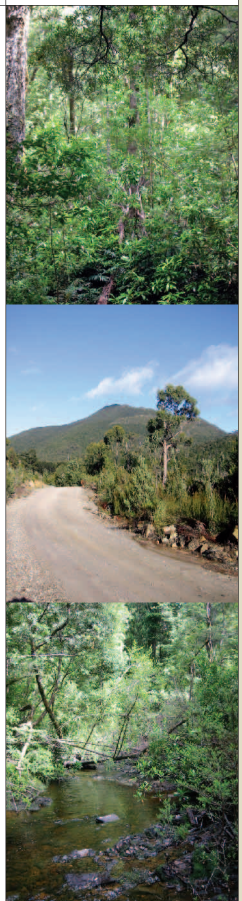
Allegiance Mining N.L.



Avebury Nickel Project

Stage 1
Viking Decline Development

Development Proposal
and
Environmental Management Plan
(DPEMP)

June 2003

NSR Environmental Consultants Pty Ltd

Allegiance Mining NL

Avebury Nickel Project
Stage 1
Viking Decline Development

Development Proposal and Environmental Management Plan

June 2003
CR 938_2_v3

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Frontispiece

This Development Proposal and Environmental Management Plan (DPEMP) describes the proposed development and environmental management practices for Stage 1 of the Avebury Nickel Project. The DPEMP contributes significantly to the basis by which the Board of Environmental Management and Pollution Control (‘the Board’) can conduct an environmental impact assessment under the *Environmental Management and Pollution Control Act 1994* (EMPCA), and assess the application for a land use permit by Allegiance Mining NL (Allegiance).

Preparation of the DPEMP has been undertaken in accordance with guidelines prepared by the Department of Primary Industries Water and Environment (DPIWE) and issued on 17 March 2003 (Appendix 1). These guidelines have been prepared in consultation with Allegiance (and its consultants) and relevant state government departments.

A land use permit is required from the West Coast Council for the project and the DPEMP provides supporting information for this application.

This document also fulfils the role of providing information on the proposed activity to other decision-making authorities and the public, who have the opportunity to make submissions on the proposal under Section 57 of the *Land Use Planning and Approvals Act 1993* (LUPAA). The land use permit application and DPEMP will be placed on public display and submissions may be lodged with the West Coast Council, as specified, under and in accordance with Section 57 of the LUPAA within 28 days of advertisements being placed in local newspapers.

In accordance with Section 25 of the EMPCA, the council will refer the application to the Board for assessment under that act and will provide to the Board copies of representations they receive pursuant to the advertisements.

The Board will undertake its assessment in accordance with Section 74 of the EMPCA, and will notify the council of any condition or restriction which must be included in any permit granted by council, or direct council to refuse to grant the permit.

Once the Board has issued directions to the planning authority, i.e., the council, and decisions concerning the issue of the land use permit have been made, advertised in local newspapers and notices given as required (within seven days of making the decision) under the LUPAA, parties who had previously lodged a submission have 14 days in which to lodge an appeal to the Resource Management and Planning Appeal Tribunal against the decision.

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Executive Summary

1. Introduction

The purpose of this Development Proposal and Environmental Management Plan (DPEMP) is to describe the proposed Stage 1 development of the Avebury Nickel Project (Figure 1.1) by Allegiance Mining NL (Allegiance), and to support an application for a land use permit under the *Land Use Planning and Approvals Act 1993*.

The DPEMP has been prepared in accordance with guidelines recommended by the Department of Primary Industries Water and Environment (DPIWE), taking into account the requirements of the *Environmental Management and Pollution Control Act 1994*.

