spread through recreational activities within the Arthur–Pieman Conservation Area); and
    - Stochastic risks (less than 250 mature individuals from fewer than 20 subpopulations).

Study area

Caladenia dienema was not recorded in the study area. As the study area is considerably inland, it is unlikely that this species occurs at the proposed mine site[22]. The nearest known recorded populations are 100 m away from the proposed mine lease boundary (see Figure 16). However, this record may be incorrect as the location places the population in thick woodland.

4.1.2 *Corunastylis brachystachya* – short-spiked midge orchid (Endangered)

(Referred to by its old name of *Genoplesium brachystachyum* in the EIS guidelines)

Abundance

There is no listing statement available in regard to *Corunastylis brachystachya*. The total numbers of individuals is unknown. Little information is available on the size or security of these populations[23].

The few records of this species suggest a potential to flower from February to April[24].

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[20] Threatened Species Section (2010) *Listing Statement for* Caladenia dienema *(windswept spider-orchid).* Department of Primary Industries, Parks, Water and Environment, Tasmania.

[21] Threatened Species Section (2010) *Listing Statement for* Caladenia dienema *(windswept spider-orchid).* Department of Primary Industries, Parks, Water and Environment, Tasmania.

[22] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[23] Threatened Species Section (2006) *Flora Recovery Plan: Tasmanian Threatened Orchids 2006-2010.* Department of Primary Industries, Water and Environment, Hobart.

[24] Wapstra, M. N. Roberts, H. Wapstra and A. Wapstra (2010) *Flowering times of Tasmanian orchids: a practical guide for field botanists.*

Distribution and habitat

Corunastylis brachystachya is known from Rocky Cape National Park and near Stanley in the north-west of Tasmania[25] (see Figure 18). It has been found most recently in March 2010 within 5 km of the study area from two populations.[26] The species is known from heathland and heathy eucalypt woodland on well-drained rocky sites[27].

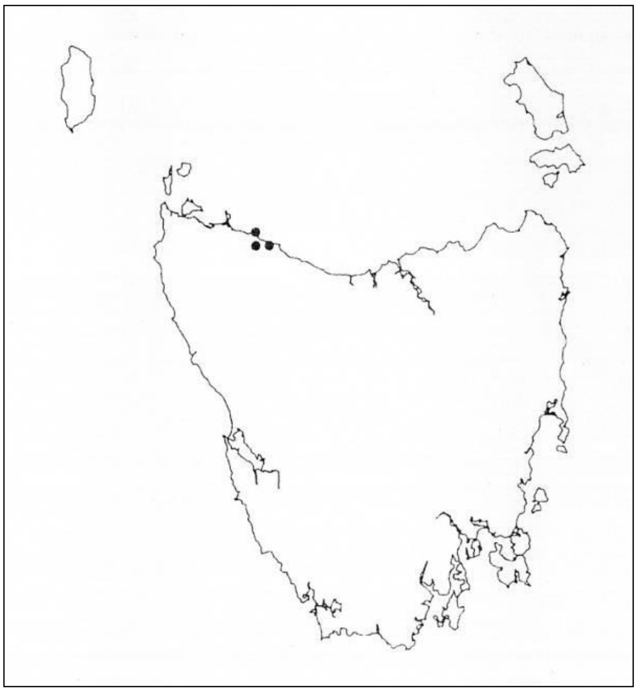

Figure 18: Distribution of *Corunastylis brachystachya (*Source: Jones et. al. (1999) *The Orchids of Tasmania.* The Miegunyah Press at Melbourne University Press, Carlton.)

Known threats

There appear to be no documents identifying particular threats to this species.

Study area

The site survey was undertaken outside the flowering season for *Corunastylis brachystachya* but the potential for this species to occur is considered to be very low[28 and 29]. The nearest known recorded populations are 3.0 kilometres away from the proposed mine lease boundary (see Figure 16).

[25] Jones, D., Wapstra, H., Tonelli, P. and Harris, S. (1999) *The Orchids of Tasmania.* The Miegunyah Press at Melbourne University Press, Carlton, Victoria.
[26] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[27] Jones, D., Wapstra, H., Tonelli, P. and Harris, S. (1999). *The Orchids of Tasmania.* The Miegunyah Press at Melbourne University Press, Carlton, Victoria .
[28] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[29] Mark Wapstra pers. comm.

4.1.3 *Diuris lanceolata* - large golden moths (Endangered)

Abundance

The estimated total population of *Diuris lanceolata* (in a good flowering year) is between 500 and 800 plants with 200 to 250 in each of the two largest populations at Anthony Beach and Rebecca Lagoon. There are six known populations. However, due to agricultural activities the populations at Woolnorth and Harcus River Road are now considered extinct. Because of the restricted area of suitable habitat, the populations at Sundown Point and Nelson Bay are small.[30] Targeted surveys in the summer of 2008/2009 located extant populations near Sundown Point and near Rebecca Lagoon, west of the study area.[31]

Flowering may occur from November to January[32].

Distribution and habitat

Diuris lanceolata is endemic to Tasmania and is confined to a 1,220 square kilometre area in the north west corner of the State. Its distribution is localised in the Arthur River region and between Stanley and Smithton (See Figure 19). The species is known from windswept coastal grassland and coastal scrub and heathland among dwarfed shrubs and sedges on moist to well drained sandy and clay loam, sometimes on rocky outcrops.[33]

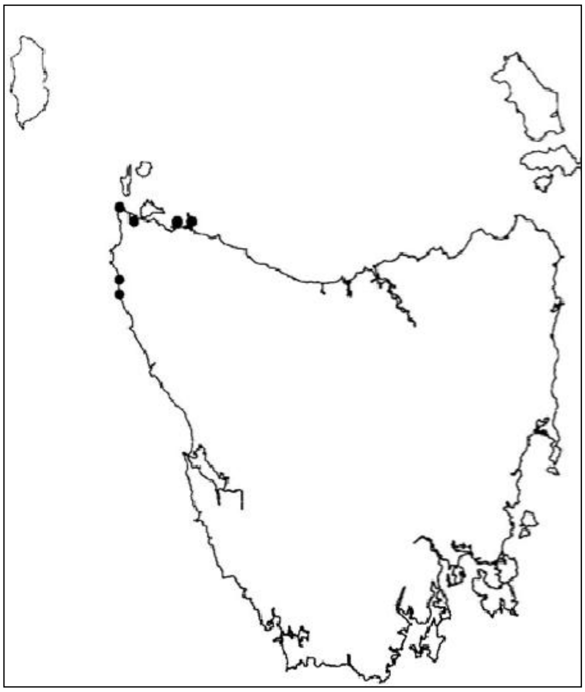

Figure 19: Distribution of *Diuris lanceolata* (Source: Threatened Species Unit (2000) *Listing Statement large golden moths* Diuris lanceolata. Department of Primary Industries, Water and Environment, Tasmania.)

[30] Threatened Species Unit (2000) *Listing Statement large golden moths* Diuris lanceolata. Department of Primary Industries, Water and Environment, Tasmania.
[31] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[32] Wapstra, M. N. Roberts, H. Wapstra and A. Wapstra (2010) *Flowering times of Tasmanian orchids: a practical guide for field botanists.*
[33] Threatened Species Unit (2000) *Listing Statement large golden moths* Diuris lanceolata. Department of Primary Industries, Water and Environment, Tasmania.

Known threats

The key threats to *Diuris lanceolata* are clearing, draining and pasture development, which is believed to have eliminated the species from much of its historical distribution. The sites at Sundown Point and Nelson Bay are not subject to any known threats.[34]

Study area

Diuris lanceolata was not recorded in the study area. The species is unlikely to extend as far inland as the study area and it is considered that there is no potential for this species to occur.[35] The nearest known recorded populations are 3.4 kilometres away from the proposed mine lease boundary (see Figure 16).

4.1.4 *Prasophyllum favonium* - western leek orchid (Critically Endangered)

Abundance

The estimated total population of *Prasophyllum favonium* is less than 40 plants. There are five known localities of the species, each with a single population (except for Couta Rocks which has two). Populations are usually very small, with 1 or 2 colonies each consisting of 3 to 5 plants occupying and an area of 5–10 metres.[36]

It potentially flowers from early October to early December[37].

Distribution and habitat

Prasophyllum favonium is endemic to Tasmania and is confined to a narrow 30 km stretch between West Point and Sandy Cape in the far north west of the State (see Figure 20).[38] There are records of the species near Couta Rocks and the Heemskirk Road from recent surveys in late 2008.[39] The species is known from among shrubs in windswept, dense low heathland on moderately drained grey to black sandy peaty loam.[40]

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[34] Threatened Species Unit (2000) *Listing Statement large golden moths* Diuris lanceolata. Department of Primary Industries, Water and Environment, Tasmania.
[35] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[36] Threatened Species Unit (2000) Listing Statement Western leek orchid *Prasophyllum favonium.* Department of Primary Industries, Water and Environment, Tasmania.
[37] Wapstra, M. N. Roberts, H. Wapstra and A. Wapstra (2010) *Flowering times of Tasmanian orchids: a practical guide for field botanists*.
[38] Threatened Species Unit (2000) Listing Statement Western leek orchid *Prasophyllum favonium.* Department of Primary Industries, Water and Environment, Tasmania.
[39] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[40] Threatened Species Unit (2000) Listing Statement Western leek orchid *Prasophyllum favonium.* Department of Primary Industries, Water and Environment, Tasmania.

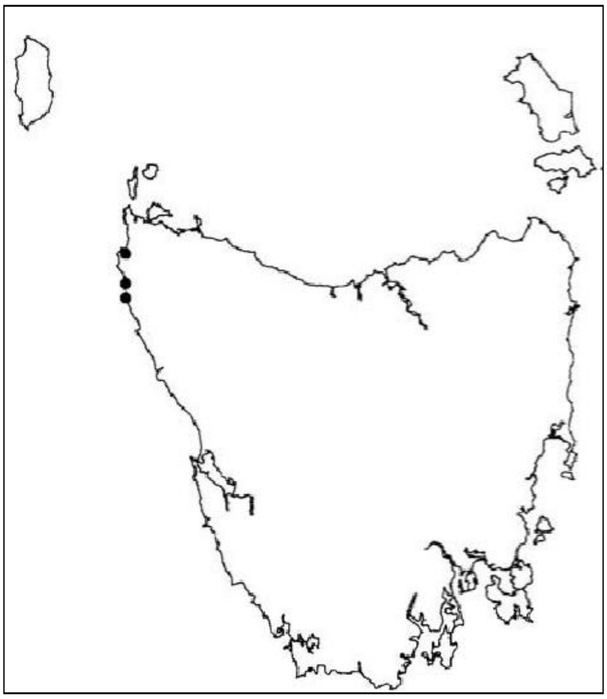

Figure 20: Distribution of *Prasophyllum favonium* (Source: Threatened Species Unit (2000) Listing Statement Western leek orchid *Prasophyllum favonium.* Department of Primary Industries, Water and Environment, Tasmania)

Known threats

The key threats to *Prasophyllum favonium* is conversion of suitable habitat to agricultural uses. The species may have had a widespread distribution in the coastal heathlands of the northern West Coast of the State. However, most of the suitable habitat in the area has been converted to agricultural use.

The key concern with this species is the small number and size of known colonies. These small populations could easily be destroyed by prolonged droughts and other localised disturbance events. Within the Arthur-Pieman Conservation Area, heathland cattle agistment poses a threat.[41]

Study area

Prasophyllum favonium was not recorded in the study area. The wet heathland on the western boundary of the study area has the greatest potential to contain this species, although it was not recorded during the survey. The potential for this species to occur in the study area is considered to be moderate.[42] The nearest known recorded populations are 3.3 kilometres away in relation to the proposed mine lease boundary (Figure 16).

[41] Threatened Species Unit (2000) Listing Statement Western leek orchid *Prasophyllum favonium.* Department of Primary Industries, Water and Environment, Tasmania.
[42] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

4.1.5 *Prasophyllum pulchellum* - pretty leek orchid (Critically Endangered)

Abundance

The estimated total population of *Prasophyllum pulchellum* (mature individuals) is approximately 130 plants. There are five known populations of the species, with the possibility of at least another on the Tasman Peninsula. To date, the populations are generally small and compact (less than 0.3 hectares in total), with the two largest populations having approximately 50 plants each.[43]

There is potential for this species to flower between October and December[44].

Distribution and habitat

Prasophyllum pulchellum is endemic to Tasmania and is known from widely scattered coastal localities in the south and north of the state (see Figure 21).[45] The species has six records from nearby at the same location over 4 years.[46] The species is known from dense low sedgy heath with pockets of paperbark or tea-tree on poorly to moderately drained sandy or peaty loam.[47]

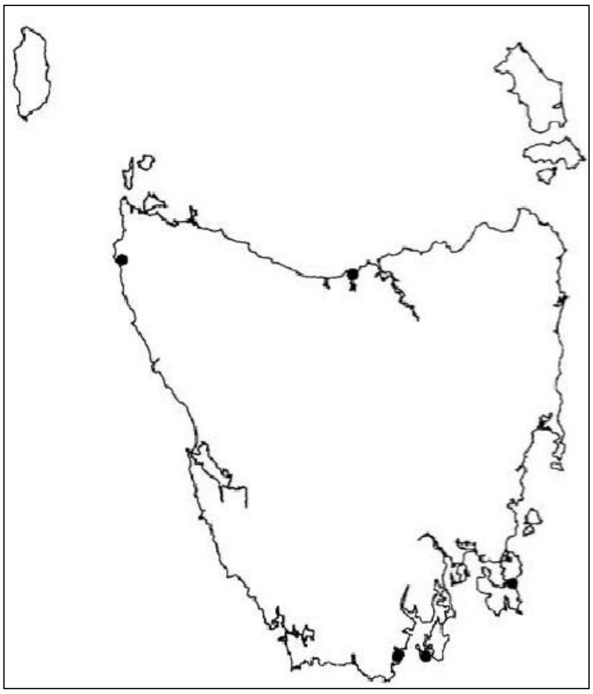

Figure 21: Distribution of *Prasophyllum pulchellum* (Source: Threatened Species Unit (2000) Listing Statement Pretty leek orchid *Prasophyllum pulchellum.* Department of Primary Industries, Water and Environment, Tasmania)

[43] Threatened Species Unit (2000) Listing Statement Pretty leek orchid *Prasophyllum pulchellum.* Department of Primary Industries, Water and Environment, Tasmania.
[44] Wapstra, M. N. Roberts, H. Wapstra and A. Wapstra (2010) *Flowering times of Tasmanian orchids: a practical guide for field botanists*.
[45] Threatened Species Unit (2000) Listing Statement Pretty leek orchid *Prasophyllum pulchellum.* Department of Primary Industries, Water and Environment, Tasmania.
[46] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[47] Threatened Species Unit (2000) Listing Statement Pretty leek orchid *Prasophyllum pulchellum.* Department of Primary Industries, Water and Environment, Tasmania.

Known threats

The key threats to *Prasophyllum pulchellum* is modification of habitat from subdivision and cropping. Inappropriate fire regimes are a threat as the species requires regular fire to stimulate emergence and flowering.

The species has a very scattered distribution with colonies containing low numbers of plants in very small patches. This makes the loss of a population a realistic threat.[48]

Study area

Twenty plants flowering in an area of 3 square metres were found during the current survey approximately 200 metres away in relation from the proposed mine lease boundary (see Figure 16). This population is in wet heathland at the edge of a slashed track. The time since last fire at the location is approximately four years.[49]

4.1.6 *Prasophyllum secutum* - northern leek orchid (Endangered)

Abundance

The estimated total population of *Prasophyllum secutum* (mature individuals) is approximately 500 plants. There are 13 known populations and more are likely to be found as the species has a wide distribution. Only two relatively large populations (100–150) have been found to date. The other populations are small (10–30 plants).[50]

There is potential for this species to flower between October and December[51].

Distribution and habitat

Prasophyllum secutum is endemic to Tasmania where it is localised and uncommon along the north coast of the State, on the West Coast at Ocean Beach and on Flinders Island (see Figure 22). The species is known from dense coastal scrub in the swales of stabilised sand dunes on white to grey sands and sandy loam.[52]

[48] Threatened Species Unit (2000) Listing Statement Pretty leek orchid *Prasophyllum pulchellum.* Department of Primary Industries, Water and Environment, Tasmania.
[49] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[50] Threatened Species Section (2008) Listing Statement Northern leek –orchid *Prasophyllum secutum.* Department of Primary Industries & Water, Tasmania.
[51] Wapstra, M. N. Roberts, H. Wapstra and A. Wapstra (2010) *Flowering times of Tasmanian orchids: a practical guide for field botanists.*
[52] Threatened Species Section (2008) Listing Statement Northern leek–orchid *Prasophyllum secutum.* Department of Primary Industries & Water, Tasmania.

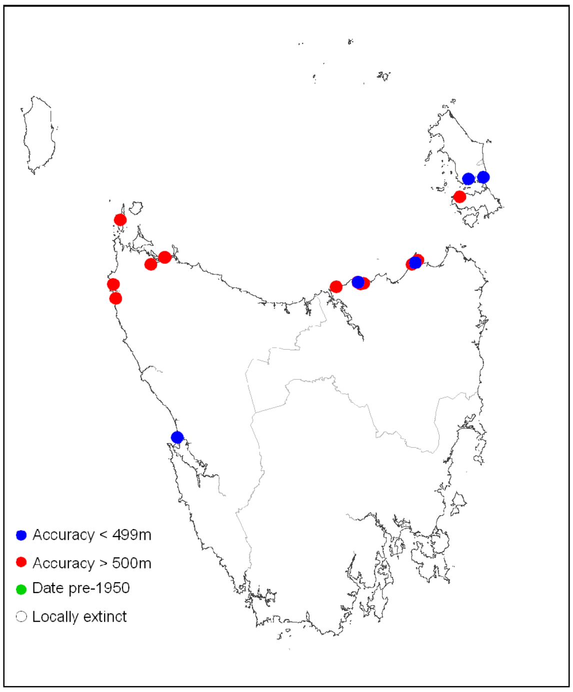

Figure 22: Distribution of *Prasophyllum secutum* (Source: Threatened Species Section (2008) Listing Statement Northern leek-orchid *Prasophyllum secutum.* Department of Primary Industries & Water, Tasmania.)

Known threats

The key threats to *Prasophyllum secutum* have been degraded or destroyed coastal heath habitat on the north coast from agriculture and coastal development. Inappropriate fire regimes are a threat as the species requires regular fire to trigger emergence and good flowering.[53]

Study area

Prasophyllum secutum was not recorded in the study area. As there are no grassy dune swales within the study area, there is considered to be no potential for this species to occur.[54] The nearest known recorded populations are 4.8 kilometres away from the proposed mine lease boundary (see Figure 16).

4.1.7 *Pterostylis rubenachii* - Arthur River greenhood (Endangered)

Abundance

The estimated total population of *Pterostylis rubenachii* is approximately 800 plants. There are 3 known populations, although most occur in only one population south of Arthur River.[55]

This species potentially flowers from October to November[56].

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[53] Threatened Species Section (2008) Listing Statement Northern leek-orchid *Prasophyllum secutum.* Department of Primary Industries & Water, Tasmania.
[54] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[55] Threatened Species Unit (2000) Listing Statement Arthur River greenhood *Pterostylis rubenachii.* Department of Primary Industries, Water and Environment, Tasmania.
[56] Wapstra, M. N. Roberts, H. Wapstra and A. Wapstra (2010) *Flowering times of Tasmanian orchids: a practical guide for field botanists*.

Distribution and habitat

Pterostylis rubenachii is endemic to Tasmania and is only found in the Arthur river area where it extends over an area of 8 square kilometres occupying 3 hectares in total (see Figure 23). The species occurred on the north west coast at Western Plains and at Cowrie Point but is now believed to be extinct at these locations. The species is known from dry, sandy slopes of sparsely vegetated stabilised sand dunes, and also in permanently wet to moist scrubby and sedgy coastal heath converted to semi-improved pasture by annual slashing.[57]

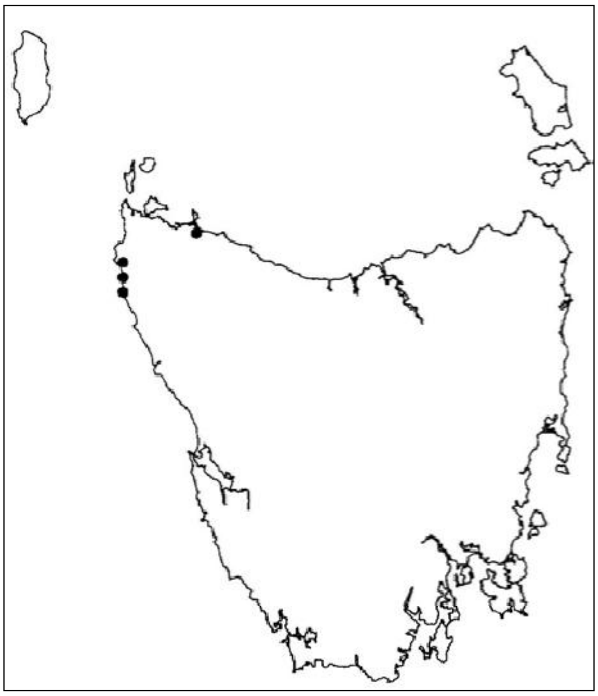

Figure 23: Distribution of *Pterostylis rubenachii* (Source: Threatened Species Unit (2000) Listing Statement Arthur River greenhood *Pterostylis rubenachii.* Department of Primary Industries, Water and Environment, Tasmania)

Known threats

The entire distribution of *Pterostylis rubenachii* is associated with modified environments maintained by slashing and winter agistment. The principal threats to the species are associated with a change of land management regimes.[58]

Study area

Pterostylis rubenachii was not recorded in the study area. As no similar habitat occurs in the study area, there is considered to be no potential for the species to occur.[59] The nearest known recorded populations are 4.8 kilometres away from the proposed mine lease boundary (see Figure 16).

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[57] Threatened Species Unit (2000) Listing Statement Arthur River greenhood *Pterostylis rubenachii.* Department of Primary Industries, Water and Environment, Tasmania.
[58] Threatened Species Unit (2000) Listing Statement Arthur River greenhood *Pterostylis rubenachii.* Department of Primary Industries, Water and Environment, Tasmania
[59] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

4.1.8 *Pterostylis ziegeleri* - grassland greenhood (Vulnerable)

Abundance

The estimated total population of *Pterostylis ziegeleri* is approximately 6000–7000 plants. There are 25 to 30 subpopulations (though some of these are considered extinct) with the largest sub population, at Crooked Billet (Brighton) consisting of 3000–4000 plants.[60]

This species can flower throughout the period from September to December[61].

Distribution and habitat

Pterostylis ziegeleri is endemic to Tasmania and is found in widely separated localities ranging from lowland coastal areas in the northwest, north and east, and in the Midlands (see Figure 24). In coastal areas, it is known from the slopes of low stabilised sand dunes and in the grassy dune swales, whilst in the Midlands it is known from native grassland or grassy woodland on well-drained clay loams derived from basalt.[62]

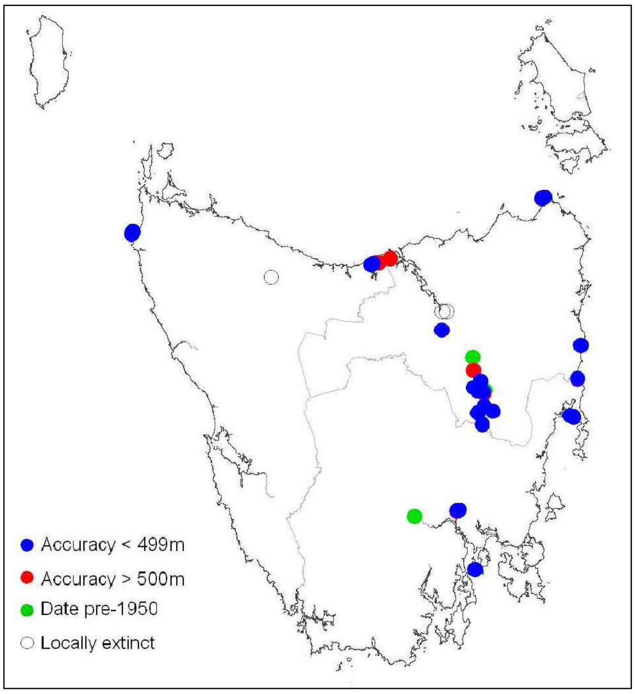

Figure 24: Distribution of *Pterostylis ziegeleri* (Source: Threatened Species Section (2009) *Listing Statement for* Pterostylis ziegeleri *(grassland greenhood),* Department of Primary Industries and Water, Tasmania.)

Known threats

The key threat to *Pterostylis ziegeleri* is the degradation of suitable habitats in the coastal subpopulations whilst in the Midlands pasture development has been the main cause of decline.[63]

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[60] Threatened Species Section (2009) *Listing Statement for* Pterostylis ziegeleri *(grassland greenhood),* Department of Primary Industries and Water, Tasmania.

[61] Wapstra, M. N. Roberts, H. Wapstra and A. Wapstra (2010) *Flowering times of Tasmanian orchids: a practical guide for field botanists*.

[62] Threatened Species Section (2009) *Listing Statement for* Pterostylis ziegeleri *(grassland greenhood),* Department of Primary Industries and Water, Tasmania.

[63] Threatened Species Section (2009) *Listing Statement for* Pterostylis ziegeleri *(grassland greenhood),* Department of Primary Industries and Water, Tasmania.

Study area

Pterostylis ziegeleri was not recorded in the study area. As no suitable habitat occurs in the study area, there is considered to be no potential for the species to occur.[64] The nearest known recorded populations are 10.5 kilometres away from the proposed mine lease boundary (see Figure 16).

4.2 Ecological communities

The proposed mine site layout will disturb the vegetation communities outlined in Table 23 and Table 25. The clearance of this vegetation will be staged over the first few years of the development (see Appendix A).

None of these communities have National Environmental Significance (*Environment Protection and Biodiversity Conservation Act 1999*). There are no MNES ecological communities within the proposed mine site or within the wider mining lease.

Table 23: Proposed overall disturbance to vegetation communities from the proposed mine site layout (aggregated by project element)

Component	Disturbance area (ha)	Vegetation type
DSO pit*	0.4614	*Eucalyptus nitida* dry forest and woodland (DNI)
	1.1734	*Eucalyptus obliqua* dry forest and woodland (DOB)
	0.7099	Western wet scrub (SWW)
	1.1763	*Eucalyptus obliqua* forest over Leptospermum (WOL)
Main pit	4.9763	*Eucalyptus nitida* dry forest and woodland (DNI)
	1.5337	Wet heathland (SHW)
	6.9351	*Eucalyptus obliqua* forest over Leptospermum (WOL)
Rock dump	2.223	*Eucalyptus nitida* dry forest and woodland (DNI)
	1.9281	Wet heathland (SHW)
	1.303	Western wet scrub (SWW)
	64.6855	*Eucalyptus obliqua* forest over Leptospermum (WOL)
Processing plant	1.7425	*Eucalyptus nitida* dry forest and woodland (DNI)
	5.6491	Western wet scrub (SWW)
	0.6084	*Eucalyptus obliqua* forest with broad-leaf shrubs (WOB)
Collection dam	0.0737	*Eucalyptus nitida* dry forest and woodland (DNI)
	0.2409	*Eucalyptus obliqua* forest over Leptospermum (WOL)
Tailings dam	14.3741	*Eucalyptus nitida* dry forest and woodland (DNI)
	0.0046	Buttongrass Moorland (undifferentiated) (MBU)
	3.5554	Western wet scrub (SWW)
	23.8946	*Eucalyptus obliqua* forest over *Leptospermum* (WOL)
Sedimentation dam	0.0167	*Eucalyptus nitida* dry forest and woodland (DNI)
	0.1231	Wet heathland (SHW)
Recycle dam	2.6045	*Eucalyptus nitida* dry forest and woodland (DNI)
	0.1599	Western wet scrub (SWW)
	1.2356	*Eucalyptus obliqua* forest with broad-leaf shrubs (WOB)
Cut-off drains and bunds	3.4051	*Eucalyptus nitida* dry forest and woodland (DNI)
	0.6331	Wet heathland (SHW)
	0.1669	Western wet scrub (SWW)
	3.823	*Eucalyptus obliqua* forest over Leptospermum (WOL)
Access and haul roads	0.4373	*Eucalyptus nitida* dry forest and woodland (DNI)
	0.117	*Eucalyptus obliqua* dry forest and woodland (DOB)
	0.0251	Wet heathland (SHW)
	0.9245	Western wet scrub (SWW)
	0.2993	*Eucalyptus obliqua* forest with broad-leaf shrubs (WOB)
	0.4756	*Eucalyptus obliqua* forest over *Leptospermum* (WOL)
Total	151.6955	

[64] Phil Barker pers. comm.

*If the DSO pit goes deeper than the currently contemplated c. 40 m, the pit will also be wider. For example, if the DSO pit is 60 m deep, the pit will be approximately 10-15 m wider either side, a total area increase of 1.5 ha.

Table 24: Proposed overall disturbance to vegetation communities from the proposed mine site layout (aggregated by community type)

Vegetation type	Component	Disturbance area within component (ha)	Total disturbance by vegetation type (ha)
Buttongrass moorland (undifferentiated) (MBU)	Tailings dam	0.4614	0.0046
Eucalyptus nitida dry forest and woodland (DNI)	DSO pit	1.1734	30.3146
	Main pit	0.7099	
	Rock dump	1.1763	
	Processing plant	4.9763	
	Collection dam	1.5337	
	Tailings dam	6.9351	
	Sedimentation dam	2.223	
	Recycle dam	1.9281	
	Cut-off drains & bunds	1.303	
	Access & haul roads	64.6855	
Eucalyptus obliqua dry forest and woodland (DOB)	DSO pit	1.7425	1.2904
	Access & haul roads	5.6491	
Eucalyptus obliqua forest over Leptospermum (WOL)	DSO pit	0.6084	101.231
	Main pit	0.0737	
	Rock dump	0.2409	
	Collection dam	14.3741	
	Tailing dam	0.0046	
	Cut-off drains & bunds	3.5554	
	Access & haul roads	23.8946	
Eucalyptus obliqua forest with broad-leaf shrubs (WOB)	Processing plant	0.0167	2.1433
	Recycle dam	0.1231	
	Access and haul roads	2.6045	
Western wet scrub (SWW)	DSO pit	0.1599	12.4687
	Rock dump	1.2356	
	Processing plant	3.4051	
	Tailings dam	0.6331	
	Recycle dam	0.1669	
	Cut-off drains & bunds	3.823	
	Access & haul roads	0.4373	
Wet heathland (SHW)	Main pit	0.117	4.2431
	Rock pump	0.0251	
	Sedimentation dam	0.9245	
	Cut-off drains & bunds	0.2993	
	Access and haul roads	0.4756	
	TOTALS	151.6955	151.6955

4.3 Fauna

Table 25 lists threatened fauna species listed under both the EPBC Act and the TSP Act that have been previously recorded or which may potentially occur in suitable habitat within 5 km of the proposed mine site.

Table 25: Threatened fauna recorded from within 5 km of the proposed mine site, or which are considered to potentially occur[65]

Species	EPBC Act listing	TSP Act listing	Likelihood of occurrence[66]
Birds			
Ceyx azureus subsp. *diemenensis* azure kingfisher [previously named *Alcedo azurea* subsp. *diemenensis*]	Endangered	Endangered	low
Accipiter novaehollandiae grey goshawk	-	Endangered	low
Lathamus discolor swift parrot	Endangered	Endangered	very low (only as a fly over)
Neophema chrysogaster orange-bellied parrot	Critically Endangered	Endangered	very low
Myiagra cyanoleuca satin flycatcher	Migratory	-	present
Aquila audax subsp. *fleayi* wedge-tailed eagle	Endangered	Endangered	low
Haliaeetus leucogaster white-bellied sea eagle	-	Vulnerable	low
Tyto novaehollandiae subsp. castanops Tasmanian masked owl	Vulnerable	Endangered	low
Mammals			
Dasyurus maculatus subsp. *maculatus* spotted-tailed quoll	Vulnerable	Rare	present
Sarcophilus harrisii Tasmanian devil	Endangered	Endangered	present
Fish			
Prototroctes maraena Australian grayling	Vulnerable	Vulnerable	none
Galaxiella pusilla eastern dwarf galaxias	Vulnerable	Vulnerable	very low
Amphibians			
Limnodynastes peroni striped marsh frog	-	Endangered	very low
Litoria raniformis green and gold frog	Vulnerable	Vulnerable	none
Invertebrates			
Oreisplanus munionga tax. *larana* Marrawah skipper	-	Endangered	none

[65] Natural Values Report, 15/11/2010, DPIPWE, Report Number: 40737 and EPBC Act Protected Matters Report 15/11/2010.
[66] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

4.3.1 *Ceyx azureus diemenensis* – Tasmanian azure kingfisher (Endangered)

[Previously named *Alcedo azurea* subsp. *diemenensis*]

Abundance

Although the population size of this *Ceyx azureus diemenensis* is not conclusively known, records are few enough to suggest that the population contains fewer than 250 mature individuals. This estimate has a low reliability factor.[67]

Distribution and habitat

Ceyx azureus diemenensis is endemic to Tasmania and occurs along several river systems in the west, south and northwest coast with the potential to occur in isolated sites in the centre and the northeast. The subspecies has been historically recorded from locations throughout the state although it is not considered common in the east and north. The extent of occurrence has been reported as 2000 km^2 (with a medium reliability factor) and an area of occupancy of 500 km^2 (with a low reliability factor).[68] Figure 25 shows the potential range of the species in Tasmania[69].

[67] http://www.environment.gov.au/biodiversity/threatened/species/pubs/25977-conservation-advice.pdf

[68] http://www.environment.gov.au/biodiversity/threatened/species/pubs/25977-conservation-advice.pdf

[69] More recent observations have extended this range to northeast and southeast Tasmania (Wapstra, M, S. Bryant & P. Bell (2010) Conservation overview of the azure kingfisher *Ceyx azureus* subsp. *diemenensis* in Tasmania. *Tasmanian Bird Report* 34: pp.8-23.

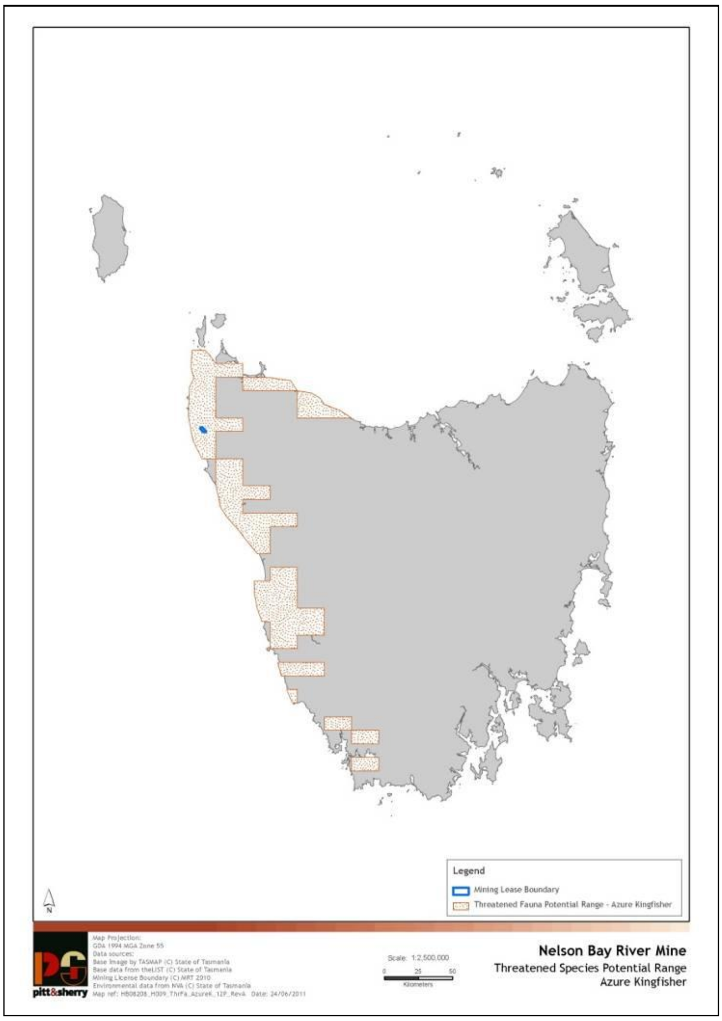

Figure 25: *Ceyx azureus diemenensis* potential range

The species inhabits tree-lined waterways, lakes, ponds and other wetlands with dense streamside vegetation, in particular in western and north-western Tasmania.[70] It feeds on small fish, freshwater crayfish, aquatic insects and occasionally amphibians and catches prey by shallow plunging from perches 1-10 m high that overhang rivers and streams. Nests are made in burrows excavated into stream banks with an entrance near the top of the stream bank, with a tunnel extending 20-40 cm to a widened nest chamber. The fledging period is approximately 4-5 weeks. The subspecies generation length is unknown but is estimated to be 3 years.[71]

Known threats

The threats to *Ceyx azureus* include the following[72]:

- Habitat clearing including forestry activities. Habitat clearing along stream banks and logging which could affect stream health may have contributed to a decline in the species including some localised extinctions

[70] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[71] http://www.environment.gov.au/biodiversity/threatened/species/pubs/25977-conservation-advice.pdf

[72] http://www.environment.gov.au/biodiversity/threatened/species/pubs/25977-listing-advice.pdf

- Acid mine drainage from tailings dams. Acidic runoff from tailings dams may adversely affect local populations. The worst affected river systems within the range of the subspecies are not inhabited, suggesting that acid mine drainage may make some sections of river systems unsuitable for the subspecies
- Fluctuating water levels caused by dams and weirs. Fluctuating levels have the potential to flood nest tunnels
- Bridge construction. Disturbance events such as clearing and grading for bridge construction works
- Flooding of nesting burrows from boat wash
- Competition with *Salmo trutta* (brown trout) (identified as the most likely reason for the decline in range of the bird). *Salmo trutta* reduce the availability of galaxiids and other small fish which are presumed to be the bird's natural prey
- Loss of habitat due to the inappropriate removal of willows (anecdotal evidence)
- Illegal removal of whitebait by recreational fishers. Poaching of whitebait from western rivers may be a reason for decline of the bird.

Whether these threats are affecting the subspecies has not been fully confirmed or quantified.[73]

Study area

No known nest sites or records occur within 5 km of the study area and suitable habitat is considered to be marginal. The most likely waterway is Nelson Bay River that has relatively fast moving water with still deep sections but the banks are generally unsuitable for nesting as they are predominantly sheer rock rather than sediments. As visual and auditory searches did not locate any azure kingfishers, the potential of occurrence is considered to be low.[74]

4.3.2 *Lathamus discolor* - swift parrot (Endangered)

Abundance

Historical breeding survey data estimates the total population of *Lathamus discolor* at no more than 1000 breeding which may be continuing to decline because of continued habitat loss.[75]

Distribution and habitat

Lathamus discolor breed in Tasmania and migrate to the mainland of Australia in autumn. In Tasmania, the breeding range of *Lathamus discolor* is largely restricted to the south east coast within the range of *Eucalyptus globulus* where the species occupies an area of less than 500 km^2. In addition, there is a smaller breeding population in the north of the state between Launceston and Smithton.[76] Figure 26 shows the habitat mapping and occurrences of the species in Tasmania.

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[73] http://www.environment.gov.au/biodiversity/threatened/species/pubs/25977-listing-advice.pdf

[74] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

[75] Swift Parrot Recovery Team (2001) *Swift Parrot Recovery Plan*. Department of Primary Industries, Water and Environment.

[76] Swift Parrot Recovery Team (2001) *Swift Parrot Recovery Plan*. Department of Primary Industries, Water and Environment.

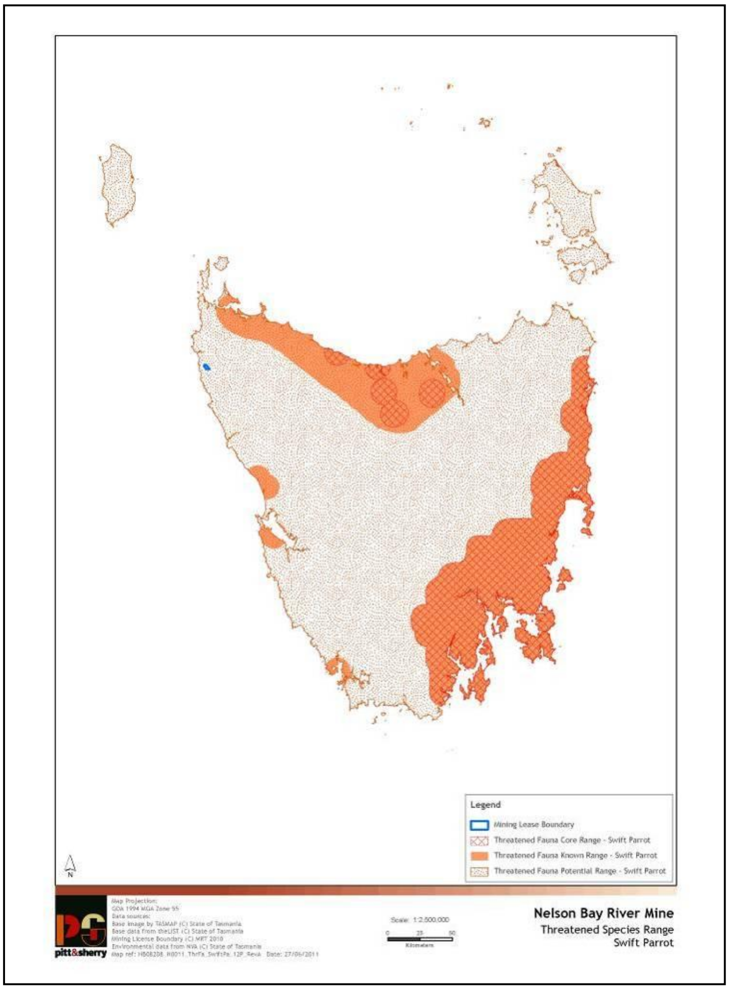

Figure 26: Habitat and distribution of *Lathamus discolor*

During the breeding season *Lathamus discolor* occur mainly in grassy *Eucalyptus globulus* forest in the east of the state where they feed on the nectar from the flowers of these eucalypts. Shrubby *Eucalyptus ovata* forest is an important food source early in the breeding season and in the years when *Eucalyptus globulus* flowering is poor.[77]

Lathamus discolor nest in hollows of old growth eucalypt species and prefer *Eucalyptus obliqua*, *Eucalyptus pulchella* and *Eucalyptus globulus* with a diameter at breast height over bark greater than 0.8 metres. In the south east of the state all of the recorded nest sites are located within 8 km of the coast, away from foraging areas, and often occur in shrubby dry *Eucalyptus obliqua* forest, grassy/shrubby dry *Eucalyptus pulchella* or grassy dry *Eucalyptus globulus* on upper slopes and ridge tops. There are known nesting areas in the north of the state in shrubby dry *Eucalyptus obliqua* forest of the Gog Range and Badgers Hills.[78]

[77] Swift Parrot Recovery Team (2001) *Swift Parrot Recovery Plan*. Department of Primary Industries, Water and Environment.
[78] Swift Parrot Recovery Team (2001) *Swift Parrot Recovery Plan*. Department of Primary Industries, Water and Environment.

Post breeding habitat is mainly in the wetter forests of the west and northwest of the state where summer and autumn flowering eucalypts are abundant including[79]:

- *Eucalyptus obliqua*
- *Eucalyptus delegatensis*
- *Eucalyptus viminalis*
- *Eucalyptus dalrympleana;* and
- *Eucalyptus pauciflora.*

Known threats

In summary, the threats to *Lathamus discolor* include the following[80]:

- Habitat loss. *Eucalyptus globulus* forest within the species restricted breeding distribution continue to be lost and fragmented due to agriculture, development of plantations and urban and coastal subdivision. Forestry and firewood collection have altered the age structure of forests across the species range resulting in the loss of older trees which provide food sources and hollows for nesting.
- Adult mortality. Collisions with chain-link fences, windows and cars contribute to a significant cause of mortality during the breeding season. Most of the collisions occur in the urban areas before young are fledged and adults are highly mobile in search for flowering eucalypts. This problem is exacerbated in years of poor *Eucalyptus globulus* flowering.

Study area

There are no records of this species within 5 km of the study area. The survey area is not considered suitable nesting habitat, although it may provide foraging habitat during the species annual migration from, and back to, the Australian mainland. The likelihood of occurrence of this species is considered to be very low; the species may be a temporary visitor to the site for short periods of time during fly over.[81]

4.3.3 *Neophema chrysogaster* - orange-bellied parrot (Critically Endangered)

Abundance

Recent population estimates of *Neophema chrysogaster* in southwest Tasmania (Melaleuca) for the period 1994 – 2004 indicate an average minimum population of 92 individuals (range 71 – 116). Other recent surveys have not found large congregations of breeding birds such as those at Melaleuca. It is therefore unlikely that the adult population exceeds 150 individuals.[82]

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[79] Swift Parrot Recovery Team (2001) *Swift Parrot Recovery Plan*. Department of Primary Industries, Water and Environment.

[80] Swift Parrot Recovery Team (2001) *Swift Parrot Recovery Plan*. Department of Primary Industries, Water and Environment.

[81] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[82] Orange-bellied Parrot Recovery Team (2006) *National Recovery Plan for the Orange-Bellied Parrot*. Department of Primary Industries and Water (DPIW), Hobart.

Distribution and habitat

Neophema chrysogaster is endemic to south east Australia including Tasmania. In Tasmania the species range extends along the west and south coast and east to Bruny Island. The species breeding range encompasses a narrow coastal strip of south west Tasmania between Louisa Bay on the south coast and Birches Inlet in Macquarie Harbour. Most of the breeding activity occurs (in what is considered as one breeding population) within 20 km of Melaleuca.[83] Figure 27 shows the habitat mapping and occurrences of the species in Tasmania.

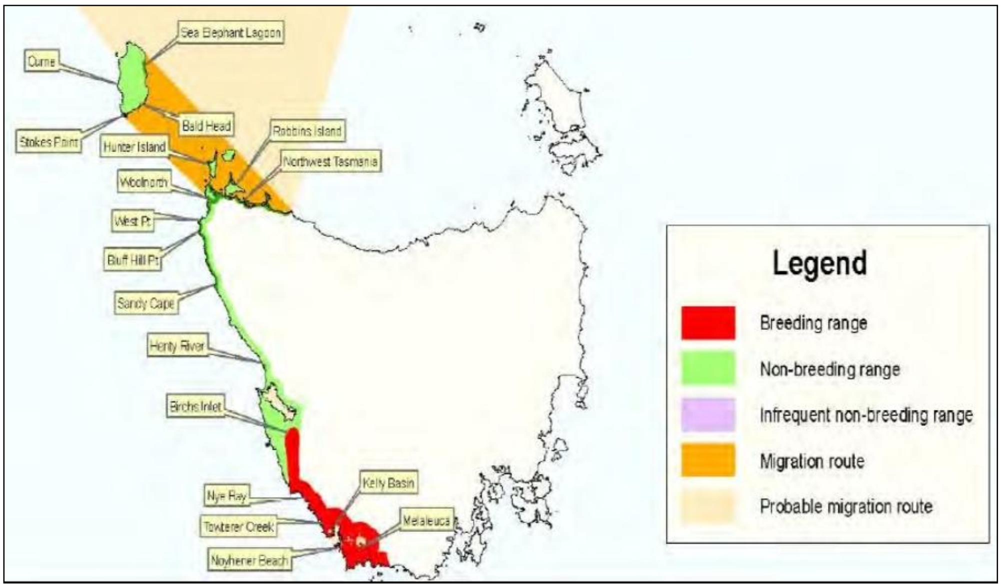

Figure 27: Habitat and distribution of *Neophema chrysogaster (Source:* Orange-bellied Parrot Recovery Team (2006) *National Recovery Plan for the Orange-Bellied Parrot*. Department of Primary Industries and Water (DPIW), Hobart.)

The species occurs in diverse habitats within 10 km of the coast, including eucalypt forest (within the breeding range) salt marshes, coastal dunes, pastures, shrublands, estuaries, islands, beaches and moorlands. Breeding habitat within the Tasmanian Wilderness World Heritage Area includes a mosaic of eucalypt forest, rainforest and extensive fire dependent moorland and sedgeland plains, intersected by wooded creeks, rivers and estuaries. Nesting is focused within 20 km of Melaleuca and 5 km of Birches Inlet, mainly in the hollows of live *Eucalyptus nitida.* The breeding population of the species is entirely contained within the Tasmanian World Heritage Area (in particular the Southwest National Park) and Southwest Conservation Area.[84]

[83] Orange-bellied Parrot Recovery Team (2006) *National Recovery Plan for the Orange-Bellied Parrot*. Department of Primary Industries and Water (DPIW), Hobart.

[84] Orange-bellied Parrot Recovery Team (2006) Department of Primary Industries and Water (DPIW), Hobart.

Known threats

The threats to *Neophema chrysogaster* include the following[85]:

- Biology and ecology relevant to threatening processes. *Neophema chrysogaster* survives as a small single population. Stochastic factors have the potential to reduce the species long term survival.
- Degradation and loss of habitat. The majority of this impact has occurred within the non–breeding range (migratory corridors and wintering areas) and includes drainage of wetlands for grazing, alteration and destruction of saltmarsh for industrial and urban development, grazing of native vegetation, vegetation clearance for agriculture, changes to land use regimes, inappropriate fire regimes and recreational activities.
- Invasive weeds. Specifically, in foraging habitats throughout the species' non-breeding range.
- Introduced predators and competitors. Mainly anecdotal observations at some locations concerning predation by European fox and feral cat. In breeding grounds, common starlings, honey bee, and sugar glider compete for nest hollows and kill incubating females at nest (impact is not yet quantified).
- Wind energy developments. Particularly throughout the migratory and winter range of the species.
- Disease within captive colonies.
- Illuminated boats and structures. Lit strictures such as lighthouses and ships pose a threat to migrating birds.
- Illegal trapping (some potential).
- Inadequate knowledge of population trends. Estimating the total size of the species is extremely difficult due to the wide distribution and dispersal of the species.
- Areas under threat. An unknown proportion of the breeding population may be subject to development pressures (recreational activities and mineral exploration) within the Cape Sorell to Low Rocky Point region. Habitats and migratory corridors throughout the non-breeding range are under land use and development pressures.

Study area

The wet heaths may provide foraging habitat for the species while the birds are migrating between Tasmania and the Australian mainland. However, the likelihood of occurrence is considered to be very low.[86]

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[85] Orange-bellied Parrot Recovery Team (2006) Department of Primary Industries and Water (DPIW), Hobart.

[86] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

4.3.4 *Myiagra cyanoleuca* - satin flycatcher (Migratory)

Abundance

Myiagra cyanoleuca has been recorded at the following population densities[87]:

- 0.08 birds/hectare near Armidale, NSW
- 1.25 birds/hectare near Bathurst, NSW
- 0.43-0.66 birds/hectare near Bombala, NSW
- 0.2 -0.5 birds/hectare at Bombala NSW
- Maximum density of 0.23 birds/hectare in the Olinda State Forest, Victoria.

The species is believed to have become increasingly common in Tasmania in the 1940s and 1950s with records in locations where the species have not previously been recorded. Over the period of the two Australian Bird Atlases, the species showed no significant regional variation between Atlas 1 and 2 reporting rates, indicating no significant changes in abundance.[88]

Distribution and habitat

Myiagra cyanoleuca is migratory, moving north in autumn to spend winter in northern Australia and New Guinea. The birds return south in spring to spend summer in south east Australia. In Tasmania they appear to be almost entirely absent in winter.

The species is widespread in eastern Australia and vagrant to New Zealand. In Tasmania the species is widespread in the east, mostly west of a line joining South Cape and Ulverstone. However, they are recorded farther west along the north coast and in the northwest. The species is very occasionally recorded at scattered sites near the western coast (for example, Temma, Strahan and Port Davey).[89] There is no available mapping of habitat and occurrences of the species in Tasmania (it is a migratory species).

The species mainly inhabits eucalypt forests, often near wetlands or watercourse. When migrating, they occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. The species prefer to nest in a fork of outer branches of trees such as eucalypts, paperbarks and banksias.[90]

Known threats

Populations of the species are said to have been reduced as a result of clearing and logging of mature forests in south east Australia. They are largely absent from regrowth forests.[91]

Study area

The species was seen foraging at several locations in the riparian areas along the Nelson Bay River. Within the current study area they were only recorded outside the proposed impact zone. Although riparian habitat does occur within the mine footprint, no satin flycatchers were recorded there.[92]

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87 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=612#australian_distribution
88 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=612#australian_distribution
89 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=612#australian_distribution
90 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=612#australian_distribution
91 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=612#australian_distribution
92 Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

4.3.5 *Aquila audax subsp. fleayi* - wedge-tailed eagle (Endangered)

Abundance

The total population of *Aquila audax subsp. fleayi* is estimated at less than 1000 individuals. This includes an adult population which is estimated at less than 440 individuals. The subspecies population is likely to be decreasing in size.[93]

Distribution and habitat

Aquila audax subsp. fleayi is endemic to Tasmania and nearby islands. The sub species is widespread on the mainland of Tasmania where it is known from coastal and inland regions, including the central highlands. It also occurs on the larger offshore islands. Breeding of the sub species occurs throughout most of this range. Distribution of the sub species is naturally fragmented because of the large home ranges and territories that are very widely dispersed.[94] Figure 28 shows the habitat mapping and occurrences of the species in Tasmania.

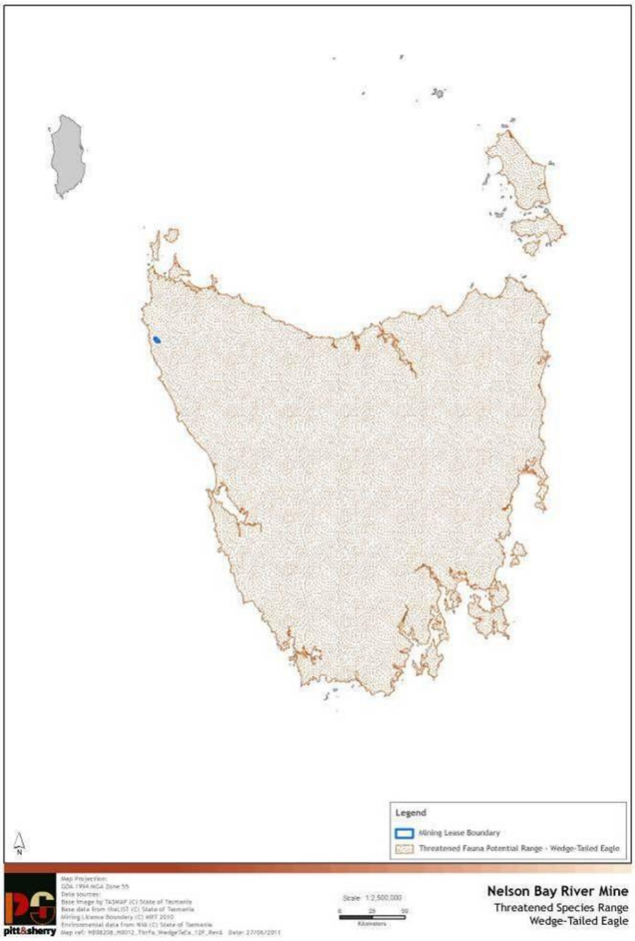

Figure 28: Habitat and distribution of *Aquila audax subsp. fleayi* (Source: Natural Values Atlas)

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93 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435

94 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435

The species mainly inhabits coastal, lowland and highland regions and has been recorded in a wide variety of habitats including dry sclerophyll forest, temperate rainforest, sub-alpine forest, dry woodland coastal heathland, small wetlands, riparian vegetation, sedgeland, grassland and farmland. Breeding is restricted to old growth dominated eucalypt species.

Wedge-tailed eagles nest in a range of old-growth forest, with the majority of the nests occurring in forests dominated by eucalypts. Nests are almost always built in an emergent tree that is among the tallest and broadest of those available and are usually in trees on sloping ground, at an aspect that offers protection from prevailing winds.

The species forages in open areas and has been recorded hunting over most types of terrestrial habitat in the state.[95]

Known threats

The threats to *Aquila audax subsp. fleayi* include the following[96]:

- Loss of habitat (specifically nesting habitat)
- Nest disturbance
- Unnatural mortality (persecution including shooting, poisoning and trapping; collision with power lines, vehicles, fences and wind turbines)
- Electrocution
- Decline in mean age of the population; and
- Decline in recruitment.

Study area

One nest record of this species has been recorded within 5 km of the study area; approximately 2 km to the northeast. The survey area was considered to have a low probability to contain nests as most of the mature eucalypts within the study area have been badly fire damaged. The deeply incised Nelson Bay River was considered to have some potential habitat as well as the area of forest in the proposed waste dump. A subsequent helicopter-based survey failed to locate any nests within the area. The survey area is considered very likely to be utilised for foraging.[97]

4.3.6 *Haliaeetus leucogaster* – white-bellied sea eagle (Migratory)

Abundance

The total population of the white-bellied sea eagle in Tasmania is estimated to be less than 1000 individuals[98].

[95] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435

[96] Threatened Species Section (2006) *Threatened Tasmanian Eagles Recovery Plan 2006 – 2010.* Department of Primary Industries and Water, Hobart.

[97] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[98] Threatened Species Section (2006) *Threatened Tasmanian Eagles Recovery Plan 2006 – 2010.* Department of Primary Industries and Water, Hobart.

Distribution and habitat

The white-bellied sea eagle is distributed around the coastline of mainland Australia and Tasmania. More than 80% of the total white-bellied sea eagle population is found in south-eastern Australia[99]. It is found in coastal habitats, particularly those close to the coast. Although it is recorded mostly in coastal lowlands it can occur up to 800 m above sea level in Tasmania. It generally breeds within 5 km of open water and prime nesting habitat is found along estuaries[100]. Figure 29 shows the habitat mapping and occurrences of the species in Tasmania.

They nest in large sheltered trees, usually eucalypts, generally within 5 km of open water. They are sensitive to disturbance during the breeding season, which occurs between August and January. They perch in a prominent place to hunt fish, eels or birds from the water, or small vertebrates or carrion on land. Their nesting requirements are similar to that of wedge-tailed eagle, although white-bellied sea eagles appear to be less susceptible than wedge-tailed eagles to disturbance that may cause abandonment of the nest during breeding[101].

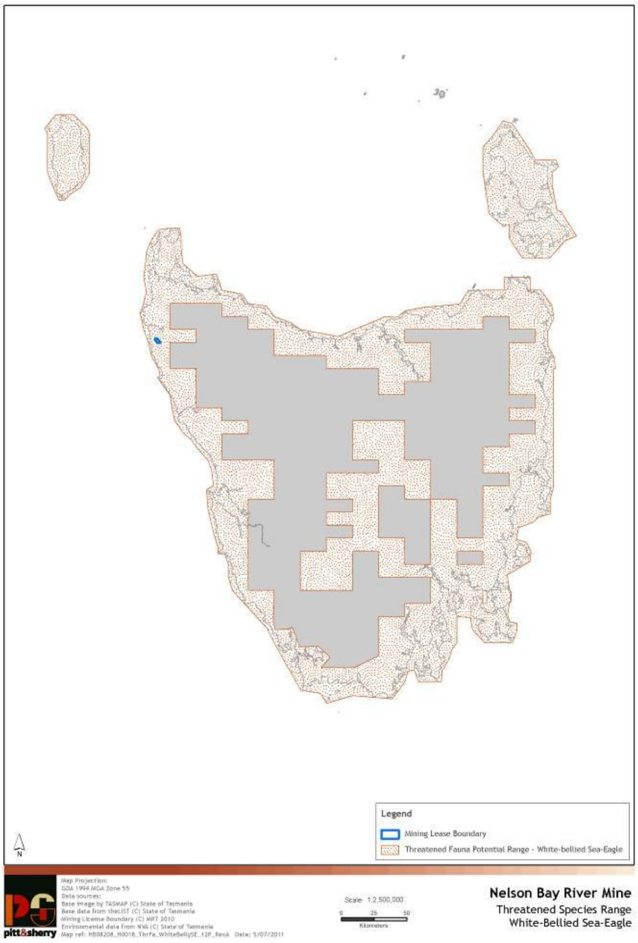

Figure 29: Habitat and distribution of *Haliaeetus leucogaster* (Source: Natural Values Atlas)

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99 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=943#population_information

100 Threatened Species Section (2006) *Threatened Tasmanian Eagles Recovery Plan 2006 – 2010.* Department of Primary Industries and Water, Hobart.

101 Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

Known threats

The threats to *Haliaeetus leucogaster* are similar to those to the wedge-tailed eagle, and include the following[102]:

- Loss of habitat (specifically nesting habitat)
- Nest disturbance
- Unnatural mortality (persecution including shooting, poisoning and trapping; collision with power lines, vehicles, fences and wind turbines)
- Electrocution
- Decline in mean age of the population; and
- Decline in recruitment.

An additional threat to the sea eagle arises from recreational use of the coastal zone, from marine pollution and debris, which can cause entanglement.

Study area

No observations of this species have been recorded within 5 km of the mine site[103].

The survey area was considered to have a low probability to contain nests as most of the mature eucalypts within the study area have been badly fire damaged. The deeply incised Nelson Bay River was considered to have some potential habitat as well as the area of forest in the proposed waste dump. A subsequent helicopter-based survey failed to locate any nests within the area[104].

4.3.7 Tyto novaehollandiae subsp. castanops – Tasmanian masked owl (Vulnerable)

Abundance

A number of population estimates of *Tyto novaehollandiae subsp. castanops* have been made ranging from 520 to 1330 breeding individuals.[105]

Distribution and habitat

Tyto novaehollandiae subsp. castanops is endemic to Tasmania, including several near shore islands. The densities of the sub species vary across the state with the highest densities occurring in the east and north and the lowest densities at elevations more than 600 m in the western half of the state (this could be due to the lack of survey effort).[106]

Figure 30 shows the habitat mapping and occurrences of the species in Tasmania.

The bird inhabits a diverse range of forests and woodlands, including agricultural and forest mosaics. Particularly favoured are forests with relatively open under stories, especially

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[102] Threatened Species Section (2006) *Threatened Tasmanian Eagles Recovery Plan 2006 – 2010.* Department of Primary Industries and Water, Hobart.
[103] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[104] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[105] http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf
[106] http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf

when this habitat adjoins areas of open or cleared land. Nesting of the sub species occurs in large tree hollows of living or dead trees but sometimes in vertical spouts or limbs.[107]

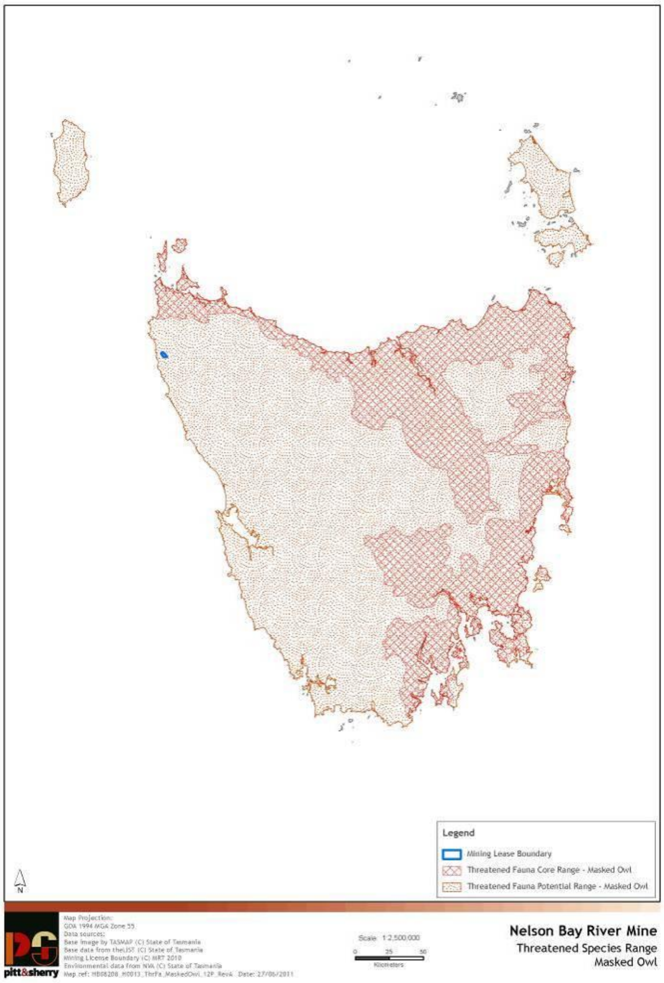

Figure 30: Habitat and distribution of *Tyto novaehollandiae subsp. castanops* (Source: Natural Values Atlas)

Known threats

In summary, the threats to *Tyto novaehollandiae subsp. castanops* include the following[108]:

- Habitat clearing and fragmentation, including forestry activities (conversion of native forest to monoculture plantation or agriculture has resulted in the loss of nesting habitat and foraging habitat)
- Rural tree decline (tree loss from dieback is causing a continuing loss of nesting habitat)
- Secondary poisoning (from consumption of flesh from another animal that has ingested a poison, for example 1080)
- Collision mortality (for example power lines and vehicles); and
- Competition for tree hollows (loss of nesting habitat results in increasing competition for large tree hollows).

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107 http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf
108 http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-listing-advice.pdf

Study area

The wet forest that has been burnt has some evidence of large hollows which may provide nesting habitat.[109]

4.3.8 *Dasyurus maculatus ssp. maculatus - spotted-tailed quoll (Vulnerable)*

Abundance

Quantitative data on the total population size is unavailable due to the cryptic nature of the animal and lack of broad scale surveys.[110]

Distribution and habitat

Dasyurus maculatus ssp. maculatus are distributed across the state with the exceptions of King Island and Flinders Island where it is locally extinct. Important populations have been located from the following locations[111]:

- Freycinet National Park
- Central-north Tasmania (including Great Western Tiers to Narawntapu)
- Cradle Mountain National Park
- Far north-western Tasmania (including the Smithton and Marrawah regions)
- Eastern Tiers/ northern Midlands (including Nugent and Ross regions)
- Southern forests/South Coast (including the Hastings region)
- Gordon River system; and
- South West Cape.

The species inhabits a large range of habitats, including rainforests, wet and dry sclerophyll forest, coastal heathland, scrub and dunes, woodland, heathy woodland, swamp forest, on beaches and sometimes in grassland or pastoral areas adjacent to forests. The species is solitary and occupies large home ranges. The male territory overlaps multiple female home ranges and has been recorded between 359 hectares and 5512 hectares in size. Females generally have a non-overlapping home range between 88 hectares and 1515 hectares in size.[112] The species travels up to 20 km at night, and shelters in logs, rocks or thick vegetation.[113]

The species is known to use multiple dens and change every 1- 4 days. Den sites have been recorded at a variety of locations including rock crevices, hollow logs, hollow tree buttresses, tree hollows, windrows, clumps of vegetation, caves, boulder tumbles, under buildings, and in the dens of rabbits and wombats. Maternal dens are similar to these sites and they are also known to dig burrows when a suitable substrate is available. A study of the mainland populations indicates that prey density and den availability are the two main factors in the use of habitat. These results are likely to apply to Tasmanian populations. Habitat critical to both Tasmanian and mainland subspecies contain adequate denning resources in large forest areas[114], and also in large areas of other habitats.