2. Project Outline

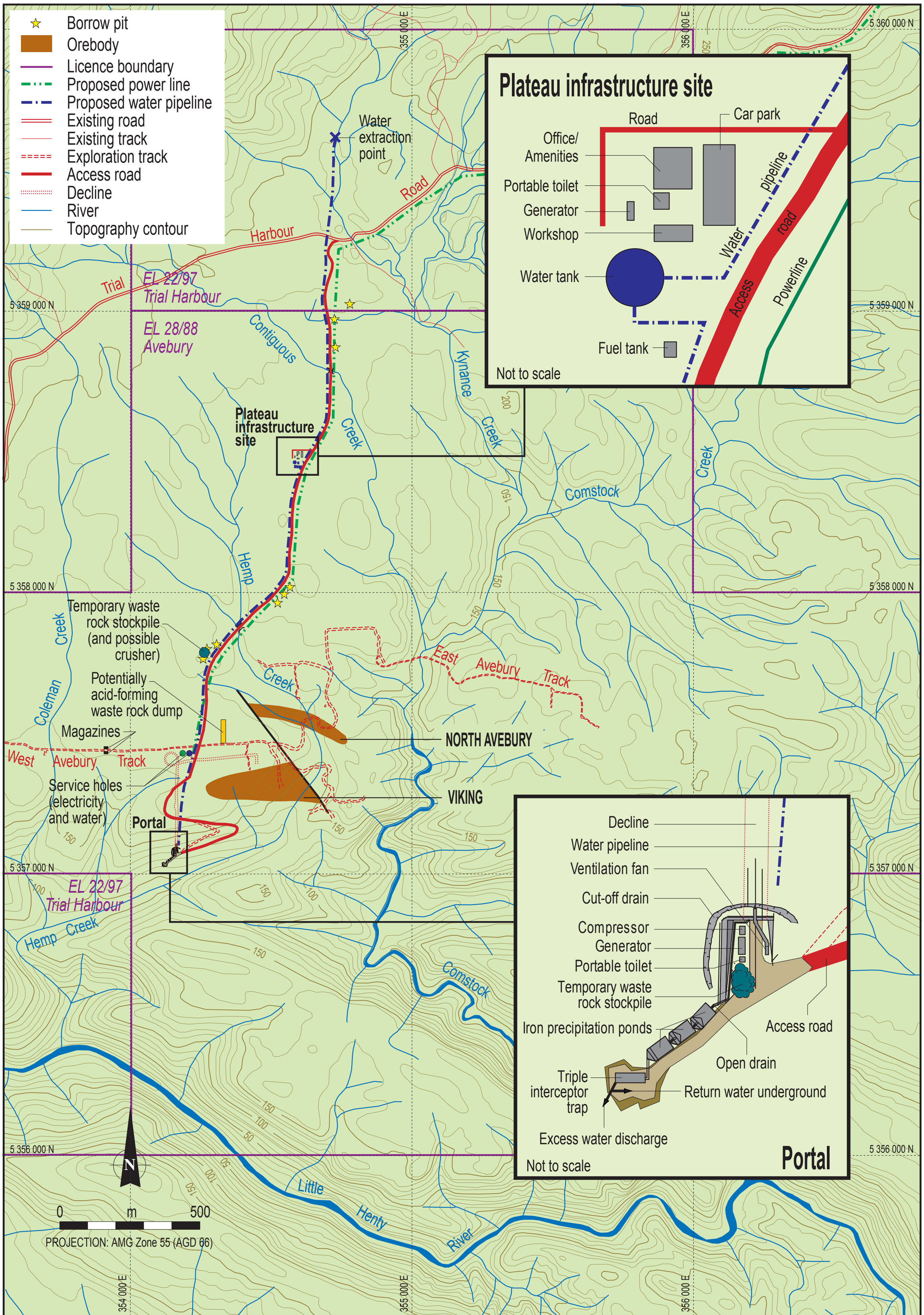
A staged approach to project development at Avebury is proposed. This DPEMP addresses Stage 1 (the first of three stages) of the Avebury Nickel Project and includes (Figure 2.1):

- Upgrading the access track that runs south from Trial Harbour Road to the on-site facilities and then further south to the decline portal.
- Development of a decline into the upper section of the Avebury deposit where high nickel grades are indicated. This will allow Allegiance to conduct:
  - Detailed resource and reserve[1] definition drilling.
  - In situ examination of the mineralisation.
  - Bulk sampling of the mineralisation for metallurgical test work.
  - Geotechnical studies to optimise the mine design.
- Establishment of on-site supporting and ancillary infrastructure and services.

Stage 1 of the Avebury Nickel Project is essentially an extension of exploration, i.e., there will be no production of ore, and will involve mining 100,000 t of development waste for construction of the decline and approximately 150 t for bulk sampling of the mineralisation.

[1] A resource estimate is based on geoscientific information only, whereas a reserve must consider those factors affecting extraction, including mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors, and should in most instances be estimated with input from a range of disciplines.

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Avebury Nickel Project location	Figure No: 1.1
	File No: 938_2_ES_F1.01_HB	Avebury Nickel Project		



NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Project general arrangement	Figure No: 2.1
	File No: 938_2_ES_F2.01_HB	Avebury Nickel Project		

Development of the three principal components associated with Stage 1 will take nine months, commencing in October 2003. Stage 1 development will be a 24-hour, 7-day per week operation and will involve approximately 25 full-time jobs, and cost approximately $7.5 million.

Based on the geotechnical studies and metallurgical testwork resulting from Stage 1, a decision to go to full-scale production would see the project enter stages 2 and 3 of development. Separate, stand-alone DPEMPs will be prepared for each of these stages.

3. Summary of DPEMP Investigations

Studies and investigations commissioned to assist in the design of the project and assess potential impacts in the DPEMP are provided in Table 3.1.

Table 3.1 DPEMP studies and investigations

Topic	Author	Appendix to the DPEMP Main Report
Flora and fauna	NSR	3
Water quality characterisation	NSR	4
Socio-economic	NSR	5
Aboriginal cultural heritage resources	Steve Stanton	6
Historic heritage	Ian Terry	7
Geochemical characterisation	Environmental Geochemistry International (EGi) Pty Ltd	8

4. Project Setting and Issues

4.1 Environmental Setting

The Avebury Nickel Project study area is accessed via the Trial Harbour Road and is situated about 8 km west of Zeehan on Tasmania's west coast (see Figure 1.1). The nearest townships are Trial Harbour to the west and Zeehan.

The project is located in a landscape of undulating to steeply-forested land incised by a series of subparallel, south-trending tributaries of the Little Henty River, which include Hemp, Kynance, Comstock and Contiguous creeks.

Zeehan and the surrounding area were established through the development of logging and mining activity. Current land uses comprise mineral exploration and mining, general nature conservation, forestry, fishing, and off-road vehicle driving, particularly on the dunes along the coast.

Vegetation of the project area can generally be described as comprising predominantly rainforest communities and mixed forest (as the rainforest degrades to wet sclerophyll communities) or a combination of both. These vegetation communities provide four broad fauna habitat types:

- Temperate rainforest.
- Buttongrass plains.
- Shrubby eucalypt forest.
- Tea-tree and paperbark wet scrub.