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[109] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[110] http://www.environment.gov.au/biodiversity/threatened/species/tiger-quoll.html
[111] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183

[112] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183
[113] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[114] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183

Known threats

In summary, the threats to *Dasyurus maculatus ssp. maculatus* include the following[115]:

- Habitat loss and modification. Considered the greatest threat to the species. In the state 50% of the species core habitat has been removed by logging or agriculture. Of the remaining 50% half has been subject to logging in the past 20 years – particularly in the north and northwest regions of the state for plantations in the 1980s
- Fragmentation. In many areas the current habitats are fragmented resulting in isolated populations. This results in inherent breeding complications, including difficulty in locating breeding partners and a lack of genetic diversity. The species naturally occurs in low population densities (breeds only once a year) meaning isolated populations have inherent breeding difficulties. Isolated populations are subject to stochastic events
- Timber harvesting. Research suggests that forestry practices that remove or reduce prey or critical habitat (including trees with hollows, hollow logs and complex vegetation structure) may render habitat unsuitable
- Poison baiting. In particular, 1080 to control red fox, wild dogs and rabbit. (However, recent research indicates that 1080 baiting is in fact not a threat[116])
- Competition and predation from introduced carnivores
- Deliberate killing and also dog attacks
- Road mortality. Road mortality is believed to be a significant factor in the decline of some populations. It is estimated that 1-2 individuals are killed daily on the main road between Hobart and the north west of the state. Juvenile males are most at risk due to extensive range. The full impacts of road mortality on the species are not well known. However, other carnivorous marsupials have been significantly impacted locally
- Wildfire and prescription burning. The impacts of wildfire and prescription burning are not well known but it may reduce prey and habitat. (However, recent research found that fire may be beneficial as it can increase the formation of tree hollows used by the species and its prey.)

Study area

There are several records of this species within 5 km of the study area. It is present in the proposed mine site area, as evidenced by the observed probable scat.[117] It is also present in the wider region around the mine site, as evidenced by road spotlight observations (Appendix P).

4.3.9 Sarcophilus harrisii – Tasmanian devil (Endangered)

Abundance

From pre-Devil Facial Tumour Disease (DFTD) (1992) to 2009 there has been an 80% decline in *Sarcophilus harrisii* sightings across the state. So far this decline has not slowed or ceased. Accurate estimates of the current population size are not available. However, considering an average decline of sightings in the annual spotlighting surveys of 16% since 2007, the best estimate of the total maximum state wide population is no more than between 17,000 and 42,000 individuals.[118]

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[115] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183

[116] Nick Mooney pers. comm.

[117] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

[118] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*). Department of Primary Industries, Parks, Water and Environment, Hobart.

Two management units have been identified: *Sarcophilus harrisii* in northwest Tasmania are genetically distinct from those found across the rest of the state.[119] There is still a small amount of movement of the species between the two groups, therefore making all of the species part of a single population.[120]

The proposed mine is well within the north western population, which has been identified as a genetically distinct management unit in northwest Tasmania across approximately 13,400 km^{2}, west of the Forth River and south to Macquarie Heads. The region encompasses four sites that have been intensively surveyed by the Devil Disease Team since 2004, and one surveyed by Hawkins in 2003. One of the sites surveyed, Woolnorth, holds the highest population density found in any of the Team's surveys, more than double that at the other sites. Extrapolating from these density estimates the northwest population may currently consist of between 3,000 and 12,500 individuals.[121]

Distribution and habitat

Sarcophilus harrisii is distributed naturally throughout mainland Tasmania and on two islands – Robbins Island (which is virtually joined to mainland Tasmania at very low tides) and remnants of an introduced population are thought to remain on Badger Island[122]. The species inhabits all terrestrial habitats within their geographic range with an extent and area of occupancy of 64,030 km^{2}. There has not been a significant change in recorded distribution in the last 10 years. It is not currently known whether DFTD will result in the contraction of the area occupied by the species via localised extinctions.

The average pre-DFTD density of the species in unmodified habitat across the state was 0.3–0.7 km^{2}. The species was more abundant in the north, which may have been due to the reliability of seasonal rainfall in the north or cooler temperatures in the south and the resultant influence of these factors on vegetation and/or prey species. The core habitat of the species comprises the low to moderate annual rainfall zone of the east and northwest of the state, including the eastern half of the state, the northern coastal region and a narrow strip down the west coast (see Figure 31).[123]

For *Sarcophilus harrisii,* good quality habitat encompasses a combination of year round food supply, enough den sites for breeding and daily movements, and structural features for refuge and foraging. Habitat requirements include the following[124]:

- Places to hide and shelter during the day (such as dense vegetation, hollow logs, burrows or caves;
- Areas with an open understorey mixed with dense patches of vegetation which allow hunting; and
- Soil suitable for burrowing for the purpose of maternal dens, although devils usually use ready-made dens.

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[119] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=299
[120] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii)*. Department of Primary Industries, Parks, Water and Environment, Hobart.
[121] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=299
[122] Nick Mooney pers. comm.
[123] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii)*. Department of Primary Industries, Parks, Water and Environment, Hobart.
[124] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii)*. Department of Primary Industries, Parks, Water and Environment, Hobart.

The combination of these features within a habitat is more important than a particular vegetation community or habitat type.[125]

Dens are typically underground burrows (such as wombat burrows), caves or log heaps[126]. Adult females are thought to remain faithful to their maternal dens for life, so maternal den disturbance can be destabilising to populations.

The preferred habitat of the species includes sclerophyll forest and coastal scrub. Predicted high densities of the species occur in mixed patches of grazing land and open forest or woodland and in coastal heathland. Low densities of the species occur in dense wet eucalypt and rainforest, alpine areas, dense wet heath and open grassland.[127]

Figure 31: *Sarcophilus harrisii* distribution and approximate core habitat[128] (Source: Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for

[125] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii)*. Department of Primary Industries, Parks, Water and Environment, Hobart.

[126] Nick Mooney pers. comm.

[127] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii)*. Department of Primary Industries, Parks, Water and Environment, Hobart.

[128] Core habitat is inferred from observations of high densities of devils prior to disease emergence. Habitat is patchy, so that there are patches of poor habitat within the shaded area, and patches of good habitat outside the shaded area: comprehensive data on the locations of these patches were not available.

the Tasmanian devil (*Sarcophilus harrisii*). Department of Primary Industries, Parks, Water and Environment, Hobart.)

Critical habitat for the species includes the following[129]:

- All DFTD free areas within mainland Tasmania with suitable habitat;All areas of pre DFTD core habitat; and
- Areas required under the recovery program for the future introduction of the species.

Known threats

Devil Facial Tumour Disease is a lethal infectious cancer which is spread by 'allograft' – where clonal cancer cells are transferred when an infectious individual bites and injures a healthy devil.

The disease is widespread across approximately 75% of the state and in all land tenure and habitat types. The affected area encompasses most previously high density areas of the core habitat.

The northwest (the region of the proposed mine site), the far west of the state and pockets of the south are the only remaining regions supporting high densities of *Sarcophilus harrisii* where DFTD has not yet been detected. The spread of DFTD is continuing with the disease front apparently moving 15 km west since 2008 (see Figure 32). The current most western location of the disease front is apparently located to the east of the Murchison Highway close to Oonah. It is possible that DFTD will reach the northwest in 3-10 years; however, it is not known whether mortality will be as high in the western populations or whether these populations will react to the disease in the same way that eastern ones have.[130]

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[129] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*). Department of Primary Industries, Parks, Water and Environment, Hobart.

[130] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*). Department of Primary Industries, Parks, Water and Environment, Hobart.

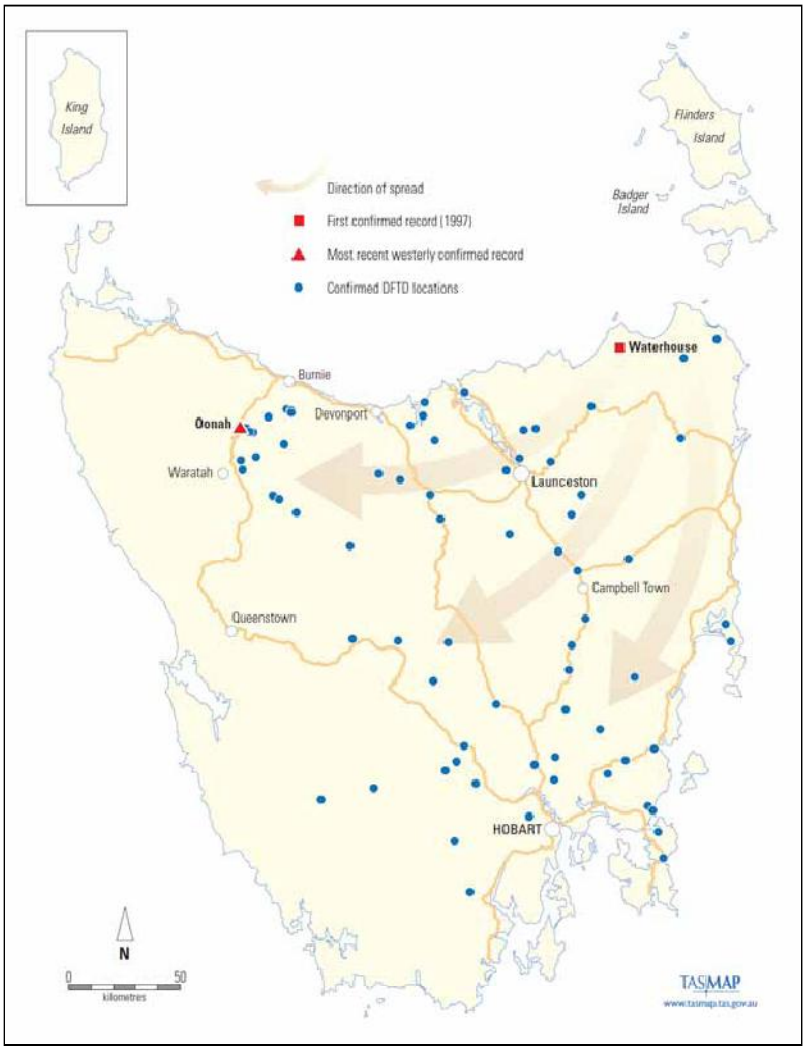

Figure 32: DFTD confirmed records and inferred direction of spread (Source: Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*). Department of Primary Industries, Parks, Water and Environment, Hobart.)

The other threats to *Sarcophilus harrisii* include the following[131]:

- Lack of genetic diversity. Low genetic diversity can reduce the species resistance to DFTD. There is a small chance that the populations in the northwest may be genetically resistant to DFTD; however, to date all individuals tested during research have contracted the disease.
- Competition and predation by foxes. Habitat preferences of European red fox overlap heavily with the species. If foxes become established they will replace most of the medium and large carnivores. This presents an enormous risk to the species recovery as foxes could prevent devils populations from becoming re-established.
- Collision with vehicles. Most of the core habitat for the species contain roads and the species has relatively large home ranges and movements. The species use roads for long distance travel and as a source for carcasses which they are attracted to for feeding. Most collisions are fatal for the species. Estimations during 2001-2004 revealed approximately 3392 devils killed on roads each year. A previous estimate for 1998 was 5000 individuals per year. In local areas where road kill has been measured,

131 Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*). Department of Primary Industries, Parks, Water and Environment, Hobart.

the impact on the species has been high (for example a 50% increase in sightings of road kill when the existing Arthur River Road was sealed). Collision with vehicles is generally considered a low level threat to the species across the state. However, in locations where the species numbers are already reduced, a loss of individuals due to collisions with vehicles could contribute to a population decline.

- Habitat loss, degradation and fragmentation. Since European settlement suitable habitat has been lost through clearing for agriculture, forest plantations, extractive industries and residential development, especially in the east of the state.
- Illegal culling and dog attacks. Current illegal culling is considered to be less than in the past but can still be locally intense. Many devils are killed each year by poorly controlled dogs and this could contribute to a population decline in locations where the species numbers are already reduced[132].
- Climate change. Climate change might occur faster than the rate of adaption by species.
- Ecosystem changes due to low species numbers. Removal of a top-order predator can have significant direct and indirect effects on an ecosystem.

Study area

Numerous records of this species occur within 5 km of the study area and scats were located at a latrine site on the exploration tracks.[133]

4.3.10 *Prototroctes maraena* - Australian grayling (Vulnerable)

Abundance

Australian Grayling were once reported as common to abundant throughout much of their range but in recent decades the species was thought to be extremely rare and perhaps in danger of extinction, especially since the closely related New Zealand Grayling had become extinct. Surveys in Victoria and New South Wales since then indicate that, while the species appears to have declined throughout much of its range, it is still widely but patchily distributed, and can be locally common in some areas[134].

Distribution and habitat

The Australian Grayling occurs in south-eastern Australia, in coastal rivers and streams in New South Wales, Victoria and Tasmania; in Tasmania, it occurs on King Island in Bass Strait, and around much of the coast (see Figure 33) but has not been recorded from the south-west, although this is probably due to lack of surveys in the region[135].

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[132] Nick Mooney pers. comm.

[133] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[134] Backhouse, G., Jackson, J. and O'Connor, J. 2008b. *Background and Implementation Information for the Australian Grayling* Prototroctes maraena *National Recovery Plan*. Department of Sustainability and Environment, Melbourne.

[135] Backhouse, G., Jackson, J. and O'Connor, J. 2008a. National Recovery Plan for the Australian Grayling *Prototroctes maraena*. Department of Sustainability and Environment, Melbourne.

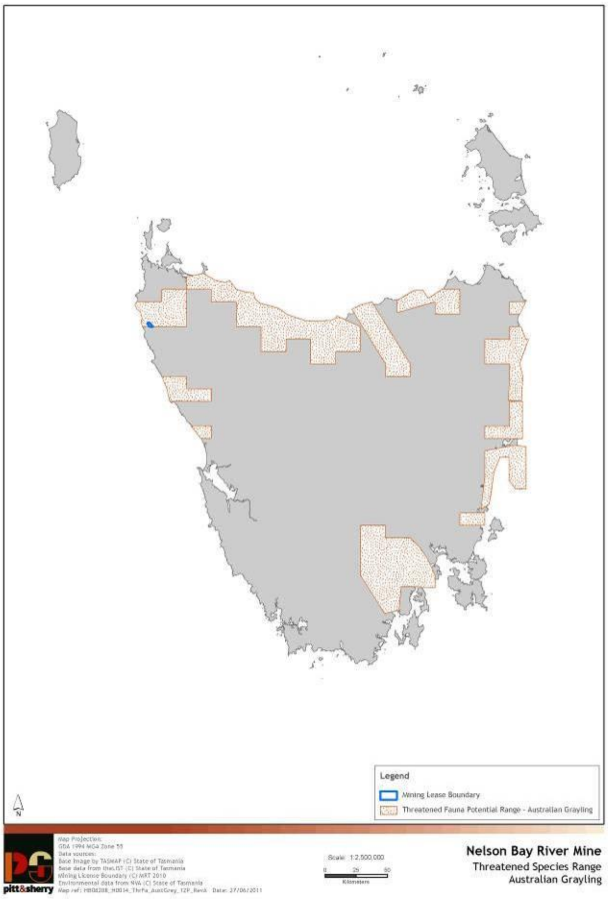

Figure 33: Habitat and distribution of *Prototroctes maraena* (Source: Natural Values Atlas)

The species inhabits the middle and lower reaches of rivers and streams that open to the sea. It needs to move between rivers and coastal seas to complete its life cycle - barriers block upstream migration, and can interfere with downstream migration, and can cause local extinction in the section of river upstream from the barrier[136].

The survey area is above a significant waterfall of more that 2 metres and so it is not likely that this species could move upstream. Refer to photo in this section.

Known threats

The major threats to the species are[137]:

- Barriers to upstream movements, including river regulation through weirs and dams
- Reduction in stream water quality
- Stream siltation
- Predation, competition and disease from introduced fish species
- Fishing.

[136] Backhouse, G., Jackson, J. and O'Connor, J. 2008a. National Recovery Plan for the Australian Grayling *Prototroctes maraena*. Department of Sustainability and Environment, Melbourne.
[137] Backhouse, G., Jackson, J. and O'Connor, J. 2008a. National Recovery Plan for the Australian Grayling *Prototroctes maraena*. Department of Sustainability and Environment, Melbourne.

Study area

The mine site is 7 km upstream from a significant waterfall (Figure 34) of more that 2 metres height, which presents a natural barrier to upstream movement of the species into Nelson Bay River. This barrier is near the mouth of Nelson Bay River, close to where it is crossed by Temma Road.

Because of barrier, there is no significant likelihood of the species being any further upstream than Temma Road, which is 7 km downstream from the mine site.

Figure 34: Waterfall which presents a natural barrier to the Australian grayling (note Temma Road bridge in background) (Source: Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.)

4.3.11 *Galaxiella pusilla* - eastern dwarf galaxias - (Vulnerable)

Abundance

Although this species is widely distributed, populations are fragmented and patchy and local extinctions have been noted.

Distribution and habitat

Populations are found in most drains in south-east South Australia, including sheltered estuarine situations; a major population has been recorded in sand pits at Cranbourne, south-east of Melbourne (Victoria)[138]. There are 23 known locations in Tasmania, distributed along the north coast of the State (Figure 35).

138 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=56790#population_information

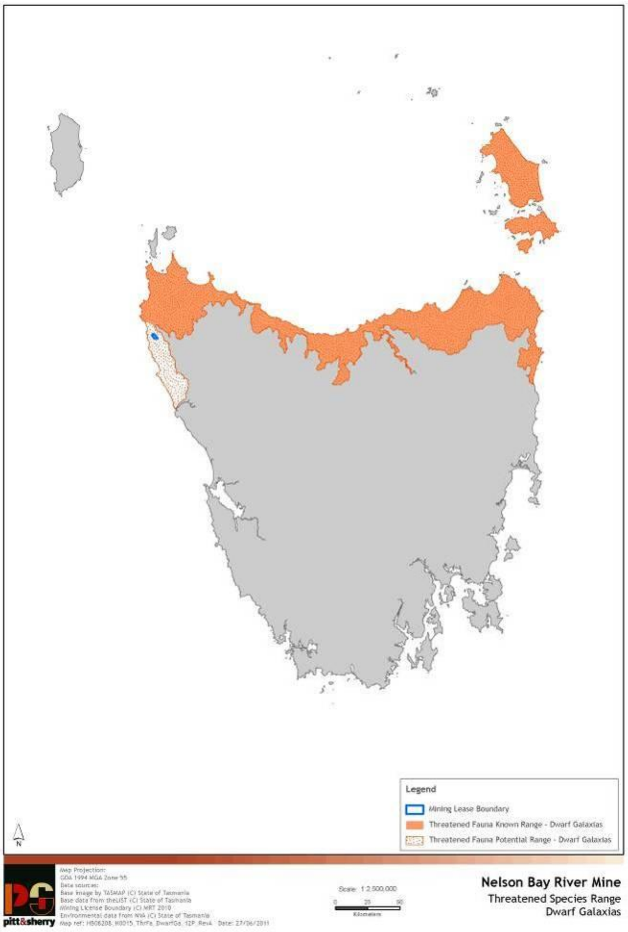

Figure 35: Habitat and distribution of *Galaxiella pusilla* (Source: Natural Values Atlas)

The dwarf galaxias typically occurs in slow flowing and still, shallow, permanent and temporary, freshwater habitats such as swamps, drains and the backwaters of streams and creeks, often (but not always) containing dense aquatic macrophytes and emergent plants[139]. Known Tasmanian sites appear to be associated with Holocene sand, gravel and alluvium deposits[140]. Distribution of populations is generally disjunct and patchy, due to the nature of its lowland, shallow, swampy habitat[141].

Known threats

The major threats to the species are[142]:

- Degradation and loss of habitat (wetlands)
- Alteration to flow regime of wetlands
- Predation from introduced fish species
- Illegal collection.

[139] Saddlier, S., Jackson, J. and Hammer, M. 2010. National Recovery Plan for the Dwarf Galaxias *Galaxiella pusilla*. Department of Sustainability and Environment, Melbourne.
[140] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[141] Saddlier, S., Jackson, J. and Hammer, M. 2010. National Recovery Plan for the Dwarf Galaxias *Galaxiella pusilla*. Department of Sustainability and Environment, Melbourne.
[142] Saddlier, S., Jackson, J. and Hammer, M. 2010. National Recovery Plan for the Dwarf Galaxias *Galaxiella pusilla*. Department of Sustainability and Environment, Melbourne.

Study area

The mine site is outside the known range of the species and there also is also no suitable habitat in the vicinity. There is no significant likelihood of it occurring within or near the mine site.

4.3.12 *Litoria raniformis* - green and gold frog (Vulnerable)

Abundance

In the past, the green and gold was distributed across a large area of south-east Australia, including Tasmania, at altitudes of up to 1300 m but the species range has declined, most notably in New South Wales.

Distribution and habitat

In Tasmania, the species occurred broadly across the north and east of the island and on Bass Strait Island but the species range has contracted in north-west, central and south Tasmania within the last few decades (Figure 36)[143].

The species is found mostly amongst emergent vegetation, in or at the edges of still or slow-flowing water bodies such as lagoons, swamps, lakes, ponds and farm dams; submerged vegetation is important habitat for breeding success and grassland provides habitat for foraging, dispersal and shelter, and may also provide overwintering sites[144].

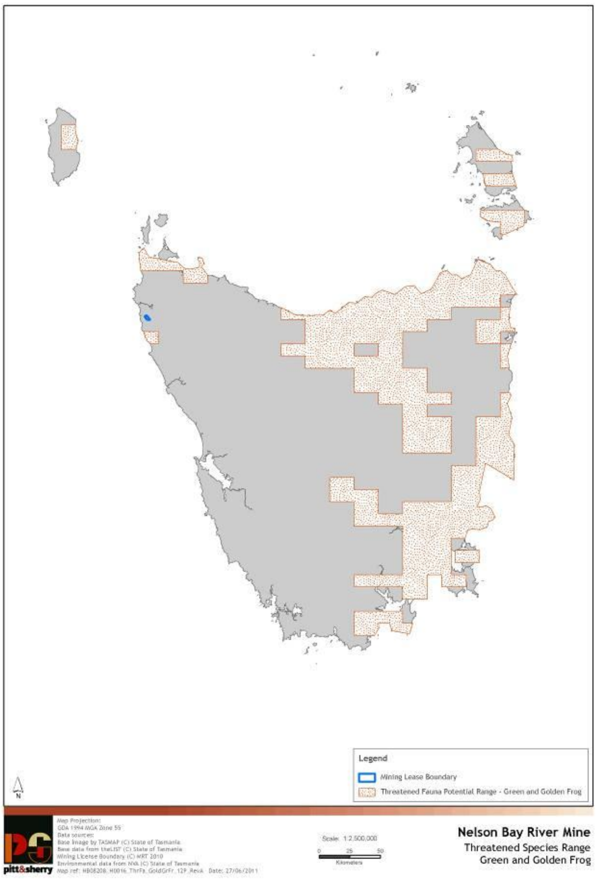

Figure 36: Habitat and distribution of *Litoria raniformis* (Source: Natural Values Atlas)

[143] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1828#populations_in_reserves
[144] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1828#populations_in_reserves

Known threats

The major threats to the species are[145]:

- Habitat loss and fragmentation
- Habitat degradation
- Altered flood regimes
- Chytrid fungus disease
- Predation by introduced fish
- Drought
- Chemical pollution of water bodies
- Biocides
- Salinisation
- Road kill
- UV radiation.

Study area

The mine site is outside the known range of the species and there also is also no suitable habitat in the vicinity. There is no significant likelihood of it occurring within or near the mine site.

4.3.13 *Astacopsis gouldi* - Tasmanian giant freshwater crayfish (Vulnerable)

Abundance

Astacopsis gouldi is listed as 'Vulnerable' under the *Environment Protection and Biodiversity Conservation Act 1999*. The species is also listed as 'vulnerable' under Tasmania's *Threatened Species Protection Act 1995*. However, no data on population numbers are available[146].

Distribution and habitat

The recorded distribution of *Astacopsis gouldi* ranges from the Arthur-Pieman catchment in North-West Tasmania, across the northern part of the state in most river systems discharging into Bass Strait[147] (see Figure 37). Two other species of *Astacopsis* are recognised: *A. franklinii* and *A. tricornis*. These are smaller *Astacopsis* species, and have different distributions to *A. gouldi*, although there is some overlap of the three species' distributions.

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[145] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1828#populations_in_reserves

[146] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64415#population_information

[147] Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River*. Report prepared for Pitt & Sherry.

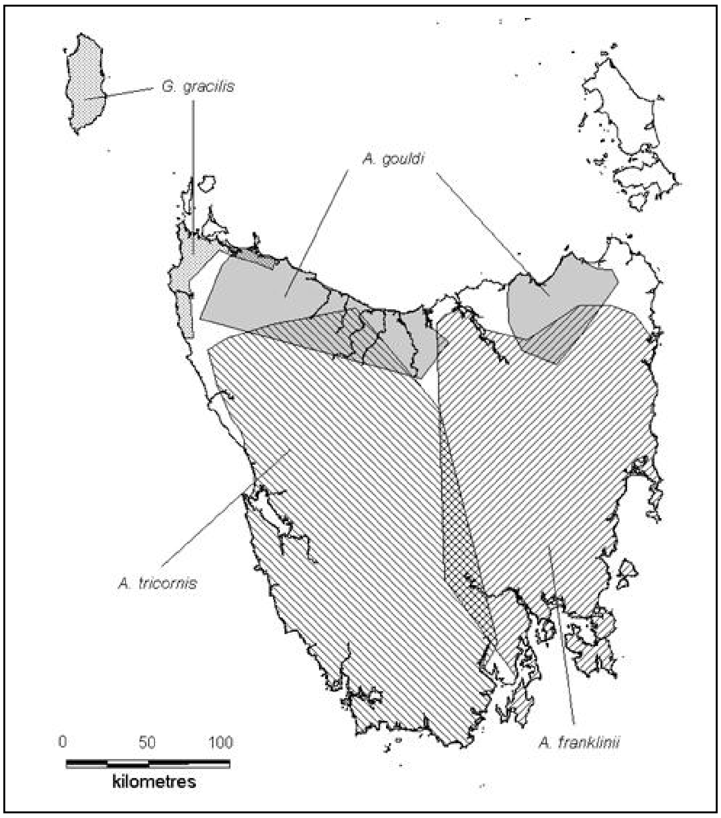

Figure 37: Habitat and distribution of *Astacopsis gouldi* (Source: Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River*)

Habitat requirements for *Astacopsis gouldi* may vary, depending on the age-class in question: juveniles require shallow, fast-flowing streams with substrates containing primarily cobbles and boulders that are used for shelter; adults often move to slower-flowing reaches where they dig burrows in stream banks and underneath logs and boulders in the stream bed[148].

Abundant in-stream and riparian vegetation provides both food and habitat for *A. gouldi*; it also protects the water from temperature extremes and often acts as a filtration system, reducing the turbidity level of the water[149]. In-stream woody debris is of particular importance to *A. gouldi* and is usually considered a critical habitat requirement; *A. gouldi* subsists primarily on woody debris and leaf litter and large logs provide the bulk of in-stream structures that *A. gouldi* uses for shelter[150].

A. gouldi prefers water temperatures of less than 18˚C and oxygen levels greater than 7mg/L, and have an approximate threshold value of 5% silt substrate and salinity threshold of 160 microsiemens/cm; these are important factors to consider when evaluating both the likelihood of *A. gouldi* being present at any given site within its distribution, and also when considering the potential impacts that any development may have on these values[151].

[148] Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River.* Report prepared for Pitt & Sherry.
[149] Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River.* Report prepared for Pitt & Sherry.
[150] Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River.* Report prepared for Pitt & Sherry.
[151] Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River.* Report prepared for Pitt & Sherry.

Known threats

The two major threats to the species are[152]:

- The cumulative effects of past and current (illegal) fishing pressure
- The large-scale habitat disturbance for agricultural, urban and forestry land use.

To maintain healthy populations, *Astacopsis gouldi* requires waterbodies with good water quality, a stable thermal regime of relatively low water temperature, snags, pools, undercut banks, and ample canopy cover. Riparian vegetation needs to be predominantly intact and extensive to provide the shading, nutrient, energy and structural inputs required for the species' in-stream habitat[153].

Habitat disturbance includes the removal or destruction of riparian vegetation, bank erosion, desnagging, channelisation, siltation, nutrification, toxic chemical inputs, instream barriers to lobster movement such as culverts and farm dams, and alterations to stream flow and thermal regime[154].

Study area

West Creek is poorly suited to *Astacopsis gouldi*, and is not considered to be potential habitat; East Creek has some potential habitat but this is limited, and would probably dry up in summer; Nelson Bay River itself has good potential habitat[155]. No *A. gouldi* were found in the site survey, however.

Nelson Bay River is at the margins of the range of the species. A single individual (juvenile) has been found in the river. However, this was in 2005, and more than 6 km from the mine site and this may be an errant or translocated individual[156].

From the known geographic range of the species and the surveys conducted for this project, there is not considered to be any significant likelihood of *A. gouldi* being present on the mine site[157].

There is also a low likelihood of the species being found in Nelson Bay River. Nevertheless, the protection of Nelson Bay River from impacts will also protect *Astacopsis* in the unlikely event that it is present in the river.

No specific *A. gouldi* protection measures are warranted.

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[152] Threatened Species Section (2006). Giant Freshwater Lobster *Astacopsis gouldi* Recovery Plan 2006-2010. Department of Primary Industries and Water, Hobart.
[153] Threatened Species Section (2006). Giant Freshwater Lobster *Astacopsis gouldi* Recovery Plan 2006-2010. Department of Primary Industries and Water, Hobart.
[154] Threatened Species Section (2006). Giant Freshwater Lobster *Astacopsis gouldi* Recovery Plan 2006-2010. Department of Primary Industries and Water, Hobart.
[155] Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River.* Report prepared for Pitt & Sherry.
[156] Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River.* Report prepared for Pitt & Sherry.
[157] Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River.* Report prepared for Pitt & Sherry.

5. Survey methods

The site specific surveys of the proposed mine site[158] have been undertaken by North Barker Ecosystem Services, a well regarded Tasmanian consultancy specialising in flora and fauna habitat assessments for major projects, including road infrastructure and mine developments.

Management of the current surveys (on ground and helicopter-based), data review and analysis, and report preparation has been undertaken by Dr Philip Barker, a Director of the Company.

Roadkill and headlight observation study results have been provided by the courtesy of the Department of Infrastructure, Energy and Resources (DIER). These data were collected for DIER by Wildspot Consulting and mapped by Northbarker Ecosystem Services.

5.1 Background research

Details of biological records from the region were accessed by North Barker Ecosystem Services from the following sources:

- Natural Values Atlas DPIPWE database including biological records[159]
- Tasveg 2.0 Digital Data – as of September 2009 – this layer has been field-truthed
- EPBC search tool[160]
- The Threatened Fauna Manual[161] - threatened species recorded from the Sundown & Temma map sheets (Tasmap, Tasmania 1:25 000 series).

5.2 Flora and fauna habitat survey methods

The detailed survey of the proposed mine and associated infrastructure occurred between the 16 and the 24 November 2010.

All types of vegetation and all perceivable habitats within it were investigated. Tasveg mapping (v2.0) was used to ensure that the variation in vegetation across the site was visited within each of the areas proposed to be impacted.

Surveys were undertaken of the aquatic and riparian environment by walking down to the Nelson Bay River at eight points within the study area. The lower reaches of Nelson Bay River were also investigated to establish whether upstream passage was possible for migratory fish species. All native and exotic vascular plant species encountered were recorded. All habitats were surveyed to describe the communities according to accepted floristic descriptions. The suitability of the habitat was considered for all threatened fauna species with potential to occur within the area. In particular, Tasmanian devil dens, hollows suitable for masked owls, streams suitable to support azure kingfishers and nesting habitat for both goshawk and eagles were targeted for consideration.

Surveys for threatened fauna were generally restricted to assessment of the suitability of habitat to support particular species, as well as observation of any evidence of their occurrence. Other evidence of animals, such as scats, feathers, bones and dens, were noted where observed.

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[158] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[159] Natural Values Report, 15/11/2010, DPIPWE, Report Number: 40737

[160] EPBC Act Protected Matters Report 15/11/2010

[161] Bryant & Jackson (1999) *Tasmania's Threatened Fauna Handbook*. Threatened Species Unit.

Observations of any likely Tasmanian devil dens, such as large hollowed bases of myrtles or dry caverns made by fallen logs, were inspected more closely for animal activity.

A specific survey was undertaken for *Ceyx azurea* subsp. *diemenensis* along Nelson Bay River which was the only riparian area considered suitable for the species. The methods used were to watch and listen for 5 minutes at each site along the creek. Birds were also looked for as we walked along the creek incidental to the timed observations at likely locations.

A helicopter-based survey of the site was undertaken in March 2011 to determine whether there were any occupied or abandoned eagle nests in the area. Observations were made for both *Aquila audax* subsp. *fleayi* and *Haliaeetus leucogaster*.

Roadkill and traffic count data for public roads along much of the proposed transport route was sourced from the Department of Infrastructure, Energy and Resources through their Tarkine Road projects. The roadkill data were collected by Wildspot Consulting between October 2009 and April 2010. The traffic counts were collected by the Parks & Wildlife Service between January 2008 and July 2009. The data are used for this study with the permission of DIER.

A survey for *Astacopsis gouldi* was undertaken in June 2011. The survey examined three sections of Nelson Bay River for habitat suitability: upstream of the mine site (near the Rebecca Road crossing), adjacent to the mine site and downstream of the mine site (near the Temma Road crossing). The survey also examined East and West Creeks on the mine site. Site surveys covered various stream lengths and riparian surveys included 30 m either side of the stream. Habitat assessment of each site was based on a combination of AusRivas, the Tasmanian River Condition Index and specific *A. gouldi* habitat criteria. Visual searching was undertaken at all sites and trapping was undertaken at the upstream and downstream sites.

5.3 Survey limitations

The following limitations apply to the current flora survey:

- The flora survey of the mine and associated mine infrastructure areas was undertaken in mid-November.
- No plant survey can guarantee that all vascular flora will be recorded during a single visit due to the limitations of the sampling technique, seasonal and annual variation in abundance and the possible absence of fertile material for identification.
- Ephemeral species that may have been overlooked include orchids, herbs and grasses that were not in flower at the time of survey. However, the field survey was deliberately timed to coincide with the flowering season of likely threatened orchid species.
- Additional species are likely to occur that may be recorded during repeated visits in different seasons over several years because of changing conditions.
- Non-vascular plants such as mosses and lichens have not been taken into account in the current survey.

All significant species known or likely to occur in the vicinity of the study area have been considered in the current assessment.

6. Relevant impacts

Guideline requirements for this section

The draft environmental impact statement must contain enough information about relevant impacts of the proposed action to allow the Minister to make an informed decision whether or not to approve under Part 9 of the EPBC Act (for the purposes of each controlling provision) the taking of the proposed action.

Provide a description of the relevant impacts of the proposed action, including:

- *a) a detailed assessment of the nature and extent of the likely relevant long-term and short-term impacts, including a summary table detailing the amount of habitat impacted for each species or commumity impacted*
- *b) a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible*
- *c) analysis of the significance of the relevant impacts to particular species and communities in the context of their known threats, distribution, abundance and ecological requirements and preferences*
- *d) details of the anticipated scope, nature and likelihood of qualitative and quantitative hydrological impacts of the proposed action is required. This should address both groundwater and surface water (and their interaction) and should address both routine and operational impacts and potential catastrophic events such as failure or flooding of the tailings dam*
- *e) any technical data and other information used or needed to make a detailed assessment of the relevant impacts*
- *f) information on the scientific reliability of investigations and conclusions drawn, including the degree of certainty or statistical confidence where appropriate. This must include any assumptions or limitations of any models used to make predictions and the qualifications of any experts consulted.*

Consideration of potential impacts must encompass direct and indirect, cumulative and facilitated impacts.

Indirect impacts are impacts that are not a direct result of the project but to which the proposed action contributes. They may include offsite or downstream impacts, such as impacts on migratory species from changes to the hydrology of estuarine areas impacted by the proposed action.

Facilitated impacts are impacts resulting from the actions of third parties that are facilitated by proposed action, such as increased shipping or road traffic facilitated through the construction of a port or road.

Cumulative impacts are impacts of the proposed action in combination with other past, present and reasonably forseeable future actions.

6.1 Flora

6.1.1 *Caladenia dienema* - windswept spider orchid (Critically Endangered)

Caladenia dienema was not recorded in the study area. The nearest known recorded population is 100 m from the proposed mine lease boundary. In relation to the actual proposed mine elements, this population is located greater than 1 km away to the west. However, this record may be incorrect as the location places the population in thick woodland, which is not the preferred habitat.

The potential habitat for the species is widespread on the west coast and is identified as coastal heathland within 1 km of the coastline. The species is known from coastal scrub and windswept coastal grassland and heaths amongst stunted shrubs and sedges on moist to well-drained sand and clay loams.[162]

As the study area is considerably inland it is unlikely that this species occurs at the proposed mine site[163].

The closest known recorded location (which may be an error) of this species in relation to the proposed mine pits is outside the radius of influence of the dewatering of the mine pits and its known preferred habitat is even further away.

In the context of the development and known threats to the species the following key threats are identified[164]:

- Land clearance (including agricultural and coastal development)
- Development on public land (many populations of the species are within the Arthur–Pieman Conservation Area); and
- Inappropriate fire regime (greater abundance at sites subject to higher intensity summer fires).

Land clearance for the proposed mine site will have no impact on the preferred habitat for this species. The increase in activity in the area may increase the risk of fire. However, fire prevention and management will be managed as an ongoing operational aspect of the mine. The proposed mine layout intersects less than 9 ha of the Arthur–Pieman Conservation Area and it is located on the outer perimeter of the protected area, away from key habitats for the species, which are within 1 km of the coastline while the mine is more than 5 km inland.

The mine will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

[162] Threatened Species Section (2010). *Listing Statement for* Caladenia dienema *(windswept spider-orchid).* Department of Primary Industries, Parks, Water and Environment, Tasmania
[163] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[164] Threatened Species Section (2010). *Listing Statement for* Caladenia dienema *(windswept spider-orchid).* Department of Primary Industries, Parks, Water and Environment, Tasmania

6.1.2 *Corunastylis brachystachya* – short-spiked midge orchid (Endangered)

[Referred to by its old name of *Genoplesium brachystachyum* in the EIS guidelines]

Corunastylis brachystachya was not recorded in the study area. The nearest known recorded populations are 3.0 kilometres away from the proposed mine lease boundary.

The species is known from heathland and heathy eucalypt woodland on well-drained rocky sites[165].

The potential for this species to occur is considered to be low at the proposed mine site[166].

The closest known recorded location of this species in relation to the proposed mine pits is well outside the radius of influence of the dewatering of the mine pits.

In the context of the development and known threats to the species, an assessment was unable to be made due to the lack of information available on known threats for this particular species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

6.1.3 *Diuris lanceolata* - large golden moths (Endangered)

Diuris lanceolata was not recorded in the study area. The nearest known recorded populations are 3.4 kilometres away from the proposed mine lease boundary.

The species is known from windswept coastal grassland and coastal scrub and heathland among dwarfed shrubs and sedges on moist to well drained sandy and clay loam, sometimes on rocky outcrops.[167]

The species is unlikely to extend as far inland as the study area and it is considered to be no potential for this species to occur.[168]

The closest known recorded location of this species in relation to the proposed mine pits is well outside the radius of influence of the dewatering of the mine pits.

Clearance and alteration to drainage are the key threats in context with the development and the known threats to the species[169]. Clearance and changes to drainage caused by the proposed mine will have no impact on the preferred habitat of this species.

The mine will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

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[165] Jones, D., Wapstra, H., Tonelli, P. and Harris, S. (1999). *The Orchids of Tasmania.* The Miegunyah Press at Melbourne University Press, Carlton, Victoria

[166] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[167] Threatened Species Unit (2000). *Listing Statement large golden moths* Diuris lanceolata. Department of Primary Industries, Water and Environment, Tasmania.

[168] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[169] Threatened Species Unit (2000). *Listing Statement large golden moths* Diuris lanceolata. Department of Primary Industries, Water and Environment, Tasmania.

6.1.4 *Prasophyllum favonium* - western leek orchid (Critically Endangered)

Prasophyllum favonium was not recorded in the study area. The nearest known recorded populations are 3.3 kilometres away from the proposed mine lease boundary.

The species is known from among shrubs in windswept dense low heathland on moderately drained grey to black sandy peaty loam.[170]

The wet heathland on the western boundary of the study area has the greatest potential to contain this species, although it was not recorded during the survey. The potential for this species to occur in the study area is considered to be moderate.[171] The species was not found during the field survey.

A potential indirect impact to a preferred habitat of this species could be a change in the habitat hydrology.

However, the wet heathland is in a groundwater recharge area, not a discharge area, and its soil water is therefore not dependent on the underlying water table. The heathland plants are shallow rooted species reliant on soil water from infiltrating rainfall, not from the underlying water table. There is therefore no significant likelihood of the heathland soil water, and hence the ecosystems dependent on it, including *Prasophyllum favonium* and other threatened orchid species, being affected by the dewatering of the mine pits.[172]

The small number and size of known colonies is the key threat in context with the development and the known threats to the species. Small populations could easily be destroyed by prolonged droughts and other localised disturbance events[173] Clearance for the proposed mine site or changes in hydrology will have no significant impact on the preferred habitat for this species.

The mine will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

6.1.5 Prasophyllum pulchellum - pretty leek orchid (Critically Endangered)

Twenty plants flowering in an area of 3 square metres were found during the current survey approximately 200 m away from the proposed mine lease boundary. This population is in wet heathland at the edge of a slashed track.[174]

The species is known from dense low sedgy heath with pockets of paperbark or tea-tree on poorly to moderately drained sandy or peaty loam.[175]

The location of the 20 plants is outside the disturbance area and mine lease boundary. No direct impacts on this population will occur from the proposed mine.

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[170] Threatened Species Unit 2000. Listing Statement Western leek orchid *Prasophyllum favonium.* Department of Primary Industries, Water and Environment, Tasmania

[171] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[172] Cromer, W. C. (2011) *Hydrogeological report, Proposed Nelson Bay River Magnetite Mine.* (Unpublished report for Shree Minerals Ltd. by William C. Cromer Pty. Ltd.).

[173] Threatened Species Unit 2000. Listing Statement Western leek orchid *Prasophyllum favonium.* Department of Primary Industries, Water and Environment, Tasmania

[174] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[175] Threatened Species Unit 2000. Listing Statement Pretty leek orchid *Prasophyllum pulchellum.* Department of Primary Industries, Water and Environment, Tasmania

The wet heathland on the western boundary of the study obviously forms a preferred habitat for this species. The growth of these plants may have been stimulated by a fire approximately 4 years ago at the site.

A potential indirect impact to a preferred habitat of this species could be a change in the habitat hydrology.

However, the wet heathland is in a groundwater recharge area, not a discharge area, and its soil water is therefore not dependent on the underlying water table. The heathland plants are shallow rooted species reliant on soil water from infiltrating rainfall, not from the underlying water table. There is therefore no significant likelihood of the heathland soil water, and hence the ecosystems dependent on it, including *Prasophyllum pulchellum* and other threatened orchid species, being affected by the dewatering of the mine pits.[176]

Inappropriate fire regimes[177] are the key threat in context with the development and the known threats to the species. The increase in activity in the area may increase the risk of fire. However, fire prevention and management will be an ongoing operational aspect of the mine.

The mine will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

6.1.6 *Prasophyllum secutum* - northern leek orchid (Endangered)

Prasophyllum secutum was not recorded in the study area. The nearest known recorded populations are 4.8 kilometres away in relation to the proposed mine lease boundary.

The species is known from dense coastal scrub in the swales of stabilised sand dunes on white to grey sands and sandy loam.[178]

As there are no grassy dune swales within the study area, there is considered to be no potential for this species to occur.[179]

The closest known recorded location of this species in relation to the proposed mine pits is well outside the radius of influence of the dewatering of the mine pits.

In the context of the development and known threats to the species the following key threats are identified[180]:

- Degraded or destroyed coastal heath habitat on the north coast from coastal development; and
- Inappropriate fire regimes (the species requires regular fire to trigger emergence and good flowering).

The proposed mine site will have no impact on the preferred habitat for this species. The increase in activity in the area may increase the risk of fire. However, fire prevention and management will be an ongoing operational aspect of the mine.

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[176] Cromer, W. C. (2011) *Hydrogeological report, Proposed Nelson Bay River Magnetite Mine.* (Unpublished report for Shree Minerals Ltd. by William C. Cromer Pty. Ltd.).

[177] Threatened Species Unit 2000. Listing Statement Pretty leek orchid *Prasophyllum pulchellum.* Department of Primary Industries, Water and Environment, Tasmania

[178] Threatened Species Section 2008. Listing Statement Northern leek –orchid *Prasophyllum secutum.* Department of Primary Industries & Water, Tasmania.

[179] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[180] Threatened Species Section 2008. Listing Statement Northern leek –orchid *Prasophyllum secutum.* Department of Primary Industries & Water, Tasmania.

The mine will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

6.1.7 *Pterostylis rubenachii* - Arthur River greenhood (Endangered)

Pterostylis rubenachii was not recorded in the study area. The nearest known recorded populations are 4.8 kilometres away in relation to the proposed mine lease boundary.

The species is known from dry, sandy slopes of sparsely vegetated stabilised sand dunes, and also in permanently wet to moist scrubby and sedgy coastal heath converted to semi-improved pasture by annual slashing.[181]

As no similar habitat occurs in the study area, there is considered to be no potential for the species to occur.[182]

The closest known recorded location of this species in relation to the proposed mine pits is well outside the radius of influence of the dewatering of the mine pits.

Change of land management regimes[183] is the key threat in context with the development and the known threats to the species. The proposed mine site will not alter the land management regimes in relation to the suitable habitat for this species.

The mine will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

6.1.8 *Pterostylis ziegeleri* - grassland greenhood (Vulnerable)

Pterostylis ziegeleri was not recorded in the study area. The nearest known recorded populations are 10.5 kilometres away in relation to the proposed mine lease boundary.

In coastal areas it is known from the slopes of low stabilised sand dunes and in the grassy dune swales, whilst in the Midlands it is known from native grassland or grassy woodland on well – drained clay loams derived from basalt.[184]

As no similar habitat occurs in the study area, there is considered to be no potential for the species to occur.[185]

The closest known recorded location of this species in relation to the proposed mine pits is well outside the radius of influence of the dewatering of the mine pits.

The degradation of suitable habitats in the coastal subpopulations [186] is the key threat in context with the development and the known threats to the species. The proposed mine site will have no impact on the preferred habitat for this species.

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[181] Threatened Species Unit 2000. Listing Statement Arthur River greenhood *Pterostylis rubenachii.* Department of Primary Industries, Water and Environment, Tasmania

[182] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[183] Threatened Species Unit 2000. Listing Statement Arthur River greenhood *Pterostylis rubenachii.* Department of Primary Industries, Water and Environment, Tasmania

[184] Threatened Species Section (2009) *Listing Statement for* Pterostylis ziegeleri *(grassland greenhood),* Department of Primary Industries and Water, Tasmania.

[185] Phil Barker, pers. comm.

[186] Threatened Species Section (2009) *Listing Statement for* Pterostylis ziegeleri *(grassland greenhood),* Department of Primary Industries and Water, Tasmania.

The mine will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

6.2 Conclusions for threatened flora (orchid) species

No plant species listed under the *Environment Protection and Biodiversity Conservation Act 1999* have been found within the mining lease.

The threatened plant species (described above and identified by the EIS guidelines) that could potentially be impacted by the mine are all orchids.

Impacts on orchids could arise from two pathways: direct impacts or indirect impacts.

Direct impacts on orchids would occur if there was direct physical disturbance or removal of individuals, populations or habitat.

Indirect impacts could arise from habitat fragmentation, altered fire regimes, spread of weeds, genetic effects of small population size, loss of mycorrhizal fungus and loss of pollinators[187].

The likelihood and potential significance of each of these impacts is discussed below.

6.2.1 Direct physical disturbance or loss of individuals

Targeted surveys (undertaken in the spring of 2010) found no threatened orchid plants within the mine lease area. Orchids do not always flower in every year and it is conceivable that individual plants could emerge in other flowering years. However, whether and where individual plants might occur some unknown time in the future can only be speculative and cannot be the basis for development planning or decision making.

6.2.2 Direct physical disturbance or loss of populations

As noted above, targeted surveys (undertaken in the spring of 2010) found no threatened orchid plants within the mine lease area but it is conceivable that orchid populations could emerge in other flowering years.

As for individual plants, whether and where populations might occur can only be speculative. However, at the population scale it is possible to make a reasoned judgement as to the likelihood of this occurring based on the preferred habitat of the orchid species.

Habitat preferences of the orchid species are summarised in

Table 26[188 and 189 and 190].

[187] Nigel Swarts pers. comm.

[188] Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[189] ECOTas (February 2009) Extension surveys for threatened flora: *Caladenia dienema* and *Prasophyllum favonium* in the Arthur-Pieman Conservation Area, *Chiloglottis trapeziformis* in the Wynyard area, *Thelymitra jonesii* and *Thelymitra malvina* in the Rocky Cape National park area, miscellaneous findings of other threatened species and species of biogeographic interest. Report prepared for Threatened Species Section (DPIPWE).

[190] DPIPWE listing statements

Table 26: Summary of preferred habitats of threatened orchid species

Species	Preferred habitat	Comments
Caladenia dienema	Coastal heathland within 1 km of the coastline. The species is known from coastal scrub and windswept coastal grassland and heaths amongst stunted shrubs and sedges on moist to well-drained sand and clay loams	The mine site is several kilometres inland but there is a record within 100 m of the lease boundary, although this is not within its preferred habitat.
Caladenia patersonii	Favours coastal and near coastal areas in the north from south of Marrawah to Bridport, occupying about 5 ha in total. It occurs in low shrubby heathland in moist to well-drained sandy and clay loam.	There area no Natural Values Atlas records within 5 km of the mine site.
Corunastylis brachystachya [Referred to by its old name of *Genoplesium brachystachyum* in the EIS guidelines]	Heathland and heathy eucalypt woodland on well-drained rocky sites	There is heathland in the western part of the mine lease but the nearest record of the species is more than 3 km away.
Diuris lanceolata	Windswept coastal grassland and coastal scrub and heathland among dwarfed shrubs and sedges on moist to well drained sandy and clay loam, sometimes on rocky outcrops	The mine site is several kilometres inland from the coast, well away from the preferred habitat of this species, and the nearest record is more than 3 km away.
Microtidium atratum	Occurs in habitats subject to periodic inundation such as swamps, depressions and soaks.	Uncommon and localised in coastal and near-coastal lowland areas, almost exclusively in the northeast and the Furneaux islands with outliers in the Arthur-Pieman area and Bruny Island in the south. There area no Natural Values Atlas records within 5 km of the mine site.
Orthoceras strictum	Occurs in a wide range of habitat types including buttongrass moorland, sedgy and scrubby heathland, sedgy eucalypt shrubland and open forest, usually on poorly to moderately drained peaty, sandy and clay soils that are at least seasonally moist.	There area no Natural Values Atlas records within 5 km of the mine site.
Prasophyllum favonium	Among shrubs in windswept dense low heathland on moderately drained grey to black sandy peaty loam	There is heathland in the western part of the mine lease but the nearest record of the species is more than 3 km away.
Prasophyllum pulchellum	Dense low sedgy heath with pockets of paperbark or tea-tree on poorly to moderately drained sandy or peaty loam	There is heathland in the western part of the mine lease and a population of this species was found within it (but outside the lease boundary).
Prasophyllum secutum	Coastal scrub in the swales of stabilised sand dunes on white to grey sands and sandy loam	The mine site is several kilometres inland from the coast, well away from the preferred habitat of this species, and the nearest record is almost 5 km away.
Pterostylis rubenachii	Dry, sandy slopes of sparsely vegetated stabilised sand dunes, and also in permanently wet to moist scrubby and sedgy coastal heath converted to semi-improved pasture by annual slashing	The mine site is several kilometres inland from the coast, well away from the preferred habitat of this species, and the nearest record is almost 5 km away.
Pterostylis ziegeleri	Slopes of low stabilised sand dunes and in the grassy dune swales	The mine site is several kilometres inland from the coast, well away from the preferred habitat of this species, and the nearest record is more than 10 km away.

Species	Preferred habitat	Comments
Thelymitra mucida	Occurs in moist to wet depressions, swamp margins and other low-lying sites in coastal and near-coastal heathland, heathy forest and shrubland in dark sandy or peaty soils, usually below about 50 m elevation.	There area no Natural Values Atlas records within 5 km of the mine site.

Protection of the species will best be achieved by protecting optimal habitat because it is that habitat that is most likely to contain sustainable populations. The preceding discussion and

Table 26 show that the orchid habitat within and in the vicinity of the mine site that is most conducive to orchid populations is the wet heathland.

The protection of wet heathland is therefore the design objective of the mine. Protecting this habitat provides the best assurance against minimising the loss of populations of threatened orchid species.

6.2.3 *Direct physical disturbance or loss of habitat*

Within the vicinity of the mine, the wet heathland is the habitat most likely to be preferred by any threatened orchid species that exist in the area. Table 23 and Table 24 (section 4.2) shows that there will be 4.2 ha of wet heathland lost within the mine footprint. These heathland patches occur above the main pit and at the northern end of the rock dump (see Figure 15 at the beginning of section 4).

The mine has been redesigned since the original EPBS referral to keep its disturbance footprint away from the large area of wet heathland found in the western part of the lease. In particular, the rock dump has been pushed east so that its footprint lies entirely to the east of West Creek, well away from that heathland.

Relative to the wider region, the 4.2 ha lost represents 1.2% of the total wet heathland occurring within a 5 km radius of the lease (see Figure 38 andTABLE), which is insignificant. In fact, the site survey undertaken by NorthBarker indicates that the vegetation mapped by Tasveg as buttongrass moorland to the west of the mine site is actually wet heathland, meaning that the 1.2% figure is probably a significant overestimate of the proportion of wet heathland in the region that would be lost due to the mine.

6.2.4 *Altered fire regimes*

As noted in the IES guidelines, the life cycle of orchids is related to fire and populations often emerge 1 to 3 years after a fire passes through a habitat area.

It is know that the fire regime has changed since European settlement, with Aboriginal firestick farming practices having ceased, wild fires being deliberately lit and suppressed and regular low intensity burns being conducted in some areas[191].

It is conceivable that the presence of the mine could alter the fire regime in the region.

[191] Threatened Species Section (2006) Threatened Tasmanian Orchids Flora Recover Plan 2006-2010. Department of Primary Industries & Water.

Without appropriate fire minimisation measures, the mine could introduce a new potential source for a fire starting. This could increase the likelihood of orchid habitat being burnt. Increased fire frequency might increase the likelihood of orchids flowering but if too intense it might also kill orchid plants and seeds or kill other plants within the orchids' preferred habitat. Increased fire might also increase the likelihood of weed invasion, and weeds could out-compete orchids for space or resources, although there is no evidence of this happening in the Arthur-Pieman region[192]. In general, however, increased fire frequency is beneficial to orchids[193]..

The presence of the mine might reduce the potential severity of wildfires in the region. The mine site will provide a fire break against the spread of any fires that did occur and mine workers would also be available to assist with fire fighting. The presence of the mine might therefore reduce the exposure of orchid habitat to wildfire. Decreased fire frequency and/or intensity might decrease the likelihood of orchids flowering.

Because of the benefits to orchids species of burning Shree Minerals will cooperate with any Government requests to conduct prescribed burning within the lease area to enhance orchid habitat, should such requests be made. However, in the absence of such requests the mine operations will be managed so as to minimise changes to the natural fire regime in the area.

The mine will actively manage its operations to minimise the risk of fire starting on the mine site and it will also actively suppress any fires that do nevertheless start or that encroach upon it from outside. However, unless infrastructure or human life is threatened (or there is a request from fire fighters), fire fighting measures will not be conducted outside the mine lease area. This restriction will minimise alterations to the prevailing fire regime to which orchids in surrounding habitat are naturally exposed.

The net effect of these management measures is that there is unlikely to be a significant change to the historical fire regime.

6.2.5 Spread of weeds

The spread of weeds and also plant diseases (such as *Phytophthora*) is highly undesirable irrespective of their potential impact on threatened orchid species and active weed and disease management measures will therefore be implemented at the mine. Indeed, they have already been implemented during the exploration phase.

Equipment, machinery and vehicle inspection, washdown and disinfection procedures will be implemented and enforced for anything coming to the mine from a site where it has been exposed to disturbed soil.

These measures will continue throughout the life of the mine.

The risk of introducing weeds and/or plant diseases to the mine site is greatest during the initial mine construction phase, when earthmoving equipment is first brought to the site. Once the mine is operating, earthmoving will be undertaken by the mine's own machines, which will remain on-site, and there will be very little requirement to bring external earthmoving equipment onto the site.

Product and worker transport will use existing formed roads and will not go off-road, so day to day operations do not present a significant risk.

With appropriate management measures, there is unlikely to be a significant risk to orchids from weed or plants disease introduction.

[192] Mark Wapstra pers. comm.
[193] Mark Wapstra pers. comm.

6.2.6 Genetic effects of small population size

Genetic effects, if any, arising from small population sizes would be a factor intrinsic to the existing gene pools and distributions of the various orchid species.

If these effects do exist, the most appropriate way to mitigate against adverse consequences would be to protect the core habitat of each species. As described above, this means protecting the wet heathland, which is achieved by the mine design.

There is no significant potential for the mine to influence the genetic characteristics of the orchids or to exacerbate any inherent genetic risks if indeed such risks exist in the first instance.

6.2.7 Loss of mycorrhizal fungus

Mycorrhizal fungus associations with orchids are know to be easily compromised by weed invasion, edge effects due to altered land use, changes to soil chemistry, changes to organic content and changes to hydrology[194].

The task for the mine therefore becomes one of ensuring that its activities do not cause any of these changes.

Weeds management has been discussed above. Those same measures will minimise the risk of weed invasion to the mine site itself and therefore consequential weed invasion of the wet heathlands in the western part of the lease.

The mine design by intent creates a clear separation buffer between the mine footprint and the wet heathland in the western part of the lease. That buffer will exclude any edge effects because the mine footprint and the heathlands will not share a contiguous boundary.

There is no identifiable causal relationship between the presence of the mine in the eastern part of the mine lease and the soil chemistry or organic content of the wet heathland in the western part. Any mooting of some possible unknown relationship could only be speculative at best, and without scientific basis. Even something as already tenuous as atmospheric fallout of dust from the haul roads or exhaust from the mine's diesel power generators is not credible given the very strong prevailing winds of the area, which blow away from the heathland, not towards it.

The remaining potential impact of the mine on mycorrhizal fungus associations with orchids is a change to the hydrology of the soil where those associations take place. As described earlier (section 3.3), the wet heathland (the preferred habitat of the orchids) in the western part of the lease is well away from the mine pits and will be at the extreme margins of the water table depression that will occur from pit dewatering. More importantly, the wet heathland is a groundwater recharge area - the heathland soil does not derive its water from the underlying groundwater but rather from precipitation from above (see section 3.3 and also Appendix D).

Even if it did occur, any lowering of the watertable below the heathland (which at most would be marginal anyway) could therefore not change the soil water regime and therefore could not affect mycorrhizal fungus associations.

In summary, no potential causal pathway can be identified by which the mine could significantly affect the mycorrhizal fungus associations of any orchids in the wet heathland in the western part of the lease.

The mine will therefore not have any significant impact on the mycorrhizal fungus associations of threatened orchid species.

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[194] Nigel Swarts pers. comm.

6.2.8 Loss of pollinators

Many orchids (but not all – some are self-pollinating) rely on insects for pollination. Loss of pollinator habitat could therefore impact on orchids by reducing their pollination rates. This loss of pollinator habitat could be direct, such as removal of the habitat of pollinating wasps, or indirect, such as the removal of the habitat of beetles that are parasitized by orchid pollinating wasps.

Protecting orchid habitat may not equally protect the habitat of their pollinators because the pollinators may use, and possibly prefer, other habitats and might only use orchid habitat opportunistically and facultatively.

The ecological relationships between orchids and pollinators in the region surrounding the mine are likely to be complex and are not well understood. Nevertheless, it is possible to make an informed judgement about the likely level of risk to orchids that might arise from a loss of pollinator habitat.

Figure 38 shows the distribution of vegetation communities in the wider region around the mine site.

Table 27 shows loss of vegetation communities due to the mine, expressed as a percentage of the area of those communities found within a 5 km radius of the mine lease (including within the lease).

Table 27: Vegetation community loss as a proportion of surrounding areas

Vegetation type	Area cleared within mine site (ha)	Area within 5 km radius of mine site (ha)	Proportion lost from within 5 km radius (%)
Buttongrass moorland (undifferentiated) (MBU)	0.0046	2814.0548	0.01
Eucalyptus nitida dry forest and woodland (DNI)	30.3146	1711.7779	1.8
Eucalyptus obliqua forest*	104.6647	3695.6324	2.8
Western wet scrub (SWW)	12.4687	1133.8719	1.1
Wet heathland (SHW)	4.2431	340.9899**	1.2

*Differentiation between DOB, WOL and WOB is not possible because of lack of differentiation in Tasveg data outside the mine's survey area
**The site survey undertaken by NorthBarker indicates that the vegetation mapped by Tasveg as buttongrass moorland to the west of the mine site is in fact wet heathland, meaning that this figure is probably a significant underestimate (and therefore the % lost due to the mine is probably a significant overestimate)

Table 27 shows that, regardless of which particular vegetation community might be preferred by particular orchid pollinators, the maximum percentage loss of any given preference within a 5 km radius of the mine is less than 3%. Notwithstanding the uncertainties about orchid pollinator habitat preferences, a less than 3% potential impact cannot reasonably be considered to be significant.

The mine will therefore not have any significant impact on orchid pollinators.

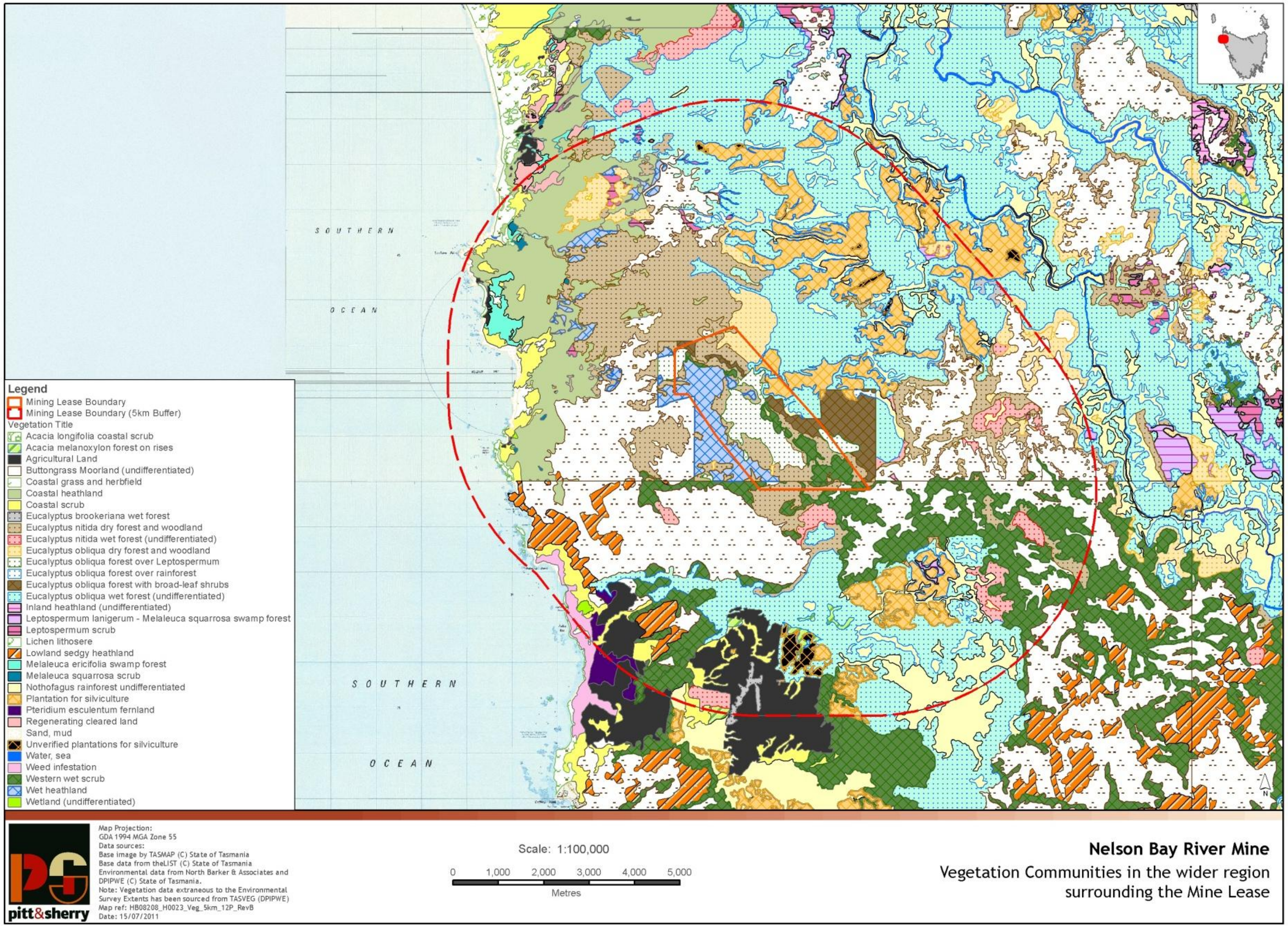

Figure 38: Distribution of vegetation communities in the wider region surrounding the mine site

6.2.9 *Proposed baseline scientific research*

The EIS guidelines require baseline research to be conducted into the mycorrhizal and pollinator requirements of impacted threatened orchids. As described above, the mine has no significant likelihood of impacting on threatened orchid species. That requirement is therefore not relevant to the approval decision for the project.

Nevertheless, the presence of the mine provides an opportunity to undertake baseline scientific research to improve our understanding of orchid ecology in northwestern Tasmania, which will aid in the protection and management of these threatened species.

Shree Minerals will therefore commission a scientific research program during the first few years of its operations, as a best practice environmental management contribution to orchid science. A proposed approach (reflecting the guidelines) is described in Appendix Q.

6.3 Ecological communities

There are no ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* in the vicinity of the proposed mine and there will therefore be no impacts on ecological communities of national significance.

6.4 Fauna

6.4.1 *Ceyx azureus diemenensis* – Tasmanian azure kingfisher (Endangered)

[Previously named *Alcedo azurea* subsp. *diemenensis*]

No known nest sites or records occur within 5 km of the study area and suitable habitat is considered to be marginal. As visual and auditory searches did not locate any *Ceyx azureus diemenensis,* the potential of occurrence is considered to be low.[195] As the species was not found during the field survey, there is no evidence to suggest that direct impacts on it will occur from the proposed mine.

Potential habitat for the species is the Nelson Bay River. The river has relatively fast moving water with still deep sections but the banks are generally unsuitable for nesting as they are predominantly sheer rock rather than sediments. [196]

The species inhabits tree-lined waterways, lakes, ponds and other wetlands with dense streamside vegetation, in particular in western and north-western Tasmania.[197] A potential direct impact on habitat could be any clearing along the Nelson Bay River. However, no such clearing of streamside habitat will occur; therefore, no direct significant impact on habitat for this species is anticipated.

Acidic runoff into rivers from mines can adversely affect local populations of this species. The worst affected river systems due to historical acid drainage within the range of the kingfisher are not inhabited by it, suggesting that acid mine drainage may make some sections of river systems unsuitable for the species.[198] However, this mine will manage acidic rock to ensure that there will be no acid runoff and no direct impact on the river system is anticipated (see section 3.8).

[195] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[196] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[197] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[198] http://www.environment.gov.au/biodiversity/threatened/species/pubs/25977-listing-advice.pdf

A potential indirect impact on the species could occur if there were any alterations to the levels of the Nelson Bay River that resulted in the flooding of any nesting tunnels that might be present. However, this indirect impact is considered very unlikely as the area is generally unsuitable for nesting and the mine will not extract water from or discharge water to the river. While there will be diversions of surface waters and groundwaters within the mine site due to the presence of the mine, there will be no significant effect on the natural flow patterns of Nelson Bay River (see section 3.16).

In the context of the development and known threats to the species the following key threats are identified[199]:

- Habitat clearing
- Acid mine drainage from tailings; and
- Fluctuating water levels caused by dams and weirs.

Whether these threats are in fact affecting the species has not been fully confirmed or quantified.[200] Known threats are addressed above as potential indirect impacts but these are not anticipated to occur as a result of the proposed mine. The mine therefore will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

6.4.2 *Lathamus discolor* - swift parrot (Endangered)

There are no records of this species within 5 km of the study area. The likelihood of occurrence of this species at the proposed mine is considered to be very low.[201]

The survey area is not considered suitable nesting habitat, although it may provide foraging habitat during the species' annual migration from, and back to, the Australian mainland. [202]

There is no evidence to suggest that direct impacts on the subspecies will occur from the proposed mine.