Characterisation of surface and ground water samples indicate that:

- Hemp Creek is typical of undisturbed upland streams in Tasmania.

- Acid rock drainage (ARD) is occurring in the catchment of Comstock Creek, as has previously been documented by DPIWE, and elsewhere in the catchment of Little Henty River. This is reflected in the observed degraded water quality in both Comstock Creek and Little Henty River.

- Groundwater from the proposed decline portal area is alkaline and generally contains low dissolved metal concentrations (with the exception of iron and, to a lesser extent, manganese).

4.2 Social Setting

Until recently, Tasmania was the only Australian state or territory undergoing population decline. Similarly, the population of Zeehan has also been declining.

The mining industry in Tasmania is a major source of wealth within the state and the township of Zeehan, in particular, is reliant on the mining industry for its survival. There are three major operational mines in the area, namely the Henty Gold Mine, Mt Lyell Copper Mine and Renison Tin Mine.

Zeehan is relatively self-sufficient in terms of day-to-day services (including utilities) and facilities. However, due to improved transport infrastructure, west coast residents tend to travel to Burnie or Launceston for regular shopping trips and to access specialist health, education and financial services.

Trial Harbour is a small coastal settlement that accommodates holiday makers and retirees. It has no commercial services or facilities.

4.3 Potential Issues

The potential environmental and social issues resulting from Stage 1 of the project include:

- Possible effects on protected environmental values (PEVs) associated with local watercourses, particularly in relation to the protection of modified aquatic ecosystems and recreational water quality and aesthetics, due to:

  - Off-site discharge of runoff.
  - Generation of development waste and the potential for ARD.
  - Management and off-site discharge of groundwater.

- Health and amenity effects on local communities due to:
  - Generation of dust, gaseous emissions, noise and ground vibration.
  - Traffic along Trial Harbour Road.
- Loss of biodiversity conservation due to:
  - Vegetation clearing and disturbance of land.
  - Associated impacts to significant fauna species.
- Economic benefits in terms of employment, requirements for goods and services and taxes.

Other issues include hydrocarbon management, fire control, general waste management and weed and pathogen management.

5. Impacts

5.1 Terrestrial Impacts

The development of Stage 1 of the Avebury Nickel Project will require approximately 12 ha of land. The siting of the majority of project facilities within mixed forest (i.e., rainforest degrading to wet sclerophyll forest) and existing areas of disturbance (e.g., utilising exploration tracks) will minimise disturbance to areas of rainforest and the subsequent loss of vegetation and habitat.

The proposed access road is the project component that has the largest land requirement (9.6 ha, including 1.5 ha for overtaking bays), of which 2.9 ha is within rainforest. In the regional context, this represents a minor vegetation loss. Roadside vegetation management will ensure that barrier and habitat fragmentation impacts will be minimised.

The Avebury Nickel Project is unlikely to impact on state and national threatened fauna species for a number of reasons, including the fact that the area affected is a small portion of a large area of surrounding habitat.

5.2 Stream Impacts

Allegiance's design and management measures are specifically aimed at minimising and mitigating off-site releases of contaminated water. In addition, a variety of erosion and sediment controls are proposed for the Avebury Nickel Project to mitigate the effects of turbid runoff from the site on the downstream drainage. Predictions of impacts on the aquatic environment are generally difficult to quantify accurately, particularly with respect to suspended solids and/or sedimentation caused by erosion. Therefore, greater emphasis will be placed on monitoring, with Allegiance establishing a comprehensive monitoring program of surface waters that may be affected by the project.

Physical Impacts

While water abstraction represents <1% of the flow in Kynance Creek during low-flow conditions, the maximum discharge of treated mine water will represent 63% of low-flow in Hemp Creek. Water abstraction will not impact on the PEVs of Kynance and Comstock creeks; however, there may be some temporary, minor impacts on aquatic ecosystems in Hemp Creek associated with the variation of flow as a result of mine water discharges. Biological monitoring will be implemented to determine if additional mitigation measures are required.

No adverse physical impacts on PEVs are expected to occur in the Little Henty River.

Water Quality Impacts

The major source of fugitive sediment will arise from construction of the access road and portal. This may result in localised sedimentation in the creeks, particularly at road crossings. Following the initial construction of the access road and portal, there will be a smaller but intermittent source of sediment in runoff from the road, particularly at creek crossings, during high rainfall. At these times it is expected that there will be naturally elevated total suspended solids concentrations in the receiving streams, therefore minimising the impacts to the PEVs of Contiguous and Hemp creeks.

The primary point source of potential water quality contaminants will be discharges of excess mine water from the water treatment facility. Prior to discharge, iron, oil, grease and sediment will be removed so that there will be minimal, if any, temporary impacts to receiving waters.

Potentially acid-forming waste rock is estimated to represent only 3% of the total waste rock generated during Stage 1 and will be placed in a below-surface dump and encapsulated with compacted, low-permeability clay. Therefore, there is a low risk that acid rock drainage will occur. Runoff from the cover of the dump will be minimal, controlled, i.e., dispersed into surrounding standing vegetation, and monitored so that, in the unlikely event that acid rock drainage does occur, additional mitigation and management measures will be implemented.

No adverse water quality impacts on PEVs are expected to occur in the Little Henty River.