Post breeding habitat for the species is mainly in the wetter forests of the west and northwest of the state where summer and autumn flowering eucalypts are abundant including[203]:

- *Eucalyptus obliqua*
- *Eucalyptus delegatensis*
- *Eucalyptus viminalis*
- *Eucalyptus dalrympleana;* and
- *Eucalyptus pauciflora.*

Approximately 70 hectares of wet *Eucalyptus obliqua* forest over *Leptospermum* (WOL) will be cleared for the proposed rock waste dump.

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199 http://www.environment.gov.au/biodiversity/threatened/species/pubs/25977-listing-advice.pdf
200 http://www.environment.gov.au/biodiversity/threatened/species/pubs/25977-listing-advice.pdf
201 Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
202 Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
203 Swift Parrot Recovery Team (2001). Swift Parrot Recovery Plan. Department of Primary Industries, Water and Environment.

The location of the proposed mine is within the potential range of the *Lathamus discolor* and the birds could forage in *obliqua* trees. However, at most the species would only be a temporary visitor to the site for short periods of time during fly over. There are many trees within the WOL with seriously fire damaged crowns which would limit the amount of flowering eucalypts currently suitable for foraging.[204]

From a state wide conservation status 427,969 hectares of WOL (analysis undertaken on WOU) is intact with 138,590 hectares reserved. From a state-wide perspective, the vegetation community is not considered threatened. Bioregionally, 63,134 hectares of this vegetation is intact with 9,945 ha reserved. Bioregionally this vegetation community is not considered threatened.[205]

Habitat loss[206] is the key threat in context with the development and the known threats to the species. However, this is probably mostly attributed to the loss of *Eucalyptus globulus* within the restricted breeding distribution of the species. Forestry and firewood collection have altered the age structure of forests across the species range.

The mine will not make a significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

6.4.3 *Neophema chrysogaster* - orange-bellied parrot (Critically Endangered)

The wet heath may provide foraging habitat for the species while the birds are migrating between Tasmania and the Australian mainland. However, the likelihood of occurrence is considered to be very low.[207]

There is no evidence to suggest that direct impacts on the species will occur from the proposed mine.

There will not be any direct impact on the wet heathland, which may provide foraging habitat for the species.

A potential indirect impact could come from an alteration of the hydrology of the wet heathland. However, the wet heathland is in a groundwater recharge area, not a discharge area, and its soil water is therefore not dependent on the underlying water table. The heathland plants are shallow rooted species reliant on soil water from infiltrating rainfall, not from the underlying water table. There is therefore no significant likelihood of the heathland soil water, and hence the ecosystems dependent on it being affected by the dewatering of the mine pits.[208] No indirect impact caused by the proposed mine altering the hydrology of the wet heathland is anticipated.

A potential direct impact on the foraging habitat could be the introduction of invasive weeds to the wet heathland as a result of the construction activities associated with the mine. Specific control measures will be implemented on site to deal with the introduction and containment of invasive weeds. With appropriate control measures in place to manage weeds, no impact on the wet heathland from invasive weeds is anticipated.

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[204] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[205] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[206] Swift Parrot Recovery Team (2001). Swift Parrot Recovery Plan. Department of Primary Industries, Water and Environment.
[207] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.
[208] Cromer, W. C. (2011) *Hydrogeological report, Proposed Nelson Bay River Magnetite Mine.* (Unpublished report for Shree Minerals Ltd. by William C. Cromer Pty. Ltd.).

In the context of the development and known threats to the species the following key threats are identified[209]:

- Degradation and loss of habitat (The majority of this impact has occurred within the non – breeding range: migratory corridors and wintering areas);
- Invasive weeds (Specifically foraging habitats throughout the species non-breeding range).

Known threats are addressed above as potential indirect and direct impacts which are not anticipated to occur as a result of the proposed mine. The mine therefore will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

6.4.4 *Myiagra cyanoleuca* - satin flycatcher (Migratory)

This species was seen foraging at several locations in the riparian areas along the Nelson Bay River. Within the current study area they were only recorded outside the proposed mine layout. [210]

There is no evidence to suggest that direct impacts on the species will occur from the proposed mine.

The species mainly inhabits eucalypt forests, often near wetlands or watercourse. On migration they occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.[211]

A potential direct impact on habitat could be any clearing along the Nelson Bay River and other suitable riparian habitat. However, no clearing of this habitat will occur. Although the closest clearing to the Nelson Bay River is approximately 30 metres (associated with the main pit), this is outside the river gorge and is not riparian vegetation (the gorge is very steep and deep in this location); therefore, no significant direct impact on habitat along the river is anticipated.

Riparian habitat occurs along West and East Creeks but this is not the where the birds were observed.[212] East Creek will not be impacted, apart from a road crossing. The rock dump has been designed to avoid impact on West Creek. There will be a 30 metre buffer along West Creek to the dump's collection drain; therefore no significant direct impact on habitat along this creek is anticipated.

Clearing and logging of mature forests in south east Australia[213] is the key threat in context with the development and the known threats to the species.

Known threats are addressed above as direct impacts which are not anticipated to occur as a result of the proposed mine. The mine therefore will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

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[209] Orange-bellied Parrot Recovery Team (2006), Department of Primary Industries and Water (DPIW), Hobart.

[210] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[211] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=612#australian_distribution

[212] Northbarker Ecosystem Services (March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment.* Report prepared for Shree Minerals.

[213] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=612#australian_distribution

6.4.5 *Aquila audax subsp. fleayi* - wedge-tailed eagle (Endangered)

This species forages in open areas and has been recorded hunting over most types of terrestrial habitat in the state.[214] The survey area is considered to be very likely utilised for foraging.[215] Approximately 152 hectares of vegetation will be cleared for the proposed mine. A direct impact on potential foraging habitat will therefore occur.

No specific figures are available on the size of home ranges occupied by the species but they are generally considered to be in the order of tens of square kilometres or more. Where suitable habitat is available, territories tend to be evenly dispersed. As a result of this, the species is only recorded nesting in low densities. The estimated densities of territories range from a maximum of one pair per 20-30 km^2 in a mosaic of dry sclerophyll forest and fertile open habitat in the lowlands of eastern and northern Tasmania, to a minimum of one pair per 1200 km^2 in the highlands of western and south – western Tasmania.[216]

Because of the small size of the mine site relative to the eagle's range, the vegetation clearing is not considered likely to have a significant impact on food supply.

The species nests in a range of old-growth forest, with the majority of nests occurring in forests dominated by eucalypts. Nests are almost always built in an emergent tree that is among the tallest and broadest of those available and are usually in trees on sloping ground, at an aspect that offers protection from prevailing winds. The species is highly sensitive to disturbance during the breeding season. [217]

Loss of nesting habitat and disturbance of breeding birds has been identified as key threats to this species.[218]

Generally, the survey area was considered to have a low probability to contain nests as most of the mature eucalypts within the study area have been badly fire damaged.[219]

A direct impact is anticipated to mature eucalypts that have the potential to be used as nest trees within the proposed waste dump area and along the northerly edge of the tailings dam. However, as the bulk of the trees in this area have been severely fire damaged and the crowns are generally dead the value of the nesting habitat has probably been degraded.[220]

Within the mining lease but outside the proposed impact zone another potential nesting area is in the riparian forest along the banks of the Nelson Bay River. The quality of the nesting habitat in this area has also been reduced by severe fire damage to the crowns of the mature eucalypts trees.[221]

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214 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435
215 *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services
216 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435
217 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435
218 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435
219 *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services
220 *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services
221 *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

There is no potential nesting habitat within the main pit, DSO pit, the processing plant and ROM pad or the southern side of the tailings dam, as these sites are exposed to wind and have either no eucalypt trees or no mature eucalypts taller than 27 m.[222]

Potential for nesting habitat within 500 m or 1 km line of sight of the mine areas is low as the forest to the northeast has been logged and regenerated or planted to eucalypt plantation. Database records indicate that there are no known locations of existing nests within a 1 km line of sight from the proposed works. The nearest known eagle nest is approximately 1.8 km to the north east of the study area (nest id 971500). [223]

A helicopter-based search for potential nest trees in all these areas described above failed to locate any nests.[224]

There is therefore no significant likelihood of the mine impacting on eagle nesting.

A facilitated impact by the proposed mine could potentially occur as a result of the increase of traffic volume to and from the proposed mine site. An increase in traffic volume could potentially result in a higher incidence of road kill or injury to individual birds as they feed on carcasses of wildlife killed by traffic.

In the context of the development and known threats to the subspecies the following key threats are identified[225]:

- Loss of habitat (specifically nesting habitat)
- Nest disturbance
- Unnatural mortality (collision with vehicles).

The proposed mine will not make a significant contribution to the loss of good quality nesting habitat for the subspecies and will only contribute to a minor reduction in potential foraging habitat.

Without mitigation, increased traffic to the site could potentially increase the incidences of unnatural mortality.

The average traffic along the high risk section of the transport route is 100 vehicles per day (see 3.17 and Appendix M). Product transport for the mine (after the first year) is likely to add approximately 34 movements per day for years 2 to 10, a 34% increase, and 82 per day for year 1, an 82% increase for that one year. Shree Minerals will be providing a bus service for workers to and from Smithton, so additional worker traffic is unlikely to be significant.

Increased traffic to the site may increase the incidence of road mortality. Although the risk increase will be low, it would be prudent to implement mitigation measures to minimise this risk because roadkill introduces a consequential risk to eagles that might feed on carcasses and become potential roadkill victims themselves.

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[222] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

[223] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

[224] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

[225] Threatened Species Section (2006). *Threatened Tasmanian Eagles Recovery Plan 2006 – 2010*. Department of Primary Industries and Water, Hobart.

6.4.6 *Haliaeetus leucogaster* – white-bellied sea eagle (Migratory)

White-bellied sea eagles share many aspects of breeding and conservation biology with wedge-tailed eagles and the two species also compete for nests, and they consequently share common management prescriptions and a common recovery plan[226].

Generally, the survey area was considered to have a low probability to contain nests as most of the mature eucalypts within the study area have been badly fire damaged.[227]

A direct impact is anticipated to mature eucalypts that have the potential to be used as nest trees within the proposed waste dump area and along the northerly edge of the tailings dam. However, as the bulk of the trees in this area have been severely fire damaged and the crowns are generally dead the value of the nesting habitat has probably been degraded.[228]

Within the mining lease but outside the proposed impact zone another potential nesting area is in the riparian forest along the banks of the Nelson Bay River. The quality of the nesting habitat in this area has also been reduced by severe fire damage to the crowns of the mature eucalypts trees.[229]

There is no potential nesting habitat within the main pit, DSO pit, the processing plant and ROM pad or the southern side of the tailings dam, as these sites are exposed to wind and have either no eucalypt trees or no mature eucalypts taller than 27 m.[230]

Potential for nesting habitat within 500 m or 1 km line of sight of the mine areas is low as the forest to the northeast has been logged and regenerated or planted to eucalypt plantation. Database records indicate that there are no known locations of existing nests within a 1 km line of sight from the proposed works. The nearest known eagle nest is approximately 1.8 km to the north east of the study area (nest id 971500). [231] Although this is more likely to be a wedge-tailed eagle nest, the shared nesting habitat makes it conceivable that sea eagles might also use that nest.

A helicopter-based search for potential nest trees in all these areas described above failed to locate any nests.[232]

There is therefore no significant likelihood of the mine impacting on eagle nesting.

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[226] Threatened Species Section (2006). *Threatened Tasmanian Eagles Recovery Plan 2006 – 2010*. Department of Primary Industries and Water, Hobart.

[227] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

[228] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

[229] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

[230] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

[231] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

[232] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

In the context of the development and known threats to the species the following key threats are identified[233]:

- Loss of habitat (specifically nesting habitat)
- Nest disturbance
- Unnatural mortality (entanglement with fishing nets).

Unlike the wedge-tailed eagle, the white bellied sea eagle is very unlikely to forage on or around the mine site. They predominantly feed at sea, along the coast, taking a variety of fish, birds, reptiles, mammals and crustaceans, and also carrion and offal[234]. Clearing of vegetation within the mine site would therefore have negligible impact on sea eagle foraging habitat.

Similarly, white bellied sea eagle are less likely to be vulnerable to roadkill than wedge-tailed eagles, whether within the mine site, along its access road or along the product transport route because these roads are all well inland (more than 5 km from the coast).

There is therefore no significant likelihood of the mine impacting on white bellied sea eagle roadkill. Nevertheless, the roadkill mitigation measures proposed for wedge-tailed eagles would also further mitigate the already negligible risk to sea eagles.

6.4.7 *Tyto novaehollandiae subsp. castanops* - Tasmanian masked owl (Vulnerable)

This species inhabits a diverse range of forests and woodlands, including agricultural and forest mosaics. Particularly favoured are forests with relatively open under stories, especially when this habitat adjoins areas of open or cleared land.[235] Its preferred habitat is lowland dry forest and woodlands.[236]

Nesting of the species occurs in large tree hollows of living or dead trees but sometimes in vertical spouts or limbs.[237] The wet forest that has been burnt has some evidence of large hollows, which may provide potential nesting habitat. Likelihood of occurrence is low, however.[238]

The densities of species vary across the state with the highest densities occurring in the east and north and the lowest densities at elevations more than 600 m in the western half of the state (this could be due to the lack of survey effort).[239]

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233 Threatened Species Section (2006). *Threatened Tasmanian Eagles Recovery Plan 2006 – 2010.* Department of Primary Industries and Water, Hobart.

234 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=943#habitat

235 http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf

236 *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

237 http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf

238 *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services

239 http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf

In context with the development and known threats to the species the following key threats are identified[240]:

- Habitat clearing and fragmentation, including forestry activities
- Collision mortality (vehicles); and
- Competition for tree hollows (loss of nesting habitat results in increasing competition for large tree hollows).

There is a potential for masked owls to use hollow trees for nesting and preclearing surveys for nests are therefore warranted.

6.4.8 *Dasyurus maculatus ssp. maculatus - spotted-tailed quoll (Vulnerable)*

There are several records of this species within 5 km of the study area. It is present in the proposed mine site area, as evidenced by the observed probable scat.[241]

The species inhabits a large range of habitats, including rainforests, wet and dry sclerophyll forest, coastal heathland, scrub and dunes, woodland, heathy woodland, swamp forest, beaches and sometimes in grassland or pastoral areas adjacent to forests.[242]

The proposed mine will contribute to potential habitat loss. However, the mine will not significantly impact on the wider availability of habitat for the species nor on the movement of quolls within that wider habitat. The potential impact on the species due to habitat reduction is therefore not considered to be significant, other than perhaps for denning habitat.

The species is known to use multiple dens and changes these every 1-4 days. Den sites have been recorded in a variety of structure types, including rock crevices, hollow logs, hollow tree buttresses, tree hollows, windrows, clumps of vegetation, caves, boulder tumbles, under buildings, and in the dens of rabbits and wombats. They are also known to dig burrows when a suitable substrate is available. A study of the mainland populations indicates that prey density and den availability are the two main factors in the use of habitat. These results are likely to apply to Tasmanian populations. Habitat critical to the species is that which contains adequate denning resources in large forest areas.[243]

Approximately 152 hectares of vegetation will be cleared for the proposed mine. The quality of the foraging habitat is likely to be similar throughout the proposed impact areas although denning opportunities are likely to be greater in the mature forest in the large dry hollows of eucalypts or under fallen logs or, in well drained sites, burrows might be dug or existing wombat burrows used.[244]

The species is solitary and occupies large home ranges. The male territory overlaps multiple female home ranges and has been recorded as ranging between 359 ha and 5512 ha in size. Females generally have a non-overlapping home range between 88 ha and 1515 ha in size.[245]

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[240] http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-listing-advice.pdf
[241] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services
[242] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183
[243] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183
[244] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services
[245] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183

Less is known about population quoll densities in this area of the State than for devils but headlight observations (Appendix P) show that quoll densities are very much lower than devil densities. While the 152 ha of the mine site footprint might contain a maximum of 1.5 devils (see section 6.4.9), that same area would very likely contain much less than 1 quoll. Clearance of the vegetation for the mine is therefore likely to displace 1 quoll at most.

Vegetation removal may remove denning opportunities but the species, in particular males, is therefore likely to range much wider than the area of the vegetation clearance.

Nevertheless, because of the potential for the species to be occupying dens within vegetation to be cleared for the mine, preclearing surveys for occupied dens are warranted. The appropriate time for these surveys would be immediately before each stage of clearing so as to ensure the temporal relevance of the surveys to the clearing activity.

Any den opportunities lost through the vegetation clearing should be replaced by the creation of compensatory new opportunities.

A facilitated impact by the proposed mine could occur as a result of the increase of traffic volume to and from the proposed mine site. An increase in traffic volume may result in a higher incidence of road kill or injury to individual animals.

Given the low density of individuals (one individual per 4 km^2) any quoll roadkill might be considered significant.[246]

It is estimated that 1-2 individuals are killed daily on the main road between Hobart and the north west of the state[247], which is a very low kill rate per kilometre. Juvenile males are most at risk due to extensive range. The full impacts of road mortality on the species are not well known but other carnivorous marsupials have been significantly impacted.[248]

In the context of the development and known threats to the species the following key threats are identified[249]:

- Habitat loss and modification
- Fragmentation; and
- Road mortality.

Increased traffic to the site may increase the incidences of road mortality. Although the risk of roadkill is low, it would be prudent to implement mitigation measures to minimise this risk.

Roadkill and headlight surveys undertaken by Wildspot Consulting for the Department of Infrastructure, Energy and Resources noted 11 spotted-tailed quoll observations and 1 spotted-tailed quoll roadkill between 5 October 2009 and 18 April 2010 on the road between Arthur River township and Roger River (Appendix P)[250].

[246] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment,* 22/03/11, Northbarker Ecosystem Services
[247] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183
[248] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183
[249] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183
[250] Data (by Wildspot Consulting) and mapping (by Northbarker Ecosystem Services) provided courtesy of the Department of Infrastructure, Energy & Resources.

The nearest quoll observation was approximately 2 km east of the junction of Wuthering Heights Road with Rebecca Road. The (only) quoll roadkill was near Roger River West, approximately 30 km to the northeast of that junction. This section of road, north of Arthur River, has a significantly higher wildlife roadkill risk than the southern Rebecca Road sections of the transport route (Appendix P).

The average traffic along the high risk section of the transport route is 100 vehicles per day (see Appendix M). Product transport for the mine (after the first year) is likely to add approximately 34 movements per day for years 2 to 10, a 34% increase, and 82 per day for year 1, an 82% increase for that one year.

The existing quoll roadkill risk is low, equivalent to 2 per year. Disregarding time of day, a 34% increase in traffic movements due to the mine might proportionally add 0.6 additional kill every year to that risk (1.6 during the first year).

Roadkill risk is primarily a night time occurrence – the risk during daylight hours is approximately 25% of the night time risk[251].

A prudent risk minimisation measure would therefore be to avoid product transport at night.

Confining product transport to daylight hours would proportionally reduce the roadkill risk increase to one fifth[252] of the total daily risk increase. The increase in traffic movements due to the mine's product transport might then proportionally add 0.6 ÷ 5 = 0.1 additional kills every year to that risk (1.6 ÷ 5 = 0.3 during the first year).

6.4.9 *Sarcophilus harrisii* - Tasmanian devil (Endangered)

Numerous records of *Sarcophilus harrisii* occur within 5 km of the study area and scats were located at a latrine site on the exploration tracks.[253]

Approximately 152 hectares of vegetation will be cleared for the proposed mine. This vegetation is potential devil habitat.

For *Sarcophilus harrisii*, good quality habitat encompasses a combination of year round food supply, enough den sites for breeding and daily movements, and structural features for refuge and foraging.

Habitat requirements include the following[254]:

- Places to hide and shelter during the day (such as dense vegetation, hollow logs, burrows or caves)
- Areas with an open understorey mixed with dense patches of vegetation which allow hunting; and
- Soil suitable for burrowing for the purpose of maternal dens.

The combination of these features within a habitat is more important than a particular vegetation community or habitat type.[255]

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[251] Nick Mooney pers. comm.

[252] A day rate 25% of the night rate means proportionally 4 night kills for every 1 day kill, so 1 in 5 occur during the day

[253] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment,* 22/03/11, Northbarker Ecosystem Services

[254] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*). Department of Primary Industries, Parks, Water and Environment, Hobart.

[255] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*). Department

The proposed mine area is potential foraging habitat and, like all forested environments, the mine site vegetation also offers denning opportunities.[256]

Devils occupy several different dens, changing them every 1 to 3 days (other than maternal dens) and they travel an average nightly distance of approximately 9 km (and up to 50 km); a typical home range size is 13 km^2 (ranging from 4 to 27 km^2) [257].

The species is therefore likely to range much wider than the area of the vegetation clearance.

The northwest population of devils impacted by the proposed mine consist of between 3000 and 12,500 individuals over an area of approximately 13,400 km^2.[258] Based on this it could be assumed that the proposed clearing of 152 hectares of habitat may displace between 0.4 and 1.5 individuals. The upper end of this range is conservatively high and would only apply if the mine site had the same devil population density as Woolnorth, which is very unlikely.

Dens are typically underground burrows (such as old wombat burrows), caves or log heaps. Although devils apparently change non-maternal dens often, female adults are thought to remain faithful to their maternal dens for life, so maternal den disturbance can be destabilising to populations.[259] The significance of any destabilisation that might be caused by vegetation clearance would be related to the number of maternal dens disturbed or lost through vegetation clearance and the availability of replacement dens in surrounding areas.

Dens will be in logs, caves, burrows amongst the vegetation, the vegetation being of use to screen dens and add roof stability; each animal will have the choice of multiple dens simply because accidents such as roof collapse or flooding happen naturally and they move to another or make a new one if this happens[260]. A conservative assumption is that all denning opportunities within the vegetation to be cleared are in use by the species. With this assumption, removal of a den would displace the occupying devil, which would attempt to find another den, thereby possibly displacing that den's occupant. Displacement attempts would propagate serially through the surrounding habitat, with displaced devils attempting to displace others in turn[261].

Because of the potential for the species to be occupying dens within the landscape to be cleared for the mine, preclearing surveys for dens are warranted. The appropriate time for these surveys is immediately before each stage of clearing so as to ensure the temporal relevance of the surveys to the clearing activity. Also, any den opportunities lost through the vegetation clearing should be replaced by the creation of compensatory new opportunities.

The location of the proposed mine site in the northwest is one of the only remaining regions supporting high densities of *Sarcophilus harrisii* where devil facial tumour disease (DFTD) has not yet been detected.[262]

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[256] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*, 22/03/11, Northbarker Ecosystem Services
[257] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=299
[258] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=299
[259] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=299
[260] Nick Mooney pers. comm.
[261] Nick Mooney pers. comm.
[262] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii)*. Department

DFTD has not been recorded in the vicinity of the proposed mine despite regular local checks of road kills, direct observation at a food station near Arthur River[263] and, most importantly, extensive trapping by the Save the Tasmanian Devil Program. The most recent trapping (from 26/10/10 to 19/11/10) was a search for the disease front and found no disease west of the Murchison Highway (DPIPWE unpublished data) which is some 50 km from the proposed mine site[264].

The current most western location of the disease front is located to the east of the Murchison Highway close to Oonah.[265] The spread of DFTD is continuing, with the disease front moving 15 km west since 2008. It is possible that DFTD will reach the northwest in 3-10 years. However, it is not known whether mortality will be as high in the western populations or whether these populations will react to the disease in the same way that eastern ones have.[266]

Based on the understanding of DFTD, the mine will not introduce any changes to the environment that would increase the risk of DFTD entering the area or facilitate the intermixing of devil populations.

All rivers and creeks separating eastern and western devil populations already have many natural crossing points (such as sandbars and logs) and/or road bridges, which provide possible east–west movement and intermixing routes. The mine will create no new stream crossings. Although a culvert crossing of East Creek will be constructed to for the mine access road, this creek is ephemeral and does not present an existing barrier to devil movement.

The study area has long been an area of forestry and mineral prospecting and tracks have existed for at least the last two decades. Because the area has already been opened up and subjected to levels of human activity, the mine proposal is unlikely to accelerate the spread of DFTD into the area.[267]

The mine lies within the western devil population and the eastern limits of that population are considered to be well to the east of the proposed mine. The mine, supporting infrastructure and associated activities would not facilitate intermixing of populations[268].

It is therefore very unlikely that the proposed mine could increase the risk of introduction of DFTD. The only conceivable way in which this could occur was if diseased or dead individuals (for example, retrieved road kill picked up east of the site) or equipment that has come in contact with diseased individuals was brought into the site[269]. The likelihood of this occurrence is negligible, and as an added safeguard this issue will be addressed during staff and contractor induction.

Although any roadkill found on Wuthering Heights Road will be handled to remove it from the road as an impact mitigation measure (see section 8.3), that road also lies within the western population and this measure could not introduce DFTD.

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[263] Nick Mooney pers. comm. of observation by Geoff King

[264] Nick Mooney pers. comm.

[265] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii)*. Department

[266] Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii)*. Department

[267] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment,* 22/03/11, Northbarker Ecosystem Services

[268] Nick Mooney pers. comm.

[269] Nick Mooney pers. comm.

A facilitated impact by the proposed mine may occur as a result of the increase of traffic volume to and from the proposed mine site. An increase in traffic volume may result in a direct impact due to higher incidence of road kill or injury to the species. The scavenging diet of the species, their occasional reluctance to leave food and their dark colour make them particularly vulnerable to being killed on the road. As a source of carcasses, and as a means of dispersion, roads attract the species and put them at risk of being killed themselves.[270] In 2008 it was suggested that over 3000 individuals are killed on Tasmanian roads each year.[271]

Roadkill rates of Tasmanian devils peak in summer, impacting relatively heavily on young animals just out of the den and migrating males which may have been driven out by dominant adults. Roadkill can have a substantial impact on even non-DFTD local populations in areas of high traffic (e.g. Cradle Valley, Freycinet before DFTD), being responsible for many premature deaths of both sexes and all ages, and could have an even more serious impact on depleted populations such as those affected by DFTD.[272]

While the study area continues to have a DFTD-free population of the species, roadkill impacts on devil populations will be less significant than they would if DFTD ever becomes established in the area, when the effects of roadkill and DFTD would be combined.[273]

The Save the Tasmanian Devil Program Roadkill Project has identified several key findings in relation to the impact of road kill on the species[274]:

- Figure 39 shows the location of reported roadkill of *Sarcophilus harrisii* between 2001 and 2010. A visual analysis of this figure indicates high roadkill density along the Murchison Highway in the northwest and on the Forestier Peninsula in the south east. In its current form, fine scale analysis is not possible, given the poor location accuracy (up to a 10 km radius in some cases) of many road kill reports (to a considerable degree the spread represents a clustering of study and interest in the issue[275]).

- The number of roadkill incidences reported to the project showed a clear temporal trend, with numbers peaking in summer and being relatively low in winter.

- Of the 100 roadkill reports in which speed limit was provided, 91 involved stretches of road with speed limits greater than 80 kph. This suggests that higher speeds are a factor in the species roadkill rates, as seen in other Tasmanian roadkill studies (this does not take into account the relative prevalence or frequency of travel on roads with different speed limits).

- The mean night-time detection distances for the species from a car with headlights on high beam is 60.8 m; this corresponds to a maximum speed of 54 kph at which a driver could stop safely to prevent collision with the species. This is an important speed relationship for any roadkill mitigation measures.

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[270] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=299
[271] Lawrence, C. & Donnelly, C. (2010) *Save the Tasmanian Devil Program Roadkill Project*. Report prepared for the Save the Tasmanian Devil Program.
[272] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment,* 22/03/11, Northbarker Ecosystem Services
[273] *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment,* 22/03/11, Northbarker Ecosystem Services
[274] Lawrence, C. & Donnelly, C. (2010) *Save the Tasmanian Devil Program Roadkill Project*. Report prepared for the Save the Tasmanian Devil Program.
[275] Nick Mooney pers. comm.

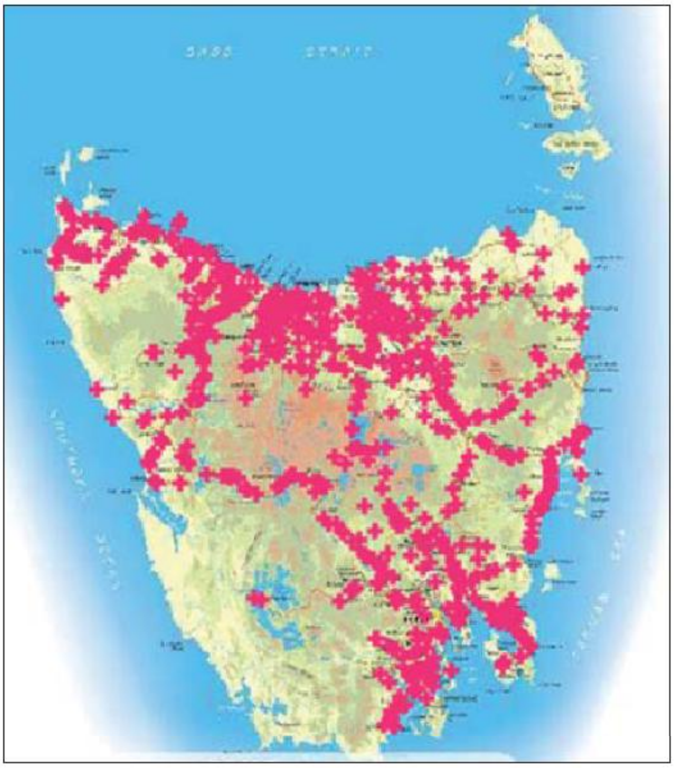

Figure 39: Location of reported roadkill *Sarcophilus harrisii* between 2001 and 2010 (Source: Lawrence, C. & Donnelly, C. (2010) *Save the Tasmanian Devil Program Roadkill Project*. Report prepared for the Save the Tasmanian Devil Program.)

Roadkill and headlight surveys undertaken by Wildspot Consulting for the Department of Infrastructure, Energy and Resources noted 258 Tasmanian devil observations and 5 roadkills between 5 October 2009 and 18 April 2010 on the road between Arthur River township and Roger River (Appendix P)[276].

The nearest devil observation was at the junction of Wuthering Heights Road with Rebecca Road. The nearest devil roadkill was approximately 25 km to the northeast of that junction, north of Arthur River. That section of road has a significantly higher wildlife roadkill risk than the southern Rebecca Road sections of the transport route (Appendix M).

The average traffic along the high risk section of the transport route is 100 vehicles per day (see see section 3.17 and Appendix M). Product transport for the mine (after the first year) is likely to add approximately 34 movements per day for years 2 to 10, a 34% increase, and 82 per day for year 1, an 82% increase for that one year. Shree Minerals will be providing a bus service for workers to and from Smithton, so additional worker traffic is unlikely to be significant.

The existing devil roadkill risk is equivalent to 10 per year[277]. A 34% increase in traffic movements due to the mine might proportionally add 3 additional kills to that risk (8 during the first year).

[276] Data (by Wildspot Consulting) and mapping (by Northbarker Ecosystem Services) provided courtesy of the Department of Infrastructure, Energy & Resources.
[277] The risk along this route appears to be substantially less than the alternative route of travelling west from the mine site through the Arthur River township – observations by Geoff King note approximately 30 roadkill per year between Arthur River and Marrawah (Nick Mooney pers. comm.)

Roadkill risk is primarily a night time occurrence – the risk during daylight hours is approximately 25% of the night time risk[278].

A prudent risk minimisation measure would therefore be to avoid product transport at night.

Confining product transport to daylight hours would proportionally reduce the roadkill risk increase to one fifth[279] of the total daily risk increase.

The increase in traffic movements due to the mine's product might then proportionally add 3 ÷ 5 = 0.6 additional kills every year to that risk (8 ÷ 5 = 1.6 during the first year).

6.4.10 *Prototroctes maraena* - Australian grayling (Vulnerable)

Because of the presence of a natural hydraulic barrier to upstream movement of Australian grayling into Nelson Bay River, there is no significant likelihood of the species being any further upstream than Temma Road, which is 7 km downstream from the mine site.

Accordingly, no specific mitigation measures for this species are warranted.

Nevertheless, the project has adopted a "protection of pristine or nearly pristine ecosystems" Protected Environmental Value (PEV) for Nelson Bay River (see section 8.5). This PEV will ensure the protection of the Australian grayling in the very unlikely event that it could migrate up the river as far as the mine (the hydraulic barrier near the mouth of the river would prevent this).

The PEV will be protected by a comprehensive and integrated mine water management regime. Water management measures are described in sections 0 through to Error! Reference source not found. and water monitoring is described in section 8.6. The management regime will ensure that discharges of excess water from the mine site to Nelson Bay River, via East and West Creeks, will not compromise the protection of pristine or nearly pristine ecosystems PEV adjacent to the mine site and that PEV will consequently be protected throughout the downstream reaches of the river also.

6.4.11 *Galaxiella pusilla* - eastern dwarf galaxias - (Vulnerable)

Because of the absence of suitable habitat, there is no significant likelihood of this species being present in the vicinity of the mine.

Accordingly, no specific mitigation measures for this species are warranted.

Nevertheless, the project has adopted a "protection of pristine or nearly pristine ecosystems" Protected Environmental Value (PEV) for Nelson Bay River (see section 8.5). This PEV will ensure the protection of the galaxias in the very unlikely event there is some suitable habitat downstream from the mine.

As described in section 6.4.10, the water management regime will protect this PEV in all reaches of Nelson Bay River.

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[278] Nick Mooney pers. comm.

[279] A day rate 25% of the night rate means proportionally 4 night kills for every 1 day kill, so 1 in 5 occur during the day

6.4.12 *Litoria raniformis - green and gold frog (Vulnerable)*

Because of the absence of suitable habitat, there is no significant likelihood of this species being present in the vicinity of the mine.

Accordingly, no specific mitigation measures for this species are warranted.

Nevertheless, the project has adopted a "protection of pristine or nearly pristine ecosystems" Protected Environmental Value (PEV) for Nelson Bay River (see section 8.5). This PEV will ensure the protection of the frog in the very unlikely event there is some suitable habitat downstream from the mine.