Summary

The Avebury Nickel Project is located in a degraded environment. The creeks within the project area, Contiguous, Kynance, Hemp and Comstock, are tributaries of the Little Henty River, the catchment of which drains historical mining areas around Zeehan. In particular, Comstock Creek is severely modified by upstream mining and forestry activities. Stage 1 of the project can best be described as advanced exploration, with minor discharges. Therefore, while localised but minor impacts to Contiguous, Kynance and Hemp creeks are predicted to occur, these will be negligible in Comstock Creek and, ultimately, the Little Henty River (which also suffers from degraded water quality).

5.3 Socio-economic Impacts

General

During Stage 1 of the Avebury Nickel Project there will be opportunities for full-time employment and the provision of goods and supporting services to the project. The resulting cash injections into the local community will also help to further boost and strengthen the economic viability of existing businesses.

The proposed development at Avebury (and the Heemskirk Wind Farm) will broaden the commercial base supporting Zeehan and diminish the town's high vulnerability to global economic factors.

Monetary benefits will also flow to the Tasmanian and federal governments in the form of taxes such as company, income and pay-roll tax. Should the project proceed to production in stages 2 and 3, royalties will also be paid to the Tasmanian Government.

An increase in local traffic will be noticeable at the start and conclusion of Stage 1 development when machinery is transported to the site (mobilisation) and then from the site (demobilisation). Ongoing traffic associated with Stage 1 of the project will be limited to light vehicles and supply trucks travelling to the project site during daylight hours. The increase in vehicle movements will be minimal compared with current traffic in and around Zeehan and will not be distinguishable from existing every-day traffic in the area.

Aboriginal and Non-Aboriginal Cultural Impacts

No Aboriginal or non-Aboriginal cultural heritage sites have been recorded in the study area and TASI-listed cultural heritage sites occurring outside the study area will not be impacted.

5.4 Other Impacts

Air Quality Impacts

The impacts from dust generation and exhaust emissions from construction machinery, equipment and vehicles are predicted to be minor in nature, localised and temporary.

Noise and Blasting Impacts

The effects of ground vibration and blasting pressure will be localised and will not be experienced by the local communities. Taking into account the site's location relative to local communities and the intervening topography, the project will not cause any significant noise impacts with respect to the local communities.

Visual Amenity Impacts

The location of the Avebury Nickel Project is such that surrounding vegetation largely screens the construction activities, most of the access road, surface infrastructure and the portal from surrounding areas. The impacts will therefore be both minor and temporary in terms of loss of visual amenity from publicly accessible vantage points. There will be no interruption to views of significant features, such as Mt. Zeehan or Mt. Heemskirk, from Trial Harbour Road.

6. Environmental Management and Monitoring

Environmental management measures will be adopted by Allegiance through the implementation of the following management plans:

- Water Management Plan.
- Air Quality Management Plan.
- Mine Waste Management Plan.
- Solid Waste Management Plan.
- Hazardous Materials Management Plan.
- Emergency Response Management Plan.
- Flora and Fauna Management Plan.
- Weed and Pathogen Management Plan.
- Archaeology and Heritage Management Plan.
- Visual Amenity and Landscape Management Plan.
- Social Management Plan.
- Fire Management Plan.
- Mine Closure and Rehabilitation Plan.

The management plans will be supported by the environmental and social monitoring program, the primary objectives of which are to:

- Further establish background conditions.

- Provide information that will determine the adequacy of environmental and, where relevant, social management practices and allow improved practices and procedures to be developed.

- Detect and measure trends or environmental/social changes, and enable analysis of their causes.

- Confirm environmental and social impacts of particular activities (as described in Chapter 4 of the DPEMP) and identify unforeseen effects and the need for additional remedial measures.

1. Introduction

1.1 Allegiance Mining NL

This Development Proposal and Environmental Management Plan (DPEMP) has been prepared by NSR Environmental Consultants (NSR) on behalf of Allegiance Mining NL (Allegiance), who wishes to develop the Avebury Nickel Project (Figure 1.1). Allegiance is a junior Australian minerals exploration company, and is publicly listed on the Australian Stock Exchange (ASX).

Allegiance has a registered office located in Sydney and can be contacted as follows:

Level 11, 49-51 York Street
SYDNEY NSW 2000
Telephone: 02 9299 1771
Facsimile: 02 9299 1817
Website: www.allegiance-mining.com.au
Email: mining@allegiance-mining.com.au

To date, the focus of the company has been on the Avebury nickel sulfide deposits of North Avebury and Viking. Further nickel sulfide deposits, i.e., Avebury East and Melba Flats, have been found close by and within the Allegiance exploration licence areas (Figure 1.2). The commercial success of the Avebury deposits will assist to determine whether these additional deposits are explored further and are economically viable to pursue.