As described in section 6.4.10, the water management regime will protect this PEV in all reaches of Nelson Bay River.

6.4.13 *Astacopsis gouldi* - Tasmanian giant freshwater crayfish (Vulnerable)

Although Nelson Bay River itself has suitable habitat, it is at the margins of the species' range and surveys found no presence of the species in the river.

Accordingly, no specific mitigation measures for this species are warranted.

Nevertheless, the project has adopted a "protection of pristine or nearly pristine ecosystems" Protected Environmental Value (PEV) for Nelson Bay River (see section 8.5). This PEV will ensure the protection of the species in the unlikely event there it is present downstream from the mine.

As described in section 6.4.10, the water management regime will protect this PEV in all reaches of Nelson Bay River.

6.5 Conclusions for threatened fauna species

The above analyses conclude that the potential impacts on fauna of National Environmental Significance warranting mitigation measures are:

- *Wedge-tailed eagle and white-bellied sea eagle*: There is a potential impact from increased roadkill risk when feeding on roadkill due to the increase in road traffic because of the mine.
- *Masked owl*: There is a potential impact on nesting owls from vegetation clearing if it occurs during the nesting season.
- *Spotted-tailed quoll*: There is a potential impact on shelter dens from vegetation clearing at any time and potential impact on breeding dens if clearing occurs during the breeding season. There is a potential impact from increased roadkill risk when crossing roads or when feeding on roadkill due to the increase in road traffic because of the mine. Based on conservative (high) assumptions about quoll densities on the site, clearing of vegetation for the mine could displace up to 1 quoll. Without mitigation, product transport could increase the quoll roadkill on the region's roads by 0.6 every year but 1.6 in year 1. Confining product transport to daylight hours would reduce these risks to 0.1 and 0.3 kills per year respectively.
- *Tasmanian devil*: There is a potential impact on shelter dens from vegetation clearing at any time and potential impact on breeding dens if clearing occurs during the breeding season. There is a potential impact from increased roadkill risk when crossing roads or when feeding on roadkill due to the increase in road traffic because of the mine. Based on conservative (high) assumptions about devil densities on the site, clearing of vegetation for the mine could displace up to 1 to 2 devils. Without mitigation, product transport could increase the devil roadkill on the region's roads by 3 per year (and 8 in year 1). Confining product transport to daylight hours would reduce these risks to 0.6 and 1.6 kills per year respectively.

6.6 Technical data

CHMA (December 2010) *An Aboriginal Cultural Heritage Assessment of the Proposed Nelson Bay River Magnetite Mine Development, North-West Tasmania* (not attached due to cultural sensitivities about locations of Aboriginal sites but is available to the Department on request).

Cromer, W. C. (2011) *Hydrogeological report, Proposed Nelson Bay River Magnetite Mine.* Unpublished report for Shree Minerals Ltd. by William C. Cromer Pty Ltd. (Appendix C)

Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River*. Report prepared for Pitt & Sherry. (Appendix O)

North Barker Ecosystem Services (2010) *Nelson River – Shree Minerals Mine & Infrastructure Proposal: Flora and Fauna Habitat Assessment*. Report prepared for Shree Minerals. (Appendix N)

Pitt & Sherry (July 2011) *Nelson Bay River Proposed Magnetite/Hematite Mine Traffic Impact Assessment*. Report prepared for Shree Minerals. (Appendix M)

Department of Infrastructure, Energy & Resources (2010) Roadkill and headlight observations on regional roads. Data collected by Wildspot Consulting between October 2009 and April 2010; mapping undertaken by Northbarker Ecosystem Services. Information provided courtesy of the Department of Infrastructure, Energy & Resources. (Appendix P)

6.6.1 Scientific reliability

[NOTE: this is a duplication of section 14.]

Information sources

- Information sources used consist of public information and the results of surveys commissioned for this particular project
- The sources of the information are shown in the relevant sections of this EIS.

Information dates

- The dates of preparation/publication of the information sources are noted in the references.

Reliability of the information

- The environmental investigations have been managed by pitt&sherry under their ISO9001 Quality System and their ISO14001 Environmental Management System
- All surveys and analysis have been undertaken by highly experienced consultants in consultation with the relevant authorities and in accordance with accepted practice.

Uncertainties

Field surveys and investigations by their nature have inherent uncertainties. For example, flora and fauna surveys are undertaken over a period of a few days and water sampling is undertaken at discrete locations and discrete times. Surveys and investigations cannot hope to be absolutely comprehensive and free of uncertainties.

Nevertheless, the timing and location of surveys and sampling can and was selected to best identify potential risks to environmental values, particularly threatened species and sensitive ecological communities. The surveys and sampling therefore provide a level of certainty sufficient to make a reasoned, evidence based determination on the potential impacts on Matters of National Environmental Significance with high confidence.

7. Summary of potential impacts on matters of National Environmental Significance

Based on the analyses described in the preceding sections, the following potential impacts on Matters of National Environmental Significance have been identified.

There are no potential significant impacts on vegetation or plants. Potential impacts are confined to fauna species: wedge-tailed eagles, masked owls, spotted-tailed quolls and Tasmanian devils. All these species are also protected under the Tasmanian *Threatened Species Protection Act 1995*.

7.1 *Aquila audax subsp. fleayi* - wedge-tailed eagle (Endangered)

The survey area has a low probability of containing eagle nests as most of the mature eucalypts within the study area have been badly fire damaged. The nearest known eagle nest is approximately 1.8 km to the north east of the study area (nest id 971500). A helicopter-based search failed to locate any other nests.

There is therefore no significant likelihood of the mine impacting on eagle nesting.

A facilitated impact by the proposed mine could potentially occur as a result of the increase of traffic volume to and from the proposed mine site, which could potentially result in a higher incidence of road kill or injury to individual birds as they feed on carcasses of wildlife killed by traffic.

Although the risk increase is low, it would be prudent to implement mitigation measures to minimise this risk because roadkill introduces a consequential risk to eagles that might feed on carcasses and become potential roadkill victims themselves.

7.2 *Tyto novaehollandiae subsp. castanops* - Tasmanian masked owl (Vulnerable)

There is a potential impact on nesting owls from vegetation clearing if owls use any of the old trees on the site for nesting and clearing occurs during the nesting season.

Preclearing surveys for occupied nests are therefore warranted.

7.3 *Dasyurus maculatus ssp. maculatus - spotted-tailed quoll (Vulnerable)*

There is a potential impact on shelter dens from vegetation clearing at any time and potential impact on breeding dens if clearing occurs during the breeding season. There is a potential impact from increased roadkill risk when crossing roads or when feeding on roadkill due to the increase in road traffic because of the mine. Based on conservative (high) assumptions about quoll densities on the site, clearing of vegetation for the mine could displace up to 1 quoll. Without mitigation, product transport could increase the quoll roadkill on the region’s roads by 0.6 every year (and 1.6 in year 1). Confining product transport to daylight hours would reduce these risks to 0.1 and 0.3 kills per year respectively.

Preclearing surveys for occupied dens, creation of new denning opportunities and roadkill mitigation measures are warranted.

7.4 *Sarcophilus harrisii* - Tasmanian devil (Endangered)

There is a potential impact on shelter dens from vegetation clearing at any time and potential impact on breeding dens if clearing occurs during the breeding season. There is a potential impact from increased roadkill risk when crossing roads or when feeding on roadkill due to the increase in road traffic because of the mine. Based on conservative (high) assumptions about devil densities on the site, clearing of vegetation for the mine could displace up to 1 to 2 devils. Without mitigation, product transport could increase the devil roadkill on the region's roads by 3 per year (and 8 in year 1). Confining product transport to daylight hours would reduce these risks to 0.6 and 1.6 kills per year respectively.

Preclearing surveys for occupied dens, creation of new denning opportunities and roadkill mitigation measures are warranted.

8. Proposed safeguards and mitigation measures

Guideline requirements for this section

The draft environmental impact statement must provide a description of the safeguards and mitigation measures proposed to deal with relevant impacts of the proposed action, including:

- *a) a description of the proposed methods*
- *b) an assessment of the expected or predicted effectiveness of the proposed measures*
- *c) any statutory or policy basis for the proposed measures*
- *d) the cost of the proposed measures*
- *e) a summary of plans to be developed and implemented for the continuing management and monitoring of the relevant impacts of the proposed action, including any provisions for independent environmental auditing*
- *f) the name of the agency responsible for endorsing or approving each proposed measure or plan*
- *g) a consolidated summary list of measures or plans proposed to be implemented to avoid or minimise the relevant impacts of the proposed action, whether taken by state governments, local governments or the proponent.*

General environmental safeguard and impact mitigation measures inherent to the mine design have been described in previous sections and are not repeated here. However, they are summarised in section 9.

Safeguards and mitigation measures specific to the protection of Matters of National Environmental Significance are described below.

As an overarching principle, the mine layout has been designed to be as compact as possible, recognising the constraints imposed by the location of the resource and site topography. In particular, in response to the findings of the fauna and flora studies the original layout was redesigned to move all infrastructure to the east of West Creek.

This avoids any impact on significant vegetation further to the west, including the extensive population of the rare (TSPA) heath *Epacris curtisiae* and a discrete population of the critically endangered (EPBCA) orchid *Prasophyllum pulchellum*. It also allows the establishment of a dedicated Fauna Habitat Protection Zone between West Creek and the western boundary of the lease.

8.1 Masked owl nests

There is a potential for masked owls to use hollow trees for nesting and preclearing surveys for nests are therefore warranted.

To mitigate against the potential impact on this species, to all practical extents vegetation clearance will be scheduled for outside the nesting season. However, if vegetation clearance must be undertaken during the nesting season, preclearance surveys will take place in the week prior to each stage of clearing to identify any nesting habitat trees currently in use by masked owls. These surveys will be conducted by a suitably qualified person.

A temporary 50 metre buffer will be established around any such nests during the forest clearing operations. The buffer will encompass all structural elements of the surrounding forest and will remain unless and until the nest has been confirmed to have been vacated (which may take up to 3 to 4 months, depending on timing relative to the breeding season).

Only after the nest has been confirmed to be vacated will the vegetation clearing be completed.

Residual impact significance

These mitigation measures will reduce the potential impacts on masked owls to a level of insignificance.

8.2 Quoll and devil dens and habitat

Pre-clearance surveys for dens

To mitigate against the potential impact on spotted-tailed quoll and Tasmanian devils, to all practical extents vegetation clearance will be scheduled for outside the denning season. However, if vegetation clearance must be undertaken during the denning season, preclearance surveys will take place in the week prior to each stage of clearing commencing to identify any occupied quoll or devil dens.

These surveys will be conducted by a suitably qualified person. Because of the mobility of devils and quolls between dens, timing the surveys to closely precede clearing is important. If surveys were undertaken too early, the survey findings could not be relied upon – dens found to be occupied during the survey might no longer be so and potential dens found to be unoccupied during the survey might have since become occupied.

In addition to identifying the dens actually in use, the preclearance surveys will determine the amount, quality and type of quoll and devil denning opportunities within the area to be cleared.

Habitat protection during vegetation clearing operations

During vegetation clearing operations, a temporary 50 m buffer will be established around any occupied maternal dens found in the pre-clearance surveys. The buffer will encompass all structural elements of the surrounding forest and will remain unless and until the den has been confirmed to have been vacated. Only after the den has been confirmed to be vacated (which may take up to 3 to 4 months, depending on timing relative to the breeding season) will the vegetation clearing be completed.

Establishment of suitable habitat within the Fauna Habitat Protection Zone

A Fauna Habitat Protection Zone (FHPZ) will be established in the western part of the lease, west of West Creek (Figure 40).

The FHPZ encompasses 154 ha of the following habitats:

- Thick scrub along West creek encompassing *Eucalyptus obliqua* forest with broad-leaf scrub and *Eucalyptus nitida* dry forest and woodland; and
- Wet heathland.

The FHPZ boundaries have been delineated so as to be readily identifiable on the ground and readily manageable, being West Creek on the east, the lease boundary on the west and existing tracks at the north and south. The linear extent of the FHPZ parallels the extent of the rock dump and tailings dam.

The FHPZ will be clearing identified on operational site maps and with site signage as an area to be protected from disturbance other than that consistent with the purposes of the zone, such as the creation of denning opportunities, the monitoring of devil and quoll populations and weed and fire management.

The creation of the zone is a specific commitment in this EIS and is also a commitment in the Development Proposal and Environmental Management Plan being submitted under the *Tasmanian Environmental Management and Pollution Control Act 1994*. Its establishment, protection and maintenance will therefore become a condition of development and operational approval. The FHPZ will be within the mining lease and will therefore be protected from interference by third parties.

The purpose of the FHPZ is to provide local refugia for any devils and quolls displaced by the clearance of 152 hectares of vegetation to the east of West Creek. Importantly, the clearance of that 152 ha will not occur in one campaign but rather progressively over the first few years of the mining operation, a period which is longer than the natural lifespan of any individual animal. Displacement of any quolls and devils will therefore be gradual and progressive.

Within the FHPZ, the following will take place in relation to devils and quolls:

- Establishment and enhancement of denning and refugia opportunities; and
- Monitoring of devil and quolls frequenting the FHPZ using camera traps.

The creation of new denning opportunities for devils and quolls will achieve at least the quantum and quality of the pre-existing natural opportunities identified during the pre-clearance surveys.

Denning and shelter opportunities for quolls and devils will be created by the establishment of windrows (piles of soil, green timber and other vegetation) within the 30 m buffer separating West Creek and the waste rock dump collection drain (see Appendix A Figure 41). The windrows will be created as close as possible to the waste rock dump collection drain to avoid damage to existing vegetation.

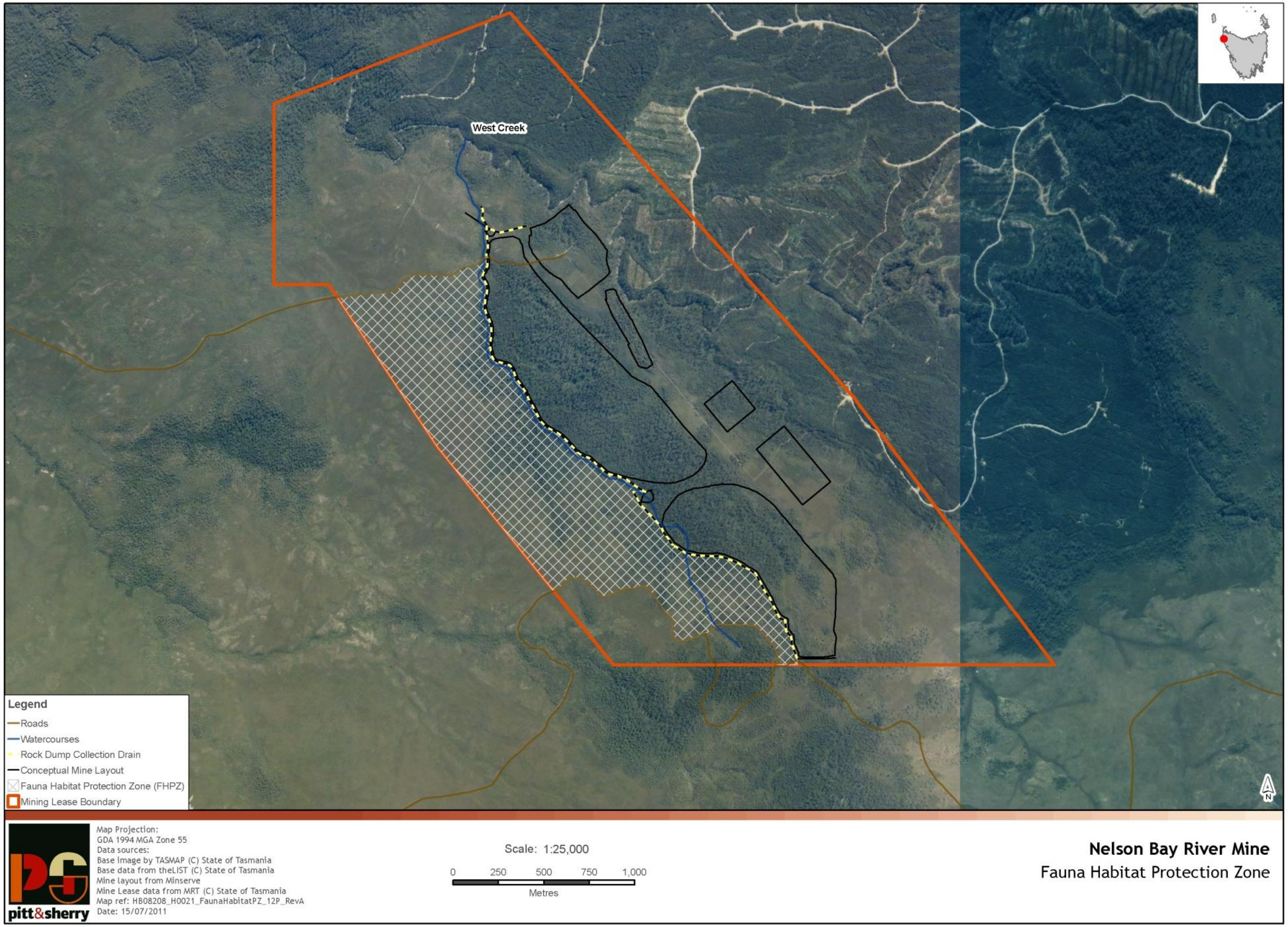

Figure 40: Location of Fauna Habitat Protection Zone

The design and establishment of windrows will be coordinated by a suitably qualified person.

As a general guide[280], at a well-drained site 3 to 5 m long lengths of tree trunks larger than 50 cm in diameter will be pushed into a settled pile at least 25 m long, 10 m wide and 4 m high, preferably including pushed topsoil also. A 1 m (at least) thick layer of branches, bark and off-cutes will then be placed on top and around all sides of the pile. As many of these windrow piles as possible will be created.

Materials for the creation of windrows will be sourced from the forest materials cleared for the waste rock dump and tailings dam and will include large trees placed specifically to create suitable denning hollows and to create good fauna shelter.

The location of windrows within the FHPZ is shown schematically in Figure 41.

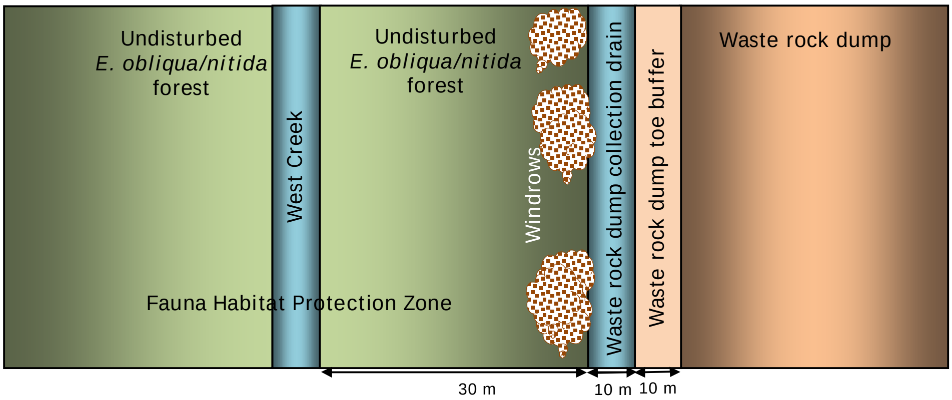

Figure 41: Schematic arrangement of the location of windrows within the Fauna Habitat Protection Zone.

Monitoring

Monitoring of the effectiveness of this proposed mitigation measure will be implemented by using camera traps.

These stations will comprise an infrared camera designed specifically for the detection of wildlife. They will be placed within the FHPZ at the windrows and along existing wildlife pads within the FHPZ (pads being the tracks which are deemed suitable for passage of the species).

Information from the sentinel monitoring stations will used to measure occurrences of devils and quolls at the windrows and within the FHPZ generally. Of particular importance will be the occurrence of devils within the FHPZ which could have DFTD.

The monitoring stations will regularly be checked for functionality and damage. At these checks the data will be downloaded and interpreted by a suitably qualified person.

Devil photos will also be examined for any signs of DFTD. Any evidence of potential symptoms will be forwarded immediately to the Save the Tasmanian Devil Program (STDP).

Monitoring information will be provided to the STDP at regular intervals.

280 Nick Mooney pers. comm.

Residual impact significance

These mitigation measures will reduce the potential impacts on quolls and devils from vegetation clearing to a level of insignificance.

8.3 Roadkill

Road kill observations on the local road network are described in section 6.4.9.

A facilitated impact by the proposed mine on wedge-tailed eagles, spotted-tailed quolls and Tasmanian devils could potentially occur as a result of the increase of traffic volumes on the region's roads due to workers and product transport vehicles travelling to and from the mine site. Increases in traffic volume could potentially lead to a higher incidence of road kill or injury to eagles, quolls and devils.

The following mitigation measures will reduce the potential roadkill risk to eagles, quolls and devils to a level of insignificance.

Speed limit reduction on roads

The mean night-time detection distances for the species from a car with headlights on high beam is 60.8 m; this corresponds to a maximum speed of 54 kph at which a driver could stop safely to prevent collision with the species.[281]

The speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour. This is the critical stopping distance for avoiding roadkill at night but will be applied throughout the day also as a conservative measure.

Removal of roadkill from roads

Mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily). The roadkill will be moved at least 40 m from the edge of the road verge. The employee responsible for roadkill removal will hold an appropriate permit under the *Nature Conservation Act 2002.*

If a roadkill eagle or quoll is found, this will be reported to the Threatened Species Unit, Biodiversity Conservation Branch (DPIPWE) as soon as possible to obtain advice on appropriate further action.

If a roadkill devil is found, it will be reported directly to the Save the Tasmanian Devil Program to obtain advice on appropriate further action.

Roadkill data will be recorded by time, date, location and species. Road kill risk maps will be updated on an annual basis.

High risk mapping

Shree Minerals will provide mine workers and product transporters with maps identifying high roadkill risk areas along the route between the mine site and Smithton. These maps will include the map shown in Appendix P and any additional maps developed by the Tasmanian Devil Program Roadkill Project.

Mine workers and product transporters will be required to pay particular attention to roadkill risk when driving through these high risk spots and will encourage them to reduce speed to below 50 kph during the dawn to dusk period (subject to road safety considerations and the convenience of other road users).

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281 Lawrence, C. & Donnelly, C. (2010) *Save the Tasmanian Devil Program Roadkill Project*. Report prepared for the Save the Tasmanian Devil Program.

Education of employees

All employees will be informed through inductions and toolbox meetings of the importance of reducing roadkill and of responding appropriately if it does occur.

Transport hour restrictions

Night time is the period of greatest quoll and devil activity and hence the time of greatest risk of roadkill for these species. The risk during daylight hours is only approximately 25% of the night time risk[282].

Product transport will therefore be restricted to daylight hours.

Daylight hours will be defined as the period between the end of the morning civil twilight period and the beginning of the evening civil twilight period. Civil twilight is the period when vehicle headlights should be switched on. Product transport will therefore be outside the headlight period.

Over a year, the average daily transport period will be approximately 12 to 13 hours, about 2 hours above that in summer and about 2 hours below that in winter.

Restricting product transport to daylight hours will reduce the incremental roadkill risk to quolls to 0.1 kills each year (0.3 in the first year) and to devils to 0.6 kills each year (1.6 during the first year).

Worker transport

The mine will provide employees with a daily bus service to and from the mine site. This will avoid up to approximately 30 additional vehicles from travelling on the region's roads.

Residual impact significance

These mitigation measures will reduce the potential roadkill impacts on eagles, quolls and devils to a level of insignificance.

8.4 Devil facial tumour disease

The significance of devil facial tumour disease (DFTD) is described in section 6.4.9.

The mine will not introduce any risk of increasing the spread of DFTD.

However, the presence of the mine in the area will provide an opportunity to facilitate further research into the disease.

Devil numbers around the mine site will be monitored as part of the mine's operational monitoring of the effectiveness of its devil (and quoll) impact mitigation measures, and these observations will be valuable data for the Save the Tasmanian Devil Program (STDP).

Shree Minerals would also be happy to cooperative and support any wider area monitoring and research being undertaken by the STDP, for example through the provision of site office facilities and other logistical support.

The potential support and contributions that Shree Minerals might provide to the STDP will be determined through consultation with the program during the operating phase of the mine.

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[282] Nick Mooney pers.comm.

8.5 Nelson Bay River

Although aquatic flora or fauna of National Environmental Significance are unlikely to be present in Nelson Bay River, the mine will be operated to ensure that the quality of the river habitats is not degraded. The river will be assumed to be a pristine environment under Tasmania's *Water Quality Management Policy 1997* and protected environmental values (PEVs) will be established for the mine's operation.

The wider region has a number of major rivers, including the Arthur, Frankland and Nelson Bay Rivers, together with an intensive network of tributary streams.

The mine site is located on the southern side of the Nelson Bay River, which flows northwest and west to the Southern Ocean at Nelson Bay, and is located wholly within the Nelson Bay River catchment. This catchment is considered to be part of the Arthur River catchment for the purposes of developing PEVs.

The mine's infrastructure will be located between two northwesterly trending tributaries of the Nelson Bay River, referred to as West Creek and East Creek. West Creek will receive overflow water from settling dams. In extreme rainfall conditions, East Creek may receive overflow water from the recycle dam.

Protected Environmental Values (PEVs)

Environmental management goals for surface waters in this area are contained in the Department of Primary Industries, Water and Environment document:

Environmental Management Goals for Tasmanian Surface Waters, Catchments within the Circular Head & Waratah/Wynyard Municipal Areas, January 2000.

Examination of this document indicates that the proposed mine site is located within State Forest in the Arthur catchment. Sections of the established PEVs for surface waters in State Forest in the Arthur River catchment that are relevant to this proposal are:

A: Protection of Aquatic Ecosystems

(ii) Protection of modified (not pristine) ecosystems
a. from which edible fish are harvested;

having regard for Forestry Tasmania's 'Management Decision Classification System'.

B: Recreational Water Quality & Aesthetics

(i) Primary contact water quality
(ii) Secondary contact water quality
(iii) Aesthetic water quality

These PEVs reflect historical impacts on the Arthur River from upstream mining.

Nelson Bay River, however, has not been subject to such impacts and for the purposes of this project the PEV of Nelson Bay River catchment will be assumed to be:

A: Protection of Aquatic Ecosystems

(i) Protection of pristine or nearly pristine ecosystems.

The project's Water Quality Objectives (WQOs) will be developed to ensure that this PEV is not compromised (see below).

8.6 Project water monitoring

Water monitoring programs have been established to provide baseline water quality data for the site.

8.6.1 Catchment monitoring

Streamflow and water quality are currently measured by the Government at the Nelson Bay River at Temma Road (Nelson Bay) – Station No. 1307. This information is contained on the Water Information System of Tasmania website:
http://water.dpiw.tas.gov.au/wist/ui

A summary of that monitoring follows (streamflow data accessed 12 October, 2010; water quality data accessed 2 July 2010).

Streamflow:
Average monthly streamflow between 1997 and 2008 ranged from a low of 1.1 cumecs in 2007 to a high of 1.6 cumecs in 1999.

Minimum recorded flows ranged from 0.002 cumecs (18 March, 2008) to 0.023 cumecs (19 January, 1996).

Maximum recorded flows ranged from 9.473 cumecs (1 September, 2008) to 24.598 cumecs (23 September, 1998).

Analytical data:
Turbidity ranged from 1.27 to 22.2 NTU's, with a mean value of 4.4 NTU's (based on 98 samples).

Field conductivity ranged from 91 to 368 µS/cm, with a mean value of 180 µS/cm (based on 107 samples).

Field pH ranged from 3.49 to 6.65, with a mean value of 4.57 (based on 71 samples).

Dissolved oxygen levels ranged from 4 to 13.2 mg/L, with a mean value of 9.4 mg/L (based on 92 samples).

8.6.2 Surface water

Surface water monitoring in Nelson Bay River commenced in February 2010, following confirmation of the proposed mine location.

Samples were collected over a 15 month period from February 2010 to May 2011, during high and low flow conditions consistent with winter and summer flow conditions in the catchment.

Monitoring sites

Eight surface water monitoring locations (NBRSW01, NBRSW02, NBRSW03, NBRSW04, NBRSW05, NBRSW06, NBRSW07 and NBRSW08) have been monitored to obtain representative samples of surface water quality in Nelson Bay River, immediately upstream and downstream of the proposed mine, and in the lower reaches of Nelson Bay River along Temma Road.

The locations of the surface water sampling sites are shown in Figure 42. Location descriptions are as follows:

- NBRSW01: 317638E 5437603N: downstream (south) side of the Rebecca Road bridge crossing of Nelson Bay River, about 2 km west of the junction of Rebecca Road and Wuthering Heights road
- NBRSW02: 312676E 5441802N: on upstream side of the road bridge crossing of Nelson Bay River
- NBRSW03: 310681E 5442017N: Nelson Bay River at southeastern end of the proposed pit site
- NBRSW04: 309934E 5442745N: Nelson Bay River at northwestern end of the proposed pit site
- NBRSW05: 305946E 5444267N: downstream side of the Nelson Bay River bridge crossing of Temma Road, at the gauging station
- NBRSW06: 305961E 5441990N: downstream side of the Sardine Creek twin-pipe culvert crossing of Temma Road
- NBRSW07: 310932E 5440983N: on West Creek, downstream from the tailings dam location
- NBRSW08: 309823E 5442467N: on West Creek, downstream from the NAF rock dump sedimentation basin.

Prior to construction work commencing, additional permanent water monitoring sites will be established in East Creek, upstream and downstream from the recycling dam overflow discharge point and in West Creek upstream from the seepage dam overflow discharge point and upstream from the NAF dump sediment pond. An additional sampling site will also be established in Nelson Bay River, immediately downstream from its confluence with West Creek.

Both West and East Creeks are ephemeral and are characterised by boggy, silty reaches and debris filled reaches, so much so that there are no riffle zones at which macroinvertebrate sampling stations could be established for Ausrivas (Tasmanian River Condition Index) monitoring[283].

The presence of the operating mine will change the flow regime of the lower section of East Creek. Discharges from the mine operations to East Creek may act to clear the debris from the creek that is currently precluding the establishment of Tasmanian River Condition Index sites. If this occurs, a Tasmanian River Condition Index station will be established there.

While the mine is operating, excess water from pit dewatering will be discharged (after treatment if required) into the lower reaches of East Creek. Excess water from the tailings dam decant will similarly discharge at this location.

[283] Todd Walsh pers. comm.

The discharge point will be approximately 20% up the length of the creek from its junction with Nelson Bay River and this small section of the creek is likely to flow more frequently and for longer periods while the mine is operating. Greater and more extended flows might allow species that otherwise could not survive an ephemeral regime to move up into the creek from Nelson Bay River, and the species assemblage could alter. However, the proposed discharge regime will ensure that East Creek is allowed to regularly dry up, just as it would naturally, and ephemeral-flow biota are unlikely to be completely excluded

The increased flow in this part of East Creek may act to clear the debris from the creek that is currently precluding the establishment of Tasmanian River Condition Index sites. If this occurs, a Tasmanian River Condition Index station will be established there, which will allow any subsequent changes in species mix to be described.

In West Creek, other than the upper section, which will be subsumed by the tailings dam, the changes to the flow regime are likely to be marginal. The dam will intercept the creek's upper catchment water and divert it into the recycle dam, which is in the East Creek catchment, but this is not a major component of the West Creek catchment as a whole. The creek is primarily fed by a number of tributary streams that drain the wet heathlands in the western parts of the lease, and these inflows will remain unaffected.

No significant changes to the aquatic life of West Creek are anticipated. If a suitable Tasmanian River Condition Index site can be found, a macroinvertebrate sampling station will be established during the mine's operations to examine this expectation.

Analytical results

Samples were analysed in the field and laboratory for the following parameters:

- Dissolved oxygen (field)
- pH (field)
- Electrical conductivity (field)
- Turbidity (field)
- Temperature (field)
- Alkalinity
- Acidity
- Total heavy metals
- Sulphate
- Nutrients
- Total anions/cations.

Indicator averages are provided in Table 28, together with the project's proposed Water Quality Objectives (WQOs) which, using the ANZECC guideline methodology, are the 80%ile values of the individual observations at NBRSW01 (located upstream of the mine site at the Rebecca Road crossing of the Nelson Bay River). The EPA will determine the final WQOs.

Table 28: Water monitoring sites – key indicator averages and proposed Water Quality Objectives

	pH	EC (µS/cm)	DO (%)	Turb (NTU)	SS (mg/L)	SO_4 (mg/L)	Cl (mg/L)	Hard (mg/L)	Al[1] (mg/L)	As (mg/L)
NBRSW01	5.11	109.7	75.4	3.3	8.0	6.8	39.4	10.4	0.362	0.001
NBRSW02	5.42	118.4	80.1	4.0	6.8	4.8	35.7	10.7	0.274	<0.001
NBRSW03	5.44	112.7	86.1	4.2	5.2	5.2	37.9	9.6	0.232	0.001
NBRSW04	5.74	115.5	85.5	3.4	4.0	6.7	31.7	19.4	0.208	0.002
NBRSW05	4.96	127.1	87.3	4.1	7.2	18.8	60.2	30.0	0.187	0.001
NBRSW06	5.17	278.8	75.3	3.5	4.0	14.6	51.0	26.0	-	<0.001
NBRSW07[1]	6.06	207.4	80.9	12.3	<5	<1	56.0	21.0	-	<0.001
NBRSW08[1]	6.4	264	75.2	9.0	<5	<1	71.0	26.0	-	<0.001
ANZECC*	6.5–7.5	350	90-110	2-25			700			0.013
WQO**	6.2	156	78	4.3	16	11	42	14	0.4	0.002

*80%ile of observed data at NBRSW01

(continued)

	Cd mg/L	Cr mg/L	Co mg/L	Cu mg/L	Pb mg/L	Mn mg/L	Ni mg/L	Zn mg/L	Fe[1] mg/L
NBRSW01	0.003	<0.001	0.001	0.002	0.027	0.020	0.001	0.014	0.302
NBRSW02	0.004	0.002	0.001	0.002	0.002	0.021	0.001	0.008	0.661
NBRSW03	0.003	0.002	0.001	0.002	0.003	0.015	0.001	0.008	0.969
NBRSW04	0.0001	0.001	0.001	0.001	0.003	0.022	0.001	0.006	0.807
NBRSW05	0.0001	0.002	0.003	0.003	0.003	0.041	0.003	0.011	0.895
NBRSW06	0.001	0.002	<0.001	0.001	0.002	0.024	0.001	0.005	-
NBRSW07[1]	<0.0001	<0.001	<0.001	<0.001	0.004	0.054	0.001	0.005	-
NBRSW08[1]	<0.0001	<0.001	<0.001	<0.001	0.001	0.018	<0.001	<0.005	-
ANZECC*	0.0002	0.001		0.0014	0.0034	1.900	0.0110	0.008	0.0006
WQO**	0.001	0.001	0.001	0.01	0.12	0.01	0.002	0.01	

*ANZECC guidelines for surface waters

**80%ile of observed data at NBRSW01

EC = electrical conductivity; DO = Dissolved oxygen; Turb = lab turbidity; Hard = hardness; SS = suspended solids; SO_4 = sulphate; Cl = chloride; Al = aluminium; As = arsenic; Cd = cadmium; Cr = chromium; Co = cobalt; Cu = copper; Pb = lead; Mn = manganese; Ni = nickel; Zn = zinc; Fe = iron.

[1] One sampling period only

The water quality across the general site area is good with no elevated concentrations causing concern.

The monitoring results indicate good water quality when assessed using *Australian and New Zealand Environment and Conservation Councils (ANZECC) Guidelines for Fresh and Marine Water Quality, 2000.* The physical water quality properties are mostly within the range of the guidelines. Concentrations of nutrients are considered to be low.

No noticeable scums, sheens or gross odours were identified during any of the sampling events at the monitoring locations.

This background data will provide a reference against which future surface water quality in Nelson Bay River can be assessed, when the proposed mine becomes operational.

The East Creek discharge point will begin to receive a discharge when dewatering of the DSO pit commences. The upstream and downstream sampling points will allow any changes in the water quality of East Creek as a result of the pit water discharge to be determined.

West Creek will begin to receive a discharge from the NAF dump sediment pond once runoff from the NAF dump accumulates; this will be during the DSO mining phase. The upstream and downstream sampling points will allow any changes in the water quality of West Creek as a result of the NAF dump runoff discharge to be determined.

Neither East Creek nor West Creek will receive any discharge of water used in the processing plant or from tailings until the main pit has been opened up and magnetite is being processed. This will be at least two years after mining operations commence and there will therefore be two years of monitoring data with only pit water discharges available before they receive any process water discharges.

The upstream and downstream monitoring points on both creeks will allow the impact of these discharges on creek water quality to be determined.

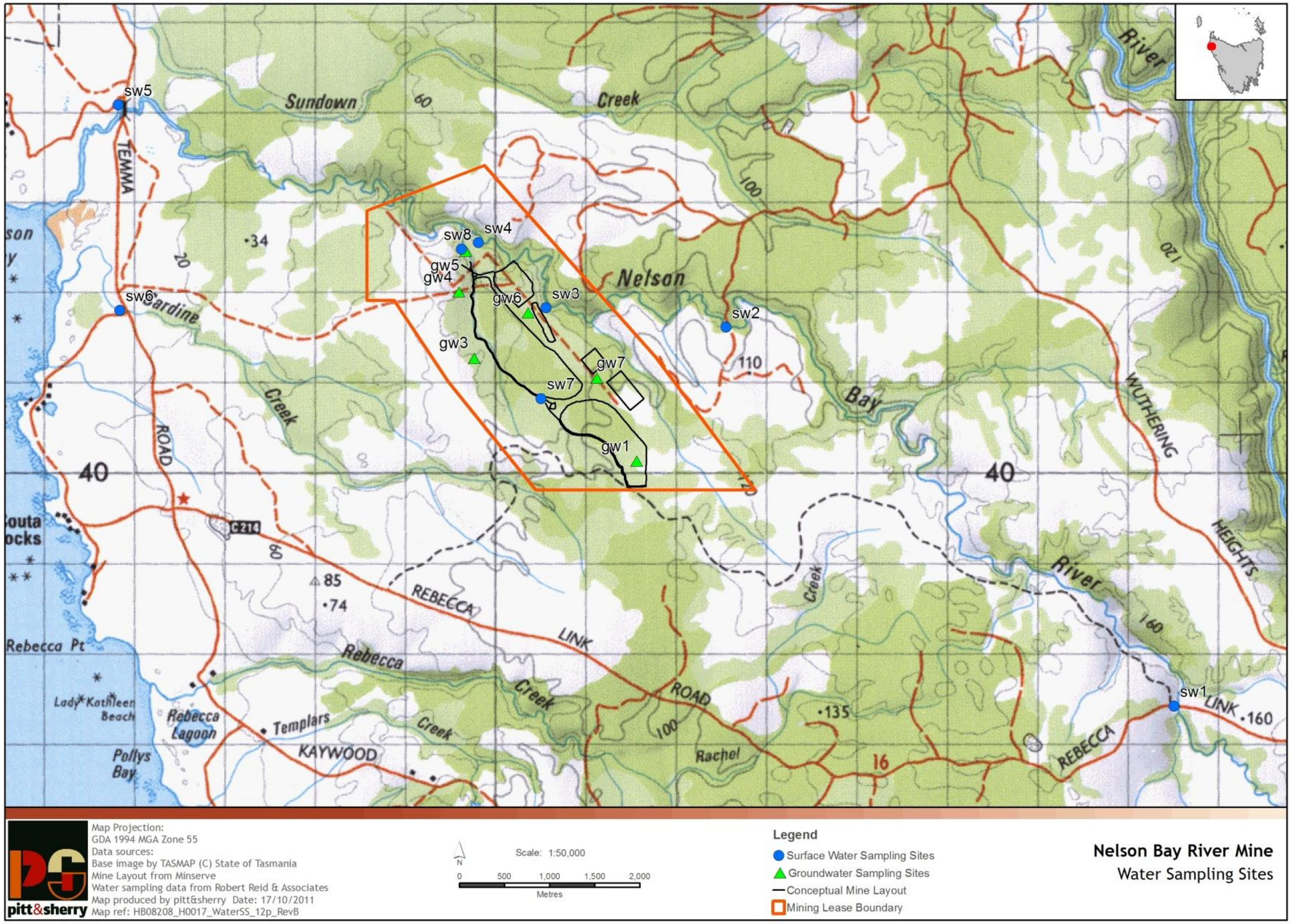

Figure 42: Established surface water and groundwater monitoring locations

8.6.3 Groundwater

Monitoring sites

Groundwater bores have been installed at six locations around the proposed mining and processing areas (Figure 42). Details of these locations are shown in Table 29. Table 30 shows measured depths to groundwater.

Access to proposed groundwater bore site NBRGW02 was not feasible at the time of installation of the other groundwater bores because of a significant boggy area on the route, as well as other difficult sites on the access route. The drillers would not take the drill rig into the area without a significant track upgrade as the existing access was considered to be unsafe, with high potential for rig damage and bogging on route. This groundwater bore will be installed during a later drilling program.

The groundwater monitoring program commenced in mid-May 2011. This program will continue at approximately six monthly intervals.

Table 29: Groundwater monitoring bore locations

Bore	Location	Easting	Northing
		(GDA 94)	
NBRGW01	South east (upstream) of the tailings dam	311690	5440320
NBRGW02	North west (downstream) of the tailings dam	309893	5441461
NBRGW03	South west of the waste rock dump	309720	5442195
NBRGW04	North west (downstream) of the waste rock dump	309797	5442651
NBRGW05	North west of the main pit	310487	5441962
NBRGW06	South east of the main pit	311249	5441240
NBRGW07	Processing plant area	311690	5440320

Groundwater levels

Table 30: Measured groundwater depths

Bore	Date	Depth to groundwater (m)
NBRGW01	18 May 2011	9.01
NBRGW02	Not yet installed	
NBRGW03	19 May 2011	8.7
NBRGW04	20 May 2011	6.5
NBRGW05	20 May 2011	0.97
NBRGW06	19 May 2011	9.83
NBRGW07	18 May 2011	0.8

Analytical results

One monitoring run has been completed at this stage. The analytical results are summarised in Table 31.

Table 31: Groundwater monitoring results

	pH	EC (µS/cm)	DO (%)	Turb (NTU)	SS (mg/L)	SO_4 (mg/L)	Cl (mg/L)	Hard (mg/L)	Al[1] (mg/L)	As (mg/L)
NBRGW01	-	-	-	26400	9360	14	72	38		0.036
NBRGW02	Not yet installed									
NBRGW03	5.26	332	28.5	58	26	9	93	24		0.003
NBRGW04	5.82	287	34.9	3220	1010	11	69	37		0.04
NBRGW05	5.74	310	19.6	320	154	12	69	23		0.099
NBRGW06	5.67	447	19.8	1060	283	10	123	38		0.013
NBRGW07	7.72	383	8.6	272	214	14	86	19		0.24
ANZECC*	6.5–7.5	350	90-110	2-25			700			0.013

*ANZECC guidelines for surface waters
(continued)

	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Pb (mg/L)	Mn (mg/L)	Ni (mg/L)	Zn (mg/L)	Hg (mg/L)
NBRGW01	0.0004	0.037	0.039	0.266	0.199	0.238	0.054	0.048	<0.0001
NBRGW02									
NBRGW03	<0.0001	0.002	0.002	0.004	0.005	0.156	0.002	<0.005	<0.0001
NBRGW04	0.0042	0.014	0.011	0.073	0.088	0.12	0.017	0.334	<0.0001
NBRGW05	0.0013	0.012	0.01	0.939	0.356	0.423	0.01	0.255	<0.0001
NBRGW06	<0.0001	0.004	0.002	0.01	0.009	0.064	0.004	0.038	<0.0001
NBRGW07	0.0002	0.003	0.014	0.003	0.022	0.271	0.016	0.015	<0.0001
ANZECC	0.0002	0.001		0.0014	0.0034	1.900	0.0110	0.008	0.0006

EC = electrical conductivity; DO = Dissolved oxygen; Turb = lab turbidity; Hard = hardness; SS = suspended solids; SO_4 = sulphate; Cl = chloride; Al = aluminium; As = arsenic; Cd = cadmium; Cr = chromium; Co = cobalt; Cu = copper; Pb = lead; Mn = manganese; Ni = nickel; Zn = zinc; Fe = iron.
[1] One sampling period only

As with the surface water sampling, this background data will provide a reference against which future groundwater quality and depth can be assessed, when the proposed mine becomes fully operational.

The groundwater shows localised elevations of copper, lead and zinc at NBRGW05 (and zinc at NBRGW04). This is likely to be a reflection of the underlying geology.

The magnetite skarn at Nelson Bay River is accompanied by a separate phase of green pyroxene-amphibole skarn which has elevated copper and, to a lesser extent, lead and zinc. Indeed, the prospect has been targeted for copper in the past.

In the NBRGW04 and NBRGW05 catchment, aeromagnetics indicates no further likelihood of significant magnetite mineralisation. However, a previous (Geopeko) soil survey found ill-defined iron and copper anomalies to the south west (and north east), at the margins of the soil survey, which likely strike parallel to the magnetite. The elevated copper, lead and zinc levels in NBRGW05 are probably related to skarn mineralisation. The elevated zinc in NBRGW04 may reflect a more distal mineralised zone (hydrothermal geological systems often zone from proximal hotter copper-rich to more distal cooler lead and zinc-rich). Previous exploration has also noted regionally significant anomalous copper (20 ppm) in a Nelson Bay River sediment survey downstream of the magnetite and 5 ppm copper returned from sediment in the NBRGW05 catchment. These findings are not surprising, given that the mine site is a mineralised area.

NBRGW01 also has weakly elevated copper and zinc, which is not unexpected given that the bore is located near the inferred southeast strike extension of the magnetite and skarn.

The comparison in Table 31 with the ANZECC guidelines for surface waters show differences typical of those between surface and ground waters, notably higher pH, conductivity, suspended solids and some metals and lower dissolved oxygen in groundwater relative to surface waters.

By virtue of its mineralisation, elevated metals occur naturally in Nelson Bay River sediments and in the groundwater within and downstream of the mineralisations. Surface waters, on the other hand, have lower concentrations of metals due to their comparatively short contact time with the mineralised zones soils.

Pit water from within the ore body is likely to have similar metal elevations to that observed at the downstream groundwater bore NBRGW05 but new groundwater moving into the open pit is likely to have lower concentrations, due to not yet having had extended contact with the ore body. Newly arrived groundwater will be the dominant component of pit water and metal concentrations in water discharged from the pits is therefore expected to reflect those of the other bores and not be significantly elevated relative to natural surface water.

The discharge of mine water to surface waters will be managed through a variable discharge regime, as described in section 3.16.

8.6.4 Operational monitoring

Surface water and groundwater

The current programs of surface water and groundwater monitoring will be continued.

The existing eight surface water sampling stations (NBRSW01, NBRSW02, NBRSW03, NBRSW04, NBRSW05, NBRSW06, NBRSW07 and NBRSW08) and six groundwater monitoring stations (NBRGW01, NBRGW03, NBRGW04, NBRGW05, NBRGW06 and NBRGW07) described in section 8.6 will be continued and the additional (seventh) groundwater site NBRGW02, which is currently not accessible, will also be established.

The surface water sites will be sampled every 3 months and the groundwater sites every six months during operations. Samples will be analysed for physicochemical parameters and metals (as listed in Table 28 and Table 31 in section 8.6). Depth to groundwater will also be recorded in the groundwater bores.

The surface water sites will be supplemented with additional sites in East Creek upstream and downstream from the recycling dam overflow discharge point, in West Creek, upstream from the tailings dam basin overflow discharge point, and upstream from the NAF dump sediment pond. Sampling at these sites will commence before mining commences.

V-notch sampling weirs will be constructed at these discharge points and the discharge flow rate, pH and turbidity will be measured weekly.

If pH levels drop below 7, representative samples will be collected for laboratory analysis to measure the dissolved metal concentrations. A reduction in pH below 7 would trigger an operational response (which would likely have been triggered further up in the discharge stream anyway) to neutralise the acidity of discharge water in the neutralisation plant. Samples will continue to be taken for laboratory analysis on a weekly basis until the pH has returned to above 7.

Main pit

Main pit water will be tested for acidity on a weekly basis. A reduction in pH below 7 will trigger an operational response to neutralise the acidity of pit water in the neutralisation plant prior to it going to the recycle dam.

DSO pit

DSO pit water will be tested for acidity on a weekly basis. A reduction in pH below 7 will trigger an operational response to neutralise the acidity of pit water in the neutralisation plant prior to it going to the recycle dam.

Recycle dam

The recycle dam will be tested for acidity on a weekly basis. A reduction in pH below 7 will not necessarily trigger an operational response to neutralise this water in the treatment plant because it will be recycled through the processing plant, where alkalinity will be added to the tailings stream (see section 3.13). However, a reduction in pH will flag a concern that would need to continue to be watched.

Tailings dam

The tailings stream will be monitored daily to determine the amount of crushed lime and/or dolomite required to achieve a residual alkalinity in the tailings dam. Testing of the tailings pH after the alkalinity addition will also be undertaken daily.

The pH of the tailings dam decant will be tested weekly as it returns to the recycle dam.

The pH and turbidity of the tailings dam overflow/seepage collection basin will be tested weekly. If pH levels drop below 7, the water will be pumped to the acid neutralisation plant.

Samples of the settled tailings will be taken every 6 months and tested for Net Acid Generating potential and Acid Neutralising Capacity, to confirm that the tailings have a residual alkalinity from the alkalinity dosing.

NAF dump

A V-notch sampling weir will be constructed at the NAF dump sediment basin discharge point and the discharge flow rate, pH and turbidity will be measured weekly.

If pH levels drop below 7, the water will be pumped to the main pit from where in turn it will be pumped to the acid neutralisation plant.

Macroinvertebrate monitoring

Pre-disturbance macroinvertebrate monitoring surveys of Nelson Bay River and West and East Creeks will be undertaken at appropriate strategic locations in accordance with the Tasmanian River Condition Index protocol, a widely accepted methodology for monitoring changes to river ecosystems.

Surveys are planned to be undertaken at five sites: one on Nelson Bay River upstream of the mine where the river is crossed by the Wuthering Heights Road bridge; one each in Nelson Bay River downstream of the entry points of West and East Creeks respectively; and one each in West and East Creeks.

The results of the pre-disturbance surveys will provide a baseline against which to compare surveys undertaken when the mine is operating.

Fish monitoring

A general fish survey will be undertaken downstream of the mine at an appropriate time of year during the first year of operations. Similar surveys will be repeated in 3 year intervals, in years 4, 7 and 10. The surveys will be in accordance with the Tasmanian River Condition Index protocol.

Nests and den observations

Sentinel Monitoring Stations will be established to monitor the use of the Fauna Habitat Protection Zone and its denning opportunities by quolls and devils.

Roadkill

Records will be maintained of roadkill removed from Wuthering Heights Road and from within the mine site.

8.7 Plans to be developed and implemented

Following project approval, operational management plans, summarised in Table 32, will be prepared before development of the mine and construction work commences.

Table 32: Operational management plans to be prepared prior to mine development and construction work commencing

Plan	Purpose
Construction Environmental Management Plan	To manage environmental impacts during construction
Mine Closure Plan	To manage closure and site rehabilitation
Fire Management Plan	To protect the assets from fire and to maintain the existing natural fire regime, consistent with existing local fire authority requirements and public property management expectations
Fauna Management Plan	To manage the establishment and maintenance of the Fauna Habitat Protection Zone, road kill mitigation measures and den activity monitoring and reporting
Environmental Monitoring Plan	To manage environmental monitoring during operations and post-rehabilitation

8.8 Agencies responsible for endorsing or approving

Mineral Resources Tasmania and the Tasmanian Environment Protection Authority (EPA) and will be responsible for endorsing and/or approving the Mine Plan and the Mine Closure Plan.

The EPA will be responsible for endorsing and approving the Construction Environmental Management Plan, the Operational Environmental Management Plan, the Fire Management Plan and the Environmental Monitoring Plan.

8.9 Costs of impact mitigation measures

The anticipated approximate costs of impact mitigation measures are provided in Table 33. These estimates are necessarily indicative and cannot be firmed up until detailed design and additional testing has been completed, following project approval.

Table 33: Approximate estimated costs of measures to be taken to mitigate impacts on Matters of National Environmental Significance

Impact mitigation measure	Approximate capital/once-off cost	Approximate annual cost (for 10 years)	Approximate total cost over mine life
Dumping excess PAF into the main dump at end of mine life	$1.2M		$1.2M
Neutralisation plant	$1M	TDB (effluent dosing)	$1M + TBD
Tailings dosing to achieve excess alkalinity	$100K (online analysers) $100K (additional testing)	TBD (tailings dosing)	$200K + TBD
Provision of bus for workers	$100K	$150K	$1.6M
Establishment and monitoring of FHPZ	$20K (cameras)	$50K	$520K
Roadkill monitoring		$40K	$400K
Baseline orchid study	$400K		$400K
Environmental manager		$100K	$1M
Independent specialists and surveys		$100K	$1M
Water monitoring		$50K	$500K
		Total over life of mine	$8M + TBD

9. Consolidated summaries of risks and mitigation measures

The mitigation and management measures that will be implemented by the mine to protect Matters of National Environmental Significance are summarised in Table 34.

There are no significant residual risks to Matters of National Environmental Significance.

The key potential risks of interest are potential impacts on threatened orchid species and potential impacts on spotted-tail quoll and Tasmanian devils. These risks have been described and assessed in previous sections of this EIS and the findings are summarised in Table 35.

9.1 Mitigation and management measures

Table 34: Summary of mitigation and management measures for Matters of National Environmental Significance

Mitigation and management measures	
Mine development	
1	The mine has been designed to achieve the minimum practical footprint.
2	All processing infrastructure will be on-site. The only off-site infrastructure used will be the State road network for product transport to Burnie port or Port Latta (although an alternative possibility is for the ore to be taken to an existing licensed processing plant under commercial arrangement). A traffic impact assessment has confirmed the adequacy of the road network for the transport task.
Vegetation clearing	
3	Vegetation to be cleared almost entirely comprises *Eucalyptus nitida* and *obliqua* forest and wet scrub, which do not have significant conservation values.
4	The mine pits lie between the two creeks that cross the mine site (West Creek and East Creek) and the mine infrastructure has been designed to also lie between them, so avoiding any significant lost of riparian habitat.
5	Topsoil will be recovered during the construction of the open pit, the waste dump areas and the access roads and will be stockpiled for future rehabilitation works.
6	The rock dump will be the largest vegetation clearance footprint. Its footprint comprises *Eucalyptus nitida* and *obliqua* forest and wet scrub, which do not have significant conservation values. This vegetation will be progressively cleared as the rock dump grows.
7	Best practice erosion and sedimentation controls, particular to specific construction areas, will be utilised throughout the project.
Threatened flora protection	
8	Vegetation to be cleared almost entirely comprises *Eucalyptus obliqua* and *nitida* forest and western wet scrub, which do not have significant conservation values.
9	There is a small, isolated fragment of wet heathland over the main pit and the northern end of the rock dump, which will be lost when the pit overburden is removed. However, the site survey found no threatened plant species in this area and these patches represent no more than 1.2% of the wet heathland in a surrounding 5 km radius.
10	There will be no disturbance of the sensitive wet heathlands to the west of West Creek, which provide known and potential habitat for threatened orchid species.
11	There is no significant likelihood for direct, facilitated or cumulative impacts on any plant species listed under the *Environment Protection and Biodiversity Conservation Act 1999*.
12	The EIS guidelines require baseline research to be conducted into the mycorrhizal and pollinator requirements of impacted threatened orchids. As described above, there will be no impacts on threatened orchids and this requirement is therefore not relevant to the approval decision for the project. Nevertheless, to enhance the understanding of orchid biology in northwestern Tasmania, Shree Minerals will commission that research during the early years of the mine's operations, as a best practice environmental management contribution to orchid science.

Mitigation and management measures	
Threatened fauna protection	
13	To mitigate against the potential impact on nesting masked owls, preclearance surveys will take place immediately before each stage of clearing to identify any nesting habitat trees currently in use by owls. These surveys will be conducted by a suitably qualified person. A temporary 50 metre buffer will be established around any such nests during the forest clearing operations. Only after the nest has been confirmed to be vacated will the vegetation clearing be completed.
14	To mitigate against the potential den-loss impact on quolls and devils (which could impact up to 1 quoll and 2 devils), preclearance surveys will take place immediately before each stage of clearing to identify any dens currently in use. These surveys will be conducted by a suitably qualified person. A temporary 50 metre buffer will be established around any maternal dens during the forest clearing operations. Only after the maternal den has been confirmed to be vacated will the vegetation clearing be completed. Because of the mobility of devils and quolls between dens, timing the surveys to closely precede clearing is important. If surveys were done too early, the surveys findings could not be relied upon – maternal dens found to be occupied during the survey might no longer be so and potential maternal dens found to be unoccupied during the survey might have since become occupied.
15	New denning opportunities will be provided by creating wildlife habitat clumps using windrows of cleared vegetation. These habitat clumps will be constructed along the western margin of the waste rock dump, which forms the boundary between the active mine site and the area of the lease that will remain undisturbed.
16	To mitigate against the potential increase in roadkill risk to quolls and devils due to worker vehicles travelling the region's roads, the speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour. This is the critical stopping distance for avoiding roadkill at night but will be applied throughout the day also as a conservative measure.
17	Shree Minerals will provide mine workers and product transporters with maps identifying high roadkill risk areas along the route between the mine site and Smithton. Mine workers and product transporters will be required to pay particular attention to roadkill risk when driving through these high risk spots and will encourage them to reduce speed to below 50 kph during the dawn to dusk period (subject to road safety considerations and the convenience of other road users).
18	To mitigate against the potential roadkill risk increase to wedge-tailed eagles, quolls and devils feeding on roadkill carcasses, mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily). The roadkill will be moved at least 40 m from the edge of the road. The employee responsible for roadkill removal will hold an appropriate permit under the *Nature Conservation Act 2002.*
19	As a risk mitigation measure against potential roadkill or eagles, quolls and devils transport product transport will be restricted to daylight hours. Daylight hours will be defined as the period between the end of the morning civil twilight period and the beginning of the evening civil twilight period. Civil twilight is the period when vehicle headlights should be switched on. Product transport will therefore be outside the headlight period. Over a year, the average daily transport period will be approximately 12 to 13 hours, about 2 hours above that in summer and about 2 hours below that in winter. Restricting product transport to daylight hours will reduce the incremental roadkill risk to quolls to 0.1 kills each year (0.3 in the first year) and to devils to 0.6 kills each year (1.6 during the first year).
20	To mitigate against the potential increase in roadkill risk to quolls and devils due to worker vehicles travelling the region's roads, Shree Minerals will provide a bus between Smithton and the mine site for mine workers, to minimise the additional number of vehicles travelling on the region's roads as a result of the mine.
21	Shree Minerals will monitor devil numbers around the mine site to confirm the effectiveness of its devil (and quoll) impact mitigation measures, and these observations will be provided to the Save the Tasmanian Devil Program (STDP). Shree Minerals will also cooperate and support any wider area monitoring and research being undertaken by the STDP.
22	Shree Minerals will prohibit dogs or other pets being brought onto the mine site.
Surface water and groundwater protection	
23	The adopted Protect Environmental Value for the Nelson Bay River is "*Protection of pristine or nearly pristine ecosystems*".
24	Water Quality Objectives have been determined from baseline water monitoring results to protect the adopted PEV.

Mitigation and management measures	
Hydrogeological impacts	
25	Dewatering the mine pits will draw down the groundwater table in surrounding areas. The amount of drawdown will diminish rapidly with distance from the pits.
26	The sensitive wet heathland to the west of the mine is in a groundwater recharge area, not a discharge area, and its soil water is therefore not dependent on the underlying water table. The heathland plants are shallow rooted species reliant on soil water from infiltrating rainfall, not from the underlying water table. There is therefore no significant likelihood of the heathland soil water, and hence the ecosystems dependent on it, including threatened orchid species, being affected by the dewatering of the mine pits.
Waste rock management	
27	Waste rock will be separated into potentially acid forming (PAF) and non-acid forming (NAF).
28	PAF waste rock will be disposed of inside the DSO pit, encapsulated in clay.
29	The majority of NAF waste rock material will be disposed of in the NAF waste rock dump but variable amounts, subject to suitability of lithology and mineral content, will be used for the following: o Construction of the tailings dam, including the various lifts in the dam wall that will be required over the life of the mine o Mine site road construction o Construction of the berm wall around the waste rock dump o Crushing and sale off-site for road base material.
30	The NAF waste rock dump will commence at the northwestern end and progressively grow to the southeast. It will have a drainage collection drain.
31	The benches of the rock dump will be progressively revegetated as the dump grows.
32	The NAF waste rock dump location has been chosen because it provides the most compact mine footprint, the shortest haul distances and it avoids incursion on significant vegetation to the west. In addition, a waste rock dump in this proposed location would be less visible from Rebecca and Temma Road than one located on the heathland to the west.
33	Although no PAF waste rock will knowingly be taken to the NAF dump, the dump design with its collection drain directing seepage to a sedimentation dam provides a mechanism to collect and treat for any acid drainage that unexpectedly does emerge.
34	As an additional security measure against unexpected acid drainage, sections of the the NAF rock dump's collection drain could if necessary be lined with acid neutralising rock, such as dolomite or limestone, which could be brought onto site for that purpose. Existing dolomite supplies are available along the product transport route and dolomite could be brought back to the site economically by back filling ore transport trucks.
35	PAF waste rock will be encapsulated inside the DSO pit within cell(s) specially designed and constructed so that oxidation of the pyritic material will be slowed down, water ingress to the material reduced (preferably prevented if possible), and any drainage from the material readily controlled and treated. If the amount of PAF material exceeds the capacity of the DSO void, the excess material will be stored in cells above the DSO pit until mine closure, at which time it will be relocated into the main pit.
36	The basic cell design for the disposal of pyritic material will consist of cells with clay lined floors and walls clay lined containment bunds. Periodically the material within the cells will be capped with clay that will act as a barrier to water ingress, before the introduction of additional pyritic material.
37	If acid is formed due to rain runoff from the exposed rock in the operating PAF cell, it will safely accumulate in the DSO pit before being pumped to the a central treatment plant for neutralisation if and as necessary prior to discharge to the recycle dam or East Creek.
38	The proposed management measures for potential acid forming material will ensure that any oxidation of pyritic material will be minimised and any acid drainage produced will be controlled to the maximum possible extent.
39	The DSO pit and main pit will be flooded on mine closure, preventing oxidation of the PAF material stored in those pits.
40	It is possible that any exposed PAF rock in the main pit wall will oxidise and generate acid through rain runoff or groundwater discharge over that part of the pit face. Main pit water will be pumped to the central treatment plant for neutralisation if and as necessary prior to discharge to the recycle dam or East Creek.
Tailings management	
41	The process tailings will be permanently stored and managed using a dedicated clay lined tailings dam.
42	The tailings dam will be designed to satisfy the requirements of the Tasmanian Assessment Committee on Dam Construction and the standards of the Australian National Committee on Large Dams (ANCOLD). Subject to a risk assessment that will be undertaken during detailed design, it is likely that the design failure risk will be 1 in 10,000 years or less.

Mitigation and management measures	
43	The tailings dam will be located near the head of East Creek. Location on the creek line reduces the volume of the dam wall but, more importantly, facilitates permanent flooding of the dam following mine closure. A permanent water cover over the tailings dam (other than the tailings beach) will prevent oxidation of pyritic material in the tailings and hence prevent acid formation.
44	The decant from the tailings dam will be pumped back to the recycled water dam (via the neutralisation plant) and hence to the processing plant.
45	A collection dam will be constructed below the dam to collect any seepage and overflow. Collected water will be returned to the process plant's recycle dam (via the neutralisation plant).
46	The tailings facility will be operated to recycle decant waterinto the beneficiation process via a recycle storage dam.
47	Free tailings water will be recycled by decant into the process plant's recycle dam and tailings water alone would not lead to the tailings dam overflowing. Incident rainfall will be add additional water to the tailings dam. Water excess to recycling needs will be pumped to the central neutralisation plant where it will be neutralised if and as necessary prior to discharge to East Creek.
48	If rainfall onto the tailings dam leads to an excess that cannot be returned to the recycle dam or East Creek discharge, this will be discharged either to the collection basin below the tailings dam and then to West Creek.
49	Depending on the rate of growth of the rock dump and hence its collection drain, either before or at mine closure the overflow from the tailings dam collection basin will be redirected to the rock dump collection drain.
50	The creek above the tailings dam will ensure that the dam remains flooded on closure. The total catchment area of the tailings dam and its upstream feed from West Creek is 70 ha. The surface area of the tailings dam is approximately 40 ha. The mean annual effective rainfall (rainfall minus evaporation) at the mine site is 570 mm. With a catchment to dam area ratio of approximately 1.75:1, the mean effective rainfall onto and into the tailings dam is therefore approximately 1 m, which will ensure a mean depth of permanent water cover of at least 1 m. The lowest annual rainfall likely to be experience at the mine site is approximately 900 mm, equivalent to the annual evapotranspiration rate. Even in drought years, there will therefore be no net evaporation from the tailings dam, and a permanent water cover depth of at least 1 m is therefore readily attainable.
Water management	
51	Cutoff drains and bunds will be constructed to divert water away from the pits (both the DSO pit and main pit), waste rock dump, tailings dam and processing plant site. This diverted water will not be subject to contamination and therefore excess will be directed into natural drainage lines, through energy dissipation structures as necessary to minimise erosion risk.
52	Potable water will be sourced from rainfall and stored in rainwater tanks.
53	Sewage will be collected for treatment in an on-site Aerated Wastewater Treatment System (AWTP) or similar. Treated effluent will be discharged into the recycle dam.
54	Site runoff from the processing plant hardstand, which may be subject to hydrocarbon contamination, will be diverted into an oil and grease separator, prior to pumping to the recycle dam.
55	The recycle water will be held in a dedicated dam, to be constructed near the processing plant. This dam will receive the decant from the tailings dam via the central neutralisation plant. Make-up water will be supplied to the recycle dam from the DSO pit, via the neutralisation plant, which will accumulate its own water after the completion of mining (and similarly from the main pit dewatering if additional make-up water is required).
56	If the water recycle dam is full, the excess will be discharged to East Creek via the neutralisation plant.
57	There will be no direct discharges to Nelson Bay River.
58	The DSO pit is expected to make approximately 100,000 m^3 of water per year, which will be enough to supply the make-up water needs, obviating the need for any extraction from Nelson Bay River.
59	Additional makeup water will also be available from dewatering of the main pit. The available amount will progressively increase as the main pit deepens, up to an estimated 400,000 m^3 per year at full pit development. If this water is excess to requirements it would be discharged to East Creek via the neutralisation plant.

Mitigation and management measures	
Plant hygiene measures	
60	Hygiene measures for Phytophthora management have been implemented at entry points to the site during the exploration phase. Appropriate hygiene protocols, including washdown procedures, will be maintained on the site during the development and operation of the mine. These protocols, which will be consistent with the recommendations of the DPIW Biodiversity Conservation Branch report titled: "Interim Phytophthora cinnamomi Management Guidelines", will include maintenance of current hygiene treatment stations at entry points to the area and ensure that personnel observe strict protocols in treating boots, equipment, vehicles and machinery before entering any potentially infected area.
Monitoring	
61	Main pit water will be regularly tested for acidity. The water will discharge to East Creek, via the neutralisation plant, where it can be treated if necessary.
62	DSO pit water will be regularly tested for acidity. DSO pit water will go to the recycle dam (via the neutralisation plant) for make-up water or, if excess to make-up water needs, it will be discharged to East Creek.
63	The recycle dam will be regularly tested for acidity. Any overflow will discharge via the neutralisation plant, where it can be treated if necessary prior to discharge to East Creek.
64	Regular monitoring of surface (3-monthly) and groundwater (6-monthly) quality will be undertaken for laboratory analysis. Discharges to East and West creeks will be field tested weekly for flow, pH and turbidity.
65	Weekly pH monitoring of the tailings dam decant will be undertaken and tailings will be analysed every 6 months.
66	Although there is no significant likelihood of impacts on threatened orchids species, Shree Minerals will nevertheless commission a baseline research program during the first 3 to 4 years of the mine's operations.
67	A pre-disturbance Tasmanian River Condition Index macroinvertebrate survey of Nelson Bay River and West and East Creeks will be undertaken prior to construction commencing to provide a baseline against which operational survey results can be compared.
68	The new denning opportunities created by vegetation windrowing will be monitored for use by quolls and devils.
69	Records will be maintained of roadkill removed from Wuthering Heights Road and from within the mine site.
Management plans	
70	The following plans will be prepared for approval by Mineral Resources Tasmania and the Tasmanian Environment Protection Authority: o Mine Plan o Construction Environmental Management Plan o Mine Closure Plan o Fire Management Plan o Fauna Management Plan o Environmental Monitoring Plan.