1.2 Scope

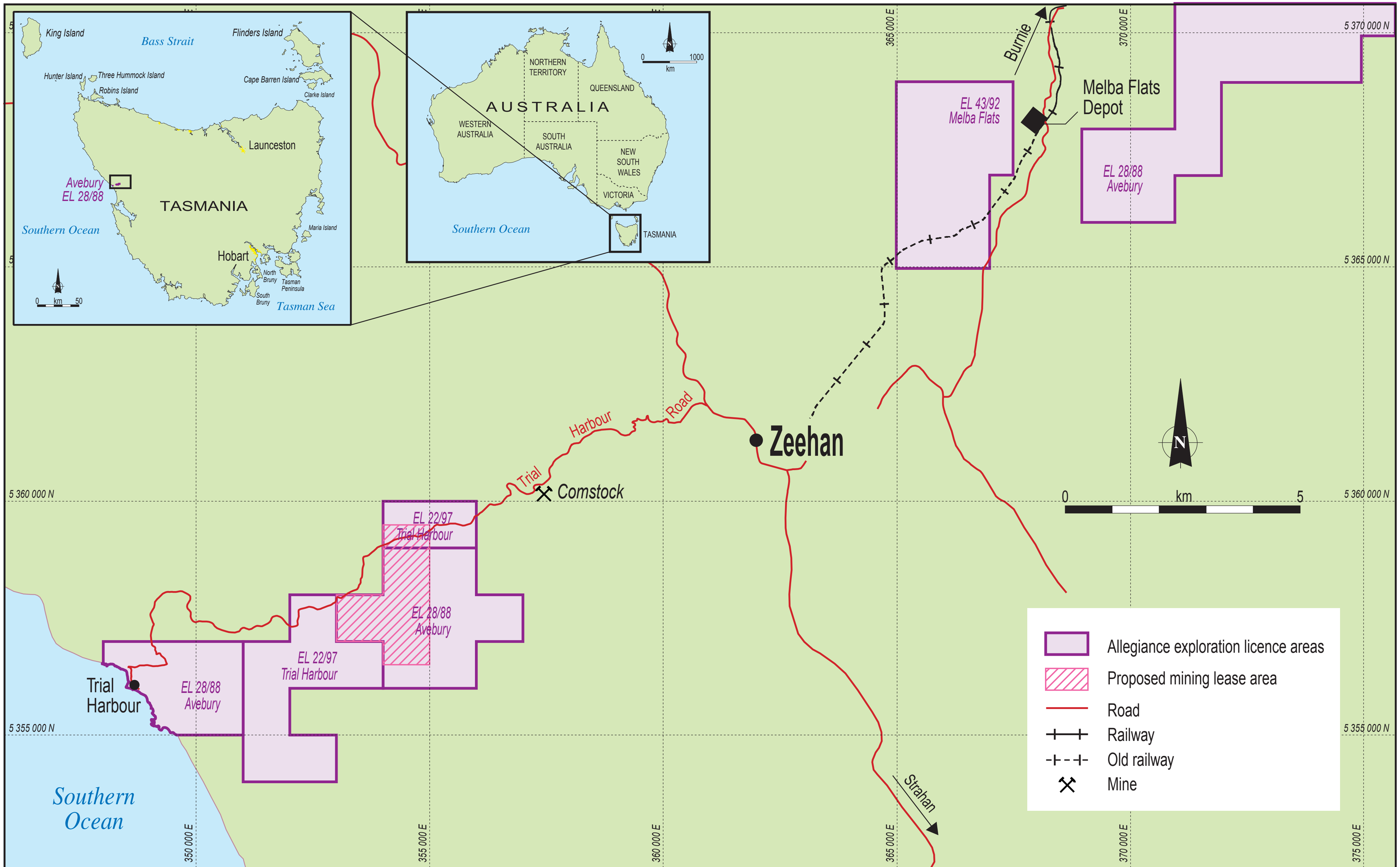
1.2.1 Stage 1

A staged approach to project development at Avebury is proposed. This DPEMP addresses Stage 1 (the first of three stages) of the Avebury Nickel Project which is scheduled to commence in October 2003 and includes:

- Upgrading the access track that runs south from Trial Harbour Road to the on-site facilities and then further south to the decline portal (Figure 1.3).
- Development of a decline into the upper section of the Avebury deposit (see Figure 1.3) where high nickel grades are indicated. The decline will allow Allegiance to conduct detailed resource and reserve[1] definition drilling, in situ

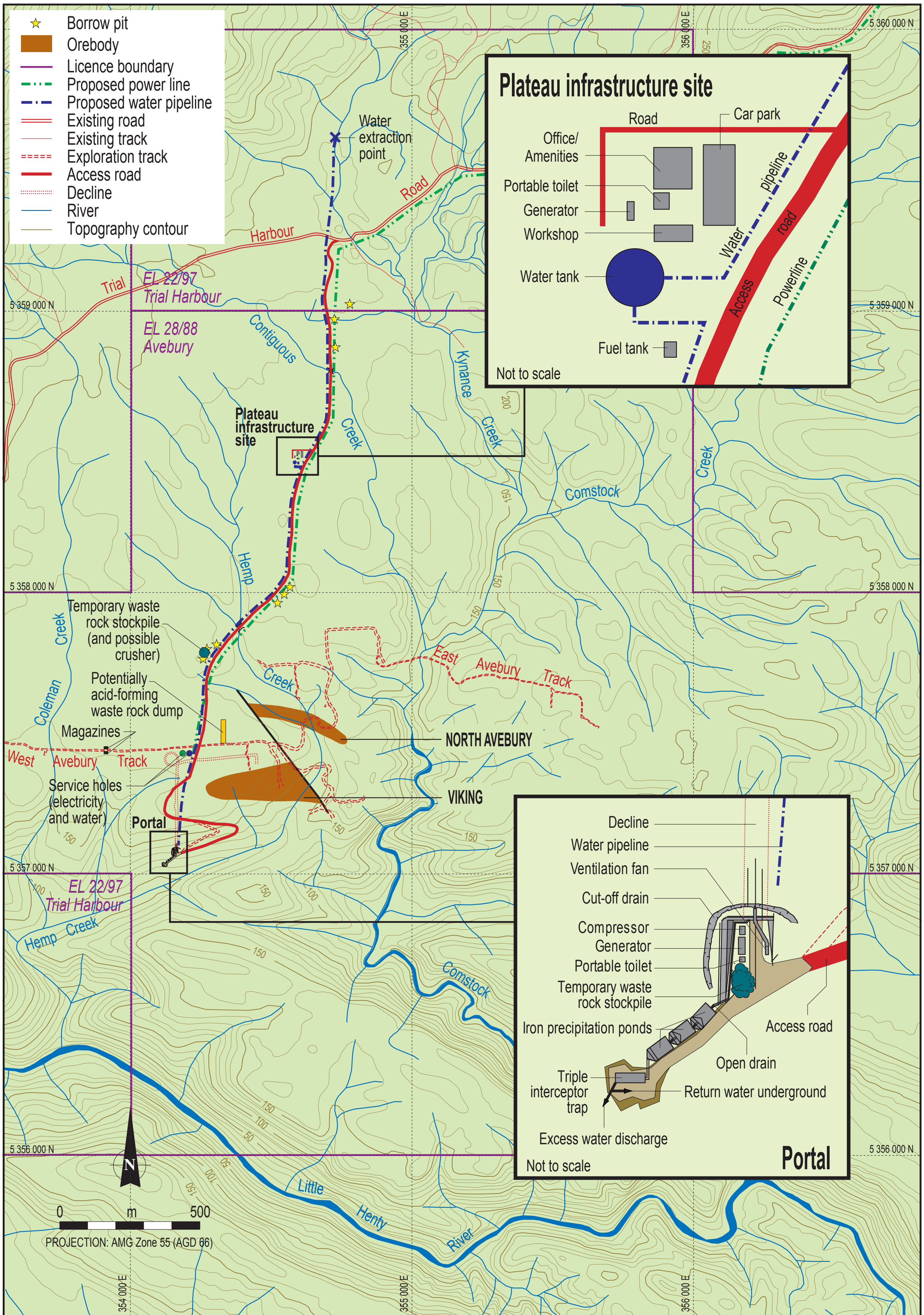
[1] A resource estimate is based on geoscientific information only, whereas a reserve must consider those factors affecting extraction, including mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors, and should in most instances be estimated with input from a range of disciplines (JORC, 1999).

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Avebury Nickel Project location	Figure No: 1.1
	File No: 938_2_F1.01_HB	Avebury Nickel Project		



NSR Environmental Consultants Pty Ltd

Job No:	938	Allegiance Mining NL	Allegiance exploration licence areas	Figure No: 1.2
File No:	938_2_F1.02_HB	Avebury Nickel Project		



NSR Environmental Consultants Pty Ltd

Job No: 938	Allegiance Mining NL	Project general arrangement	Figure No: 1.3
File No: 938_2_F1.03_HB	Avebury Nickel Project		

examination of the mineralisation, bulk sampling of the mineralisation for metallurgical test work, and geotechnical studies to optimise the mine design.

- Establishment of on-site supporting and ancillary infrastructure and services including electricity, water supply, workshop, office, ablutions, magazine, crib-room and diesel storage areas (see Figure 1.3).

The following chapters provide a description of the environment in which the project is situated, existing exploration activities, the proposed Stage 1 development, environmental and socio-economic impacts, and mitigation and management strategies to be implemented by Allegiance.

1.2.2 Stages 2 and 3

Based on the geotechnical studies and metallurgical testwork resulting from Stage 1, a decision to go to full-scale production would see the project enter Stage 2 of development. This would involve extraction of 300,000 tonnes per year (t/yr) of material from the underground mine and trucking the resource to an existing off-site facility for processing over a two-year period (from March 2004).

Stage 3 would see an increase in mining activity, resulting in the extraction of about 500,000 t/yr. Stage 3 would involve constructing a crusher and mill on-site, together with a tailing storage facility, thereby eliminating the need to transport ore off-site for processing. Construction for Stage 3 would commence in 2006 and will be scheduled to ensure continuity of production. On-site processing of ore is envisaged to continue for a minimum of six years beyond 2006.

Separate, stand-alone DPEMPs will be prepared for Stage 2 and Stage 3 of the project.

1.3 Historical Background

Allegiance holds several exploration licences in the Zeehan area (see Figure 1.2).

Between 1991 and 1997, the area was actively explored, primarily for zinc deposits, by CRA under a joint venture agreement between Allegiance and CRA Exploration Pty Limited (CRAE). Following a corporate re-organisation in 1997, in which CRAE was absorbed into Rio Tinto Exploration Pty Limited, management of the project was passed to Allegiance.

Since 1997, Allegiance has re-focused its exploration strategy in the area on the search for commercial nickel sulfide deposits and spent approximately $5 million. Exploration has concentrated on the Avebury East, Melba Flats and, in particular, the Avebury prospect, which is covered by Exploration Licence (EL) 28/88 (see Figure 1.2).

Currently, Allegiance has a 100% interest in the project but is required to pay Rio Tinto a 2% net smelter royalty on any metalliferous production from future mining operations within EL 28/88.

Once the decline has been developed, Allegiance will undertake additional detailed resource and reserve definition drilling.

1.4 Environmental Legislation

The Avebury Nickel Project requires environmental and planning approvals from the Tasmanian government in order to proceed with the licences and construction permits that will allow construction of Stage 1.

Legislation, conventions, agreements, policies and strategies relevant to the Avebury Nickel Project are summarised in Appendix 2. This section sets out the following:

- The Tasmanian approvals process (Section 1.4.1).
- Other Tasmanian legislation (Section 1.4.2).
- Commonwealth (Section 1.4.3) environmental and planning approvals and the legislation governing those processes.
- Tasmanian policies and strategies (Section 1.4.4).
- Best practice environmental management (Section 1.4.5).