9.2 Key assessed risks and their residual significance

Table 35: Summary of key risks assessed for Matters of National Environmental Significance

Matter	Risk assessed	Residual significance?
Threatened orchids		
Direct disturbance or loss of individual plants	Targeted surveys (undertaken in the spring of 2010) found no threatened orchid plants within the mine lease area. Orchids do not always flower in every year and it is conceivable that individual plants could emerge in other flowering years. However, whether and where individual plants might occur some unknown time in the future can only be speculative and cannot be the basis for development planning or decision making.	Not significant
Direct disturbance or loss of populations	Targeted surveys (undertaken in the spring of 2010) found no threatened orchid plants within the mine lease area but it is conceivable that orchid populations could emerge in other flowering years. Although it is conceivable that populations of threatened orchid species might appear within non-preferred habitat, these occurrences would be incidental and by definition would be within areas that are not optimal. Protection of the species will best be achieved by protecting optimal habitat because it is that habitat that is most likely to contain sustainable populations. The protection of wet heathland is therefore the design objective of the mine. Protecting this habitat provides the best assurance against minimising the loss of populations of threatened orchid species, irrespective of whether particular populations may or may be found within the habitat in any particular seasonal survey.	Not significant
Direct physical disturbance of loss of habitat	Within the vicinity of the mine, the wet heathland is the habitat most likely to be preferred by any threatened orchid species that exist in the area. The mine footprint will require the clearance of 4.2 ha of wet heathland patches (to the east of West Creek) but will entirely protect a very much larger area of wet heathland that lies in the western part of the lease (west of West Creek). Relative to the wider region, the 4.2 ha lost represents only 1.2% of the total wet heathland mapped by Tasveg as occurring within a 5 km radius of the lease. In fact, the site survey indicates that the vegetation mapped by Tasveg as buttongrass moorland to the west of the mine site is actually wet heathland, meaning that the 1.2% figure is probably a significant overestimate of the actual proportion of wet heathland in the region that would be lost due to the mine.	Not significant
Altered fire regimes	Fire can have positive and negative effects on orchids. Orchids often flower 1 to 3 years after a fire. On the other hand fires could kill orchids if they are too intense. The mine will actively manage its operations to minimise the risk of fire starting on the mine site and it will also actively suppress any fires that do nevertheless start or that encroach upon it from outside. The net effect of these management measures is that there is unlikely to be a significant change to the historical fire regime.	Not significant
Spread of weeds	The spread of weeds and also plant diseases (such as Phytophthora) is highly undesirable irrespective of their potential impact on threatened orchid species and active weed and disease management measures will therefore be implemented at the mine. Indeed, they have already been implemented during the exploration phase. Equipment, machinery and vehicle inspection, washdown and disinfection procedures will be implemented and enforced for anything coming to the mine from a site where it has been exposed to disturbed soil. These measures will continue throughout the life of the mine.	Not significant

Matter	Risk assessed	Residual significance?
Genetic effects of small population size	Genetic effects, if any, arising from small population sizes would be a factor intrinsic to the existing gene pools and distributions of the various orchid species. If these effects do exist, the most appropriate way to mitigate against adverse consequences would be to protect the core habitat of each species. As described above, this means protecting the wet heathland, which is achieved by the mine design. There is no significant potential for the mine to influence the genetic characteristics of the orchids or to exacerbate any inherent genetic risks if indeed such risks exist in the first instance.	Not significant
Loss of mycorrhizal fungus	Mycorrhizal fungus associations with orchids are know to be easily compromised by weed invasion, edge effects due to altered land use, changes to soil chemistry, changes to organic content and changes to hydrology. The task for the mine therefore becomes one of ensuring that its activities do not cause any of these changes. Weed management measures will minimise the risk of weed invasion to the mine site itself and therefore consequential weed invasion of the wet heathlands in the western part of the lease. The mine design by intent creates a clear separation buffer between the mine footprint and the wet heathland in the western part of the lease. That buffer will exclude any edge effects because the mine footprint and the heathlands will not share a contiguous boundary. There is no identifiable causal relationship between the presence of the mine in the eastern part of the mine lease and the soil chemistry or organic content of the wet heathland in the western part. Any mooting of some possible unknown relationship could only be speculative at best, and without scientific basis. The remaining potential impact of the mine on mycorrhizal fungus associations with orchids is a change to the hydrology of the soil where those associations take place. The wet heathland (the preferred habitat of the orchids) in the western part of the lease is well away from the mine pits and will be at the extreme margins of the water table depression that will occur from pit dewatering. More importantly, the wet heathland is a groundwater recharge area. The heathland soil does not derive its water from the underlying groundwater but rather from precipitation from above. Even if it did occur, any lowering of the watertable below the heathland (which at most would be marginal anyway) could therefore not change the soil water regime and therefore could not affect mycorrhizal fungus associations.	Not significant
Loss of pollinators	Many orchids (but not all – some are self-pollinating) rely on insects for pollination. Loss of pollinator habitat could therefore impact on orchids by reducing their pollination rates. However, regardless of which particular vegetation community might be preferred by particular orchid pollinators, the maximum percentage loss of any given vegetation community within a 5 km radius of the mine is less than 3%.	Not significant
Wedge-tailed eagle		
Nest disturbance	The survey area has a low probability of containing eagle nests as most of the mature eucalypts within the study area have been badly fire damaged. The nearest known eagle nest is approximately 1.8 km to the north east of the study area (nest id 971500). A helicopter-based search failed to locate any other nests.	Not significant
Roadkill	An increase of traffic volume to and from the proposed mine site could potentially result in a higher incidence of road kill or injury to individual birds as they feed on any carcasses of wildlife killed by traffic. However, roadkill minimisation measures and the removal of any roadkill from mine roads and Wuthering Heights Road will mitigate this risk.	Not significant

Matter	Risk assessed	Residual significance?
Masked owl		
Nest loss due to vegetation clearing	There is a potential impact on nesting owls from vegetation clearing if owls use any of the old trees on the site for nesting and clearing occurs during the nesting season. However, preclearance surveys will take place immediately before each stage of clearing to identify any nesting habitat trees currently in use by masked owls. A temporary 50 metre buffer will be established around any such nests during the clearing operations. Only after the nest has been confirmed to be vacated will the vegetation clearing be completed.	Not significant
Spotted-tailed quoll		
Displacement by vegetation clearing	Based on conservative (high) assumptions about quoll densities on the site, clearing of vegetation for the mine could displace up to 1 quoll. However, the area cleared will not be significant relative to the movement range of quolls or the large area of surrounding vegetation.	Not significant
Den loss due to vegetation clearing	There is a potential impact on quolls from vegetation clearing if any maternal dens are present and occupied and clearing occurs during the denning season. However, preclearance surveys will take place immediately before each stage of clearing to identify any maternal dens currently in use by quoll. A temporary 50 metre buffer will be established around any such dens during the clearing operations. Only after the den has been confirmed to be vacated will the vegetation clearing be completed. New denning opportunities will be created within a Fauna Habitat Protection Zone to the west of the mine footprint by constructing numerous windrows of cleared vegetation piles. Materials for the creation of the windrows will be sourced from the forest materials cleared for the waste rock dump and tailings dam and will include large trees placed specifically to create suitable denning hollows and to create good fauna shelter.	Not significant
Roadkill	An increase of traffic volume to and from the proposed mine site could potentially result in a higher incidence of quoll road kill. However, this risk will be mitigated through a number of measures. The speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour. This is the critical stopping distance for avoiding roadkill at night but will be applied throughout the day also as a conservative measure. Mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily). The roadkill will be moved at least 40 m from the edge of the road verge. Product transport will be restricted to daylight hours. Without this restriction, product transport could increase the quoll roadkill on the region's roads by 0.6 every year (and 1.6 in year 1). Confining product transport to daylight hours will reduce these risks to 0.1 and 0.3 kills per year respectively.	Not significant
Tasmanian devils		
Displacement by vegetation clearing	Based on conservative (high) assumptions about devil densities on the site, clearing of vegetation for the mine could displace up to 2 devils. However, the area cleared will not be significant relative to the movement range of devils or the large area of surrounding vegetation.	Not significant
Den loss due to vegetation clearing	There is a potential impact on devils from vegetation clearing if any maternal dens are present and occupied and clearing occurs during the denning season. However, preclearance surveys will take place immediately before each stage of clearing to identify any maternal dens currently in use by devils. A temporary 50 metre buffer will be established around any such dens during the clearing operations. Only after the den has been confirmed to be vacated will the vegetation clearing be completed.	Not significant

Matter	Risk assessed	Residual significance?
	New denning opportunities will be created within a Fauna Habitat Protection Zone to the west of the mine footprint by constructing numerous windrows of cleared vegetation piles. Materials for the creation of the windrows will be sourced from the forest materials cleared for the waste rock dump and tailings dam and will include large trees placed specifically to create suitable denning hollows and to create good fauna shelter.	
Roadkill	An increase of traffic volume to and from the proposed mine site could potentially result in a higher incidence of devil road kill. However, this risk will be mitigated through a number of measures. The speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour. This is the critical stopping distance for avoiding roadkill at night but will be applied throughout the day also as a conservative measure. Mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily). The roadkill will be moved at least 40 m from the edge of the road verge. Product transport will be restricted to daylight hours. Without this restriction, product transport could increase the devil roadkill on the region's roads by 3 every year (and 8 in year 1). Confining product transport to daylight hours will reduce these risks to 0.6 and 1.6 kills per year respectively.	Not significant

10. Proposed offset (compensation) measures

Guideline requirements for this section

Where impacts on matters of national environmental significance cannot be avoided or mitigated, the draft environmental impact statement must provide a description of any strategies to offset (compensate for) those impacts. The proposed strategies must have regard to any relevant publicly available guidance issued by the Department in relation to offsets, and in particular must:

a) *demonstrate how they will achieve long-term conservation outcomes*
b) *have regard to the nature, scale and intensity of the impacts of the proposed action on the site*
c) *consider the approach of the relevant state or territory.*

There are no significant residual impacts on Matters of National Environmental Significance and so no offsets are required.

However, a Fauna Habitat Protection Zone (FHPZ) will be established within the mine lease (see section 8.2) to provide local refugia for any devils and quolls that are displaced by the clearance of vegetation for the mine. The FHPZ will be to the west of West Creek. New denning opportunities for spotted-tailed quoll and Tasmanian devils will be created using windrows of cleared vegetation along the eastern edge of the zone.

The creation of the zone is a specific commitment in this EIS and is also a commitment in the Development Proposal and Environmental Management Plan being submitted under the *Tasmanian Environmental Management and Pollution Control Act 1994*. Its establishment, protection and maintenance will therefore become a condition of development and operational approval. The FHPZ will be within the mining lease and will therefore be protected from interference by third parties.

11. Other approvals and conditions

Guideline requirements for this section

The draft environmental impact statement must provide information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include:

a) details of any local or state government planning scheme, or plan or policy under any local or state government planning system that deals with the proposed action, including:

i. what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy

ii. how the scheme provides for the prevention, minimisation and management of any relevant impacts

b) a description of any approval that has been obtained from a state, territory or Commonwealth agency or authority (other than approval under the EPBC Act), including any conditions that apply to the proposed action

c) a statement identifying any additional approval that is required

d) *a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.*

11.1 State legislation and local government planning schemes

The Tasmanian Resource Management and Planning System (RMPS) was established to achieve sustainable outcomes from the use and development of the State's natural and physical resources. Several pieces of legislation embody the aims of the RMPS.

Within the context of this development proposal, there are a number of applicable statutes:

- *State Policies and Projects Act 1993*
- *Land Use Planning and Approvals Act 1993*
- *Environmental Management and Pollution Control Act 1994*.

11.1.1 State policies

The *State Policies and Projects Act 1993* establishes the process to put in place State Policies in relation to the Resource Management and Planning System of Tasmania. State policies seek to ensure a consistent and coordinated approach and incorporate the minimum amount of regulation necessary to achieve their objectives of managing natural resources. State Policies are implemented through their integration into Local Government Planning Schemes.

Currently there are three State Policies:

- *State Coastal Policy 1996* (Coastal Policy)
- *State Policy on Water Quality Management 1997* (Water Quality Policy)
- *State Policy on Protection of Agricultural Land 2009* (PAL Policy).

State Coastal Policy 1996 (Coastal Policy)

The purpose of the *State Coastal Policy 1996* is to implement the sustainable development objectives of the RMPS in Tasmania's coastal areas.

The Policy is based on the following three core principles that address these objectives:

- "Natural and cultural values of the coast shall be protected
- The coast shall be used and developed in a sustainable manner; and
- Integrated management and protection of the coastal zone is a shared responsibility."

The Coastal Policy is applicable to all Tasmanian State waters and land (excepting Macquarie Island) within one kilometre inland of the high-water mark.

The Coastal Policy is not applicable to any part of this proposal as no part of the site is within one kilometre of the high-water mark.

State Policy on Water Quality Management 1997 (Water Quality Policy)

The purpose of the Water Quality Policy is to achieve the sustainable management of Tasmania's surface water and groundwater resources by protecting or enhancing their qualities while allowing for sustainable development in accordance with the objectives of the RMPS.

A baseline surface water monitoring program has been implemented to investigate water quality data and to ensure that any potential project impacts on the waterways are monitored, controlled or managed appropriately (Refer: Section 4, Measures to avoid or reduce impacts). Groundwater monitoring will be installed before the main pit is developed and processing commences.

The management measures that will be applied to ensure compliance with the Water Quality Policy include:

1. Construction areas will be clearly demarcated in contract documents so that disturbed areas are kept to a minimum and no unnecessary soil or vegetation disturbance occurs
2. Where required, erosion and sediment control measures such as silt stop fencing, sediment traps and erosion control matting will be installed prior to the commencement of construction activities
3. Overland drainage flow will be diverted away from disturbed areas and bare soil to outfalls with sediment traps to reduce the potential for erosion
4. Rehabilitation and revegetation of disturbed areas will occur as soon as practicable on completion of construction to reduce the potential for ongoing soil erosion to occur
5. Stockpiled materials will be managed to ensure that dust and potential runoff is minimised and does not enter watercourses
6. Erosion control measures and sediment traps will be regularly monitored; sediment material will be collected and disposed of on site.

State Policy on Protection of Agricultural Land 2009 (PAL Policy)

The purpose of the PAL Policy is to "conserve and protect agricultural land so that it remains available for the sustainable development of agriculture, recognising the particular importance of prime agricultural land". The main objective of the PAL Policy is to ensure that the productive capacity of agricultural land is appropriately recognised and protected in the use and development of agricultural land.

The PAL Policy focuses on protecting prime agricultural land (land capability classes 1, 2 and 3) from conversion to non-agricultural uses or from being fettered from being used for agricultural activities.

There is no prime agricultural land in the area of the proposed mine development.

11.1.2 Land Use Planning and Approvals Act 1993

Under the *Land Use Planning and Approvals Act 1993*, Councils are required to administer the development and use of land within their municipal boundary. The assessment of development and use is undertaken in accordance with the relevant planning scheme(s).

The proposed development is located within the boundaries of the Circular Head Municipality. The proposed use and development within the municipality will be assessed in accordance with the *Circular Head S.46 Planning Scheme No. 1 1995 as consolidated at the 2nd June 2003*.

Circular Head S.46 Planning Scheme No. 1 1995

The Mining Lease and surrounding area are within the Forest Resource Zone of the *Circular Head S.46 Planning Scheme No.1, 1995* (the Scheme).

The intent (4.9.1) of the Forest Resource Zone is:

1) *To identify the areas of forest on Crown Land which are under the control of the Forestry Commission;*
2) *To identify private land where a Private Timber Reserve or Timber Harvesting Plan has been sought and approved by the Forestry Commission;*
3) *To identify other land which is suitable for Commercial Forestry operations.*

The resource extraction is best defined as Industry Extractive / Extractive Industry[1], which is a discretionary use or development in this zone.

Industry Extractive: *means any land used for the excavation of any resource(s) such as sand, earth, soil, clay, turf, gravel, rock, stone, minerals or the like.*

1 Clause 4.9.2 Use of Land list *"Extractive Industry"* rather than Industry Extractive as defined in Part 13 of the Scheme. It has been assumed these definitions refer to the same activity and the difference is the result of an error in drafting the Scheme.

11.1.3 Environmental Management and Pollution Control Act 1994

The project is a level 2 activity under Schedule 2 of the *Environmental Management and Pollution Control Act 1994* and a Development Proposal and Environmental Management Plan (DPEMP) will be submitted to Environment Protection Authority for assessment and approval.

11.1.4 Aboriginal Relics Act 1975

An Aboriginal Cultural Heritage Assessment of the site has been undertaken for the proposed project by CHMA in December 2010[284]. Key findings from this assessment were:

The Tasmanian Aboriginal Site Index (TASI) data base shows that there are ten registered Aboriginal heritage sites that are situated within a 5 km radius of the study area. None of these sites are actually located within the bounds of the study area, however. The closest sites to the study area are situated around 1.5 km to the south. These are sites TASI 7052 (an artefact scatter) and TASI 7162 (an isolated artefact).

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284 CHMA, 2010. *An Aboriginal Cultural Heritage Assessment of the Proposed Nelson Bay River Magnetite Mine Development, North-West Tasmania*.

The field investigations identified no Aboriginal heritage sites or areas of potential archaeological sensitivity within the study area, which was assessed as being of low archaeological sensitivity. The study concluded that there are no site specific Aboriginal heritage constraints to the development.

11.1.5 Threatened Species Protection Act 1995

Flora and fauna surveys for the proposed development have identified habitat for four fauna species listed under the Tasmanian *Threatened Species Protection Act* 1995 that may be impacted by the proposal. Although two threatened flora species were found in the survey area, these will be outside the mine disturbance footprint and will not be impacted.

Potential impacts, avoidance and mitigation on Tasmanian listed threatened species will be assessed in the DPEMP to be prepared and submitted for approval.

Management advice will be sought as necessary from the Policy and Conservation Assessment Branch of the Department of Primary Industries, Parks, Water and the Environment.

11.1.6 Historic Cultural Heritage Act 1995

There are no known or anticipated features of historic heritage significance in the area of the proposed mine development.

11.1.7 Forest Practices Act 1985

For many activities a Forest Practices Plan (FPP) is required under the *Forest Practices Act 1985* where the clearing of forest is in excess of 1 hectare or 100 tonnes of timber (in areas of 'vulnerable land' these thresholds are lower). However, mining operations are explicitly excluded from this requirement where a LUPAA permit is in place, which will be the case for this project.

11.2 Approvals obtained

The only approvals obtained to date relate to relevant approvals from Mineral Resources Tasmania to undertake exploration activities on the site.

11.3 Additional approvals required

The following additional key approvals will be required:

- Mining lease and mine plan (from Mineral Resources Tasmania)
- Land use planning permit (from Circular Head Council)
- Environmental approval (from the Environment Protection Authority)
- Dam construction approvals (from the Assessment Committee for Dam Construction).

11.4 Monitoring, enforcement and review procedures

This section relates to monitoring, enforcement and review procedures that either have been or are likely to be imposed under any other environmental approval (or conditions of approval).

Monitoring procedures

The project is subject to a mine lease approval by the Tasmanian Minister for Mines through Mineral Resources Tasmania (MRT). MRT will also approve the mine plan. The lease and mine plan approvals may include monitoring requirements.

The project is subject to a separate environmental approval process under the Tasmanian *Environmental Management and Pollution Control Act 1994*. A Development Proposal and Environmental Management Plan (DPEMP), which includes a Mine Closure Plan, is being submitted separately to the Environment Protection Authority for assessment and approval.

The EPA will advise Circular Head Council of the environmental conditions that Council must include in any land use planning permit that Council issues for the project.

The DPEMP includes a number of monitoring commitments and those commitments are expected to be reflected in the EPA's conditions of approval, together with any additional requirements that the EPA may consider appropriate.

Circular Head Council may choose to add further monitoring conditions.

The Assessment Committee for Dam Construction (ACDC) is expected in include dam construction and integrity monitoring as conditions of dam approval.

Enforcement procedures

MRT will enforce mine lease and mine plan conditions of approval.

The EPA Division of the Tasmanian Department of Primary Industries, Parks, Water & Environment will enforce the EPA's approval conditions on behalf of the EPA.

Circular Head Council will enforce its own conditions.

The ACDC will enforce its own conditions.

Review procedures

MRT, the EPA, Council and the ACDC are likely to require regular reporting and review as part of their approval conditions.

For example, the mine plan will be regularly updated as mining proceeds. The Mine Closure Plan will similarly be regularly reviewed and updated. The ACDC will review dam construction completion reports.

12. Environmental record of proponent

Guideline requirements for this section

The draft environmental impact statement must provide:

a) details of any proceedings under a Commonwealth, state or territory law for the protection of the environment or the conservation and sustainable use of natural resources against the person proposing to take the action (including in the case of a corporation, any related entities)

b) details of the corporation's environmental policy and planning framework.

12.1 Legal proceedings against the proponent

No proceedings have been undertaken against Shree Minerals Limited or the Chairman, Mr Sanjay Loyalka (the proponent), under a Commonwealth, state or territory law for the protection of the environment or the conservation and sustainable use of natural resources.

12.2 Environmental policy of the corporation

Shree Minerals was formed in April 2008 and has been conducting its exploration activities in a sound and responsible manner.

The Shree Minerals Environmental Policy is as follows:

Shree Minerals Ltd (Shree) aims to achieve a high standard of care for the natural environment in all the activities in which it engages. At each stage of development it proactively aims to avoid or to minimise environmental impacts. We see the environment as an opportunity for economic growth and business success while acknowledging that all of our activities must be balanced with protection of the environment. To achieve the standards of environmental performance to which it is committed, Shree shall endeavour to ensure the following:

- *Conducts operations, as a minimum, in compliance with all relevant environmental codes of practice, licences and legislation.*
- *Identifies monitors and manages environmental risks arising from its operations including:*
  - *Undertakes studies to ensure that no rare or endangered flora or fauna are impacted by its activities*
  - *Minimises impacts of its activities on the surrounding area*
  - *Rehabilitates disturbed areas so the impacts are temporary.*
- *Seeks continuous performance improvement in environmental management, production processes, waste management and the use of resources.*
- *Communicates regularly with employees about its aim and about the responsibilities of individuals.*
- *An integral process through all phases of Shree's mining and exploration activities is the assessment and control of environmental impacts. Extensive use is made of specialist consultants to ensure we have access to the best possible information on managing environmental aspects across our projects.*

13. Economic and social matters

Guideline requirements for this section

In deciding whether or not to approve the proposed action, the Minister must consider economic and social matters. The draft environmental impact statement must include information on:

a) *employment opportunities expected to be generated by the project (including construction and operational phases)*
b) *the projected economic value of the proposed action at the regional, state and national levels*
c) *any consultation undertaken in relation to the proposed action, including:*
   i. *consultation that has already taken place*
   ii. *proposed consultation*
   iii. *if there has been consultation on the proposed action, any documented response to, or result of, the consultation*
d) *identification of potentially affected parties, including a discussion of any communities that may be affected and a discussion of their views.*

The project is expected to provide significant economic and social benefits at the local and regional scale.

13.1 Employment opportunities

Construction employment

Mine construction will largely be undertaken by mine employees, with support by contractors as necessary. Approximately 15 to 20 employees are anticipated.

Operational employment

Contractors will be responsible for in-pit operations and will provide all the equipment and personnel for the in-pit mining and transport activities. The processing operations will be staffed by Shree personnel. Approximately 20 to 30 employees are anticipated on site.

It is anticipated that the proposal will provide jobs for the next 10 years, with a potential future increase in the workforce if throughput rates are increased or alternative onsite mining areas are developed.

It is anticipated that the proposed mining operation will support an estimated 65 direct and indirect jobs.

13.2 Projected economic value

The project is expected to provide significant economic and social benefits at the local, regional and State levels.

Recently updated economic modelling estimates that at full operating capacity the project would:

- Employ 125 full time employees (by the company & /or through contractors) with many more employed indirectly because of flow-on effects.
- Result in a business turnover of approximately $70 to $88 million per annum for a total of approximately $1.5 billion over the Project life.

The construction of the processing plant and infrastructure will cost approximately $15 M and $5 M respectively. It is expected that construction will be undertaken by a local contractor(s), thereby benefiting the local community.

North western Tasmania has a diverse range of wealth generating industries, including agricultural production and processing, forestry and forest processing, mining, specialized manufacturing and nature and culture based tourism. Despite this, the prosperity of the region is lower than the national average. The recent closure of several important manufacturing facilities has further reduced the resilience of the economy of this area.

Economic analyses have concluded that north western Tasmania:

- Has latent economic productive capacity which is currently undeveloped
- Is characterized by a level of productivity well below the national average
- Has the potential to further diversify and deepen Tasmania's economic capability and performance
- Could build on its existing contribution to foster Tasmania's competitive advantage

This development will assist the region to progress towards a more resilient future as a key component of regional Australia, with improved social equity and quality of life within its community.

13.3 Consultation

Shree Minerals Limited is committed to an open and constructive dialogue with key stakeholders and interested parties. Consultations with the following organisations / groups / persons have occurred:

- Circular Head Council (September 2010; February 2011)
- Forestry Tasmania (March 2011)
- Minister for Mines (September 2010, April 2011)
- Mineral Resources Tasmania (September 2010, March 2011)
- Relevant local politicians (September 2010; February 2011, April 2011)
- Tarkine Coalition (February 2011, April 2011, May 2011)
- Tasports, Tasrail (August 2010, April 2011)
- Potential transport operators (August 2010)
- Potential mining and construction contractors (August, September 2010)
- Arthur-Pieman Conservation Area Consultative Committee (June 2011).

In addition, the Aboriginal Heritage investigation team has worked closely with the Tasmanian Aboriginal community by liaising with the Tasmanian State Government Aboriginal Heritage Office (Aboriginal Heritage Tasmania) and undertaking consultation with relevant Aboriginal communities regarding the current investigations. Management of these investigations has been undertaken in accordance with the Tasmanian *Aboriginal Relics Act 1975*, and in consultation with the Aboriginal community.

13.4 Potentially affected parties

This section relates to parties who could be affected by the proposal. It is not intended to cover commercial interests (eg. transport companies) or interested stakeholders (eg. community organisations).

There are no directly affected third parties.

There will be an indirect affect on other users of the road network through the increased traffic volumes due to product transport.

14. Information sources

Guideline requirements for this section

With respect to any information it contains, the draft environmental impact statement must state:

a) the source of the information
b) how recent the information is
c) how the reliability of the information was tested
d) what uncertainties (if any) are in the information
e) the qualifications and experience of the study team and any specialist consultants
f) the parts of the environmental impact statement each individual was responsible for, or had input into.

14.1 Sources

Key information sources include:

CHMA (December 2010) *An Aboriginal Cultural Heritage Assessment of the Proposed Nelson Bay River Magnetite Mine Development, North-West Tasmania* (not attached due to cultural sensitivities about locations of Aboriginal sites but is available to the Department on request).

Cromer, W. C. (2011) *Hydrogeological report, Proposed Nelson Bay River Magnetite Mine.* Unpublished report for Shree Minerals Ltd. by William C. Cromer Pty Ltd. (Appendix C)

Kanunnah P/L (June 2011) *Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River*. Report prepared for Pitt & Sherry. (Appendix O)

North Barker Ecosystem Services (2010) *Nelson River – Shree Minerals Mine & Infrastructure Proposal: Flora and Fauna Habitat Assessment*. Report prepared for Shree Minerals. (Appendix N).

Pitt & Sherry (July 2011) *Nelson Bay River Proposed Magnetite/Hematite Mine Traffic Impact Assessment*. Report prepared for Shree Minerals. (Appendix M).

Department of Infrastructure, Energy & Resources (2010) Roadkill and headlight observations on regional roads. Data collected by Wildspot Consulting between October 2009 and April 2010; mapping undertaken by Northbarker Ecosystem Services. Information provided courtesy of the Department of Infrastructure, Energy & Resources. (Appendix P).

Other sources are as cited in the text.

14.2 Recency of information

Assessment of the flora, fauna habitat and Aboriginal cultural heritage is based on studies specifically commissioned for this project. These have included:

- A preliminary flora and fauna habitat assessment and constraints analysis undertaken in August 2008 by Philip Milner Landscape Consultant Pty Ltd.
- A targeted flora and fauna habitat assessment of the proposed mine and associated infrastructure areas, undertaken by North Barker Ecosystem Services between the 16th and the 24th of November, 2010.
- A helicopter-based survey of potential eagle nest sites undertaken by North Barker Ecosystem Services in March 2011.

- An Aboriginal cultural heritage survey of the proposed mine and associated infrastructure areas, undertaken by Cultural Heritage Management Australia between the 16th and 18th November, 2010.
- A survey for *Astacopsis gouldi* was undertaken in June 2011 by Todd Walsh of Kanunnah PL.
- Roadkill and headlight surveys of regional roads were undertaken between October 2009 and April 2010.

14.3 Reliability of information

[NOTE: this is a duplication of section 6.6.1.]

Information Sources

- Information sources used consist of public information and the results of surveys commissioned for this particular project.
- The sources of the information are shown in the relevant sections of this EIS.

Information Dates

- The dates of preparation/publication of the information sources are noted in the references.

Reliability of the Information

- The environmental investigations have been managed by pitt&sherry under their ISO9001 Quality System and their ISO14001 Environmental Management System.
- Both the flora and fauna habitat assessment and the Aboriginal heritage survey have been undertaken by highly experienced consultants in consultation with the relevant authorities and in accordance with accepted practice.

Uncertainties

Field surveys and investigations by their nature have inherent uncertainties. For example, flora and fauna surveys are undertaken over a period of a few days and water sampling is undertaken at discrete locations and discrete times. Surveys and investigations cannot hope to be absolutely comprehensive and free of uncertainties.

Reduction of Uncertainties

Notwithstanding the inherent uncertainties of field surveys and investigations, the timing and location of surveys and sampling can and was selected to best identify potential risks to environmental values, particularly threatened species and sensitive ecological communities. The surveys and sampling therefore provide a level of certainty sufficient to make a reasoned, evidence based determination on the potential impacts on Matters of national Environmental Significance with high confidence.

14.4 Study team qualifications and experience

Key members of the study team are provided in Table 36.

14.5 Individual responsibilities for input

These are described above in Table 36.

Table 36: Study team

Person	Company	Role	Qualifications & Experience	Input responsibilities
Sanjay Loyalka	Shree Minerals	Project Manager	CEO and Director of Shree Minerals, financial manager	Authorisation of EIS
Mahendra Pal	Saigeocon	Project Advisor	Director of Shree Minerals, consulting geologist	Review of EIS
Robert Reid	Consultant	Geological surveys	Consulting geologist	Geological interpretation, rock sampling
Simon Tear	Hellman & Schofield	PAF estimation	Consulting geologist	Geological interpretation, block modelling
Alwyn Hyde-Page	Minserve	Mine design	Consulting mining engineer	Mine layout and pit and dump design
Paul Stewart	Minserve	Mine design	Consulting mining engineer	Mine layout and pit and dump design
Matthew Behre	SGS Mineral Services	Waste rock analysis	Metallurgist	Acid accounting laboratory analysis of waste rock samples
Jerome Conway-Mortimer	SGS Mineral Services	Waste rock analysis	Metallurgist	Acid accounting laboratory analysis of waste rock samples
Dr Ian Woodward	Pitt & Sherry	EIS author	Consulting environmental scientist	Preparation of EIS
Dr Michael Pollington	Pitt & Sherry	EIS author	Consulting environmental scientist	Preparation of EIS
Jim Lockley	Pitt & Sherry	EIS advisor	Consulting environmental scientist	Preparation of EIS
Charlie Livesey	Pitt & Sherry	EIS author	Consulting environmental scientist	Preparation of EIS
Doug Tangney	Pitt & Sherry	Water sampling	Consulting environmental scientist	Surface and groundwater sampling
Michael Walsh	Pitt & Sherry	GIS mapping	GIS	Map preparation
Dr Philip Barker	NorthBarker	Flora and fauna surveys	Consulting biologist	Flora and fauna survey
Karen Zeigler	NorthBarker	Flora and fauna surveys	Consulting biologist	Flora and fauna survey
Stuart Huys	CHMA	Aboriginal heritage	Consulting archaeologist	Aboriginal heritage survey
Bill Cromer	W.C. Cromer & Ass	Hydrogeology	Consulting hydrogeologist	Conceptual hydrogeological model
Todd Walsh	Kannunah	Astacopsis survey	Consulting biologist	*Astacopsis gouldi* survey
Nick Mooney	Consultant	Wildlife advice	Consulting biologist	Advice to Pitt & Sherry on quoll and devil impact mitigation
Mark Wapstra	ECOTas	Flora advice	Consulting biologist	Flora and fauna impact advice

Appendix A

Conceptual mine layouts showing staging

DSO mining (year 1)
Mid-mine life (year 5)
End of mine (year 10)
10 years after closure

Appendix B

Conceptual mine pit cross-sections

Appendix C

Conceptual processing plant design

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Appendix D

Hydrogeological report

Appendix E

Preliminary flowsheet for high grade hematite

Appendix F

Preliminary flowsheet for low grade hematite

Appendix G

Preliminary processing flowsheet for magnetite

Appendix H

Water management staging

Appendix I

Waste rock accounting analytical results

Appendix J

K-NAG test interpretive report

Appendix K

Pit section potential acid forming (PAF) zones

Appendix L

PAF waste rock estimation

Appendix M

Traffic impact assessment report

Appendix N

Flora and fauna assessment report

Appendix O

Giant freshwater crayfish report

Appendix P

Roadkill and headlight survey data

Appendix Q

Contribution to orchid biology research program

transport infrastructure | community infrastructure | industrial infrastructure | climate change

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