1.4.1 Tasmanian Approvals

The Tasmanian environmental and planning assessment and approval process is governed by the following key legislation (Figure 1.4):

- *Land Use Planning and Approvals Act 1993* (LUPAA*).*
- *Environmental Management and Pollution Control Act 1994* (EMPCA).

The application for environmental approval is part of an application made to the local planning authority under the LUPAA. The environmental approval process centres on the environmental impact assessment (EIA) to be prepared by the Environmental Management and Pollution Control Board (Board) under sections 73 and 74 of the EMPCA.

The Director of Environmental Management formally advised Allegiance that the proposed Stage 1 development is considered a Level 2 activity in accordance with Schedule 2 of the EMPCA (17 March 2003) and, to initiate the approvals process, Allegiance is required to prepare a DPEMP. Guidelines for preparation of the DPEMP were also released by DPIWE. Studies and investigations commissioned to assist in the design of the project and assess potential impacts in the DPEMP are provided in Table 1.1.

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	**Environmental approval process**	Figure No: 1.4
	File No: 938_2_F1.04_HB	Avebury Nickel Project		

Table 1.1 DPEMP studies and investigations

Topic	Author	Appendix
Flora and fauna	NSR	3
Water quality characterisation	NSR	4
Socio-economic	NSR	5
Aboriginal cultural heritage resources	Steve Stanton	6
Historic heritage	Ian Terry	7
Geochemical characterisation	Environmental Geochemistry International (EGi) Pty Ltd	8

After submission of the planning permit application (which includes this DPEMP as supporting documentation) and its referral by the Planning Authority, i.e., the West Coast Council, to DPIWE, the DPEMP is placed on public display. DPIWE assesses the resulting public comments and, in conjunction with its own assessment of the document, prepares a report that is considered by the Board. The Board then notifies the Planning Authority of conditions that need to be incorporated in the planning permit or directs the Planning Authority to refuse to grant a permit.

1.4.2 Other Tasmanian Legislation

In addition to the legislation governing the environmental and planning process, the following list of Tasmanian legislation has been assessed in the preparation of the DPEMP, and their relevant statutory or regulatory requirements as identified in this DPEMP have been or will be observed:

- *Aboriginal Relics Act 1975*.
- *Crown Lands Act 1976*.
- *Dangerous Goods Act 1998 and Regulation*s.
- *Fire Services Act 1979*.
- *Forest Practices Act 1985*.
- *Historic Cultural Heritage Act 1995*.
- *Inland Fisheries Act 1995*.
- *Local Government (Building and Miscellaneous Provisions) Act 1993*.
- *Mineral Resources Development Act 1995*.
- *National Environment Protection Council (Tasmania) Act 1995*.
- *National Parks and Wildlife Act 1970*.
- *Threatened Species Protection Act 1995*.
- *Mineral Resources Development Act 1995*.
- *Water Management Act 1999*.
- *Weed Management Act 1999*.
- *Workplace Health and Safety Act 1995*.

Other relevant legislation, statutes and standards are listed in Appendix 2.

1.4.3 Commonwealth Approvals

Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA), in force since 16 July 2000, enables the Commonwealth to join with the states and territories to provide a national scheme of environment protection and biodiversity conservation.

The EPBCA replaced five Commonwealth statutes: *Environment Protection (Impact of Proposals) Act 1974; Endangered Species Protection Act 1992; National Parks and Wildlife Conservation Act 1975; World Heritage Properties Conservation Act 1983*; and *Whale Protection Act 1980.*

The EPBCA provides for the preparation of recovery plans for nationally threatened species and ecological communities listed under the EPBCA.

Other Commonwealth Legislation

The following additional items of Commonwealth legislation have been assessed in the preparation of the DPEMP and their relevant statutory or regulatory requirements as identified in this DPEMP have been or will be observed:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984.*
- *Australian Heritage Commission Act 1975.*
- *Crown Estates Act 1961.*
- *Native Title Act 1993.*

1.4.4 Tasmanian Policies and Strategies

State Policy on Water Quality Management 1997

This policy was prepared pursuant to the *State Policies and Projects Act 1993* and gazetted in September 1997. The objectives of this policy are to:

(a) focus water quality management on the achievement of water quality objectives which will maintain or enhance water quality and further the objectives of Tasmania's Resource Management and Planning System;

(b) ensure that diffuse source and point source pollution does not prejudice the achievement of water quality objectives and that pollutants discharged to waterways are reduced as far as is reasonable and practical by the use of best practice environmental management;

(c) ensure that efficient and effective water quality monitoring programs are carried out and that the responsibility for monitoring is shared by those who use and benefit from the resource, including polluters, who should bear an appropriate share of costs arising from their activities, water resource managers and the community;

(d) facilitate and promote integrated catchment management through the achievement of objectives (a) to (c) above; ………..

In a process managed by DPIWE and based on public consultation, the Board and the West Coast Council define protected environmental values (PEVs) and the areas to which they apply. PEVs for surface waters in the West Coast municipal area have been defined for the Little Henty River, Hemp Creek and Comstock Creek. The operation must ensure that the defined PEVs are not compromised beyond a mixing zone[1] (see also Section 2.2.4).

Given that the Comstock Zinc Mine is located upstream of the Avebury Nickel Project on Comstock Creek, Allegiance has established the current quality of receiving waters (Section 2.2.3).

Other Policies

Tasmania joined the National Environment Protection Council (NEPC) in 1995 and gazetted the *National Environment Protection Council (Tasmania) Act 1995.* This act specifies the processes to be followed to implement national environment protection measures (NEPMs). In Tasmania, once developed, a NEPM becomes a state policy. Of the six NEPMs that have been established, five are relevant to the Avebury Nickel Project and were considered in preparation of the DPEMP. They are:

- Ambient air quality.
- Assessment of site contamination.
- Diesel vehicle emissions.
- National pollutant inventory.
- Movement of controlled wastes.

DPIWE has developed a draft Environment Protection Policy (Air Quality). This policy applies to the ambient environment throughout Tasmania and is scheduled to commence in July 2003 when the Environment Protection (Atmospheric Pollution) Regulations 1974 will be rescinded.

DPIWE has also prepared a draft Environment Protection Policy (Noise). The current target date for commencement of this policy is 1 January 2004 at which time the Environment Protection (Noise) Regulation 1977 will be rescinded (Walter, pers. com., 2003).

Other relevant Tasmanian and Commonwealth policies and strategies are listed in Appendix 2.

[1] Which 'means a three dimensional area of the receiving waters around a point of discharge of pollutants within which it is recognised that the water quality objectives for the receiving waters may not be achieved' as defined in the State Policy on Water Quality Management 1997.

1.4.5 Best Practice Environmental Management (BPEM)

As far as this document is concerned, it is possible to discuss BPEM only with respect to Allegiance's development. BPEM is defined in Chapter 4 of EMPCA as follows:

> 4(1) For the purposes of this Act, the best practice environmental management of an activity is the management of the activity to achieve an ongoing minimisation of the activity's environmental harm through cost-effective measures assessed against the current international and national standards applicable to the activity.
>
> (2) In determining the best practice environmental management of an activity, regard must be had to the following measures:—
>
> (a) strategic planning by the person carrying out, or proposing to carry out, the activity;
>
> (b) administrative systems implemented by the person, including staff training;
>
> (c) public consultation carried out by the person;
>
> (d) product and process design;
>
> (e) waste prevention, treatment and disposal.
>
> (3) Subsection (2) does not limit the measures to which regard may be had in determining the best practice environmental management of an activity.

Environmental management philosophies and practices that Allegiance considers to be consistent with 'best practice' for the Avebury Nickel Project are documented in this report. These are based in part on the Australian Environment Protection Agency series of booklets 'Best Practice Environmental Management in Mining' (EPA, 1995/1996).

1.5 Environmental Policy

A corporate environmental policy has been developed by Allegiance for the Avebury Nickel Project, and reflects the company's commitment to managing its activities in an environmentally responsible manner and pursuing environmental excellence (Box 1.1).

1.6 Mineral Resource

Stage 1 of the Avebury Nickel Project is an extension of exploration and focuses on accessing the resource for further assessment; it does not involve mining the resource.

Box 1.1 Allegiance's Environmental Policy

- Ensure that employees and contractors are informed about this policy and made aware of their environmental responsibilities in relation to Allegiance's activities.
- Require all contractors to comply with Allegiance's policies.
- Comply with this policy and applicable legislation, regulations and policies and strive for best practice.
- Implement sound environmental management systems so as to minimise the effect of Allegiance's activities on the environment.
- Ensure sufficient resources are allocated to environmental management and provide relevant training and support for personnel to fulfil their environmental responsibilities.
- Keep the community informed on a regular basis of Allegiance's activities and consult with the community in relation to Allegiance's operations.
- Seek continuing improvement through monitoring, review, auditing and reporting.
- Rehabilitate areas disturbed as defined in the applicable environmental management plan.

1.6.1 Resource

Exploration and drilling to date has identified the resource estimate provided in Table 1.2.

The resource was estimated by independent consultant Michael V McKeown of McKeown Mining Pty Limited and reported in accordance with the Australasian Code for Reporting of Mineral Resources and Ore Reserves (JORC, 1999). Michael McKeown is a Fellow of the Australasian Institute of Mining and Metallurgy and meets the requirements of the JORC Code in regard to such estimates being made by a 'competent person', i.e., he has more than five years relevant experience in the estimation, assessment and valuation of mineral resources of this style of mineralisation and type of deposit.

1.6.2 Production Rates

Stage 1 of the Avebury Nickel Project will involve mining 100,000 t of development waste for construction of the decline over a nine-month period. This will provide access to the resource for mining during Stage 2 of the project.

Table 1.2 Avebury Nickel Project resource estimate December 2002

Deposit	**Resource (t)**	**Grade (% Ni)***	**Cut-off Grade (% Ni)**	**Contained Ni (t)****
Indicated Mineral Resource				
North Avebury	1,260,000	1.5	0.8	18,900
Viking	1,880,000	1.5	1.0	28,200
Sub-total	3,140,000	1.5		**47,100**
Inferred Mineral Resource				
North Avebury	200,000	1.8	0.8	3,600
Viking	720,000	1.5	1.0	10,800
Sub-total	920,000	1.6		**14,400**
Total Mineral Resource				
North Avebury	1,460,000	1.5	0.8	22,500
Viking	2,600,000	1.5	1.0	39,500
Total	**4,060,000**	**1.5**		**61,500**

* Assays are rounded to the nearest decimal place.
** Arithmetic discrepancies due to rounding of Ni grade.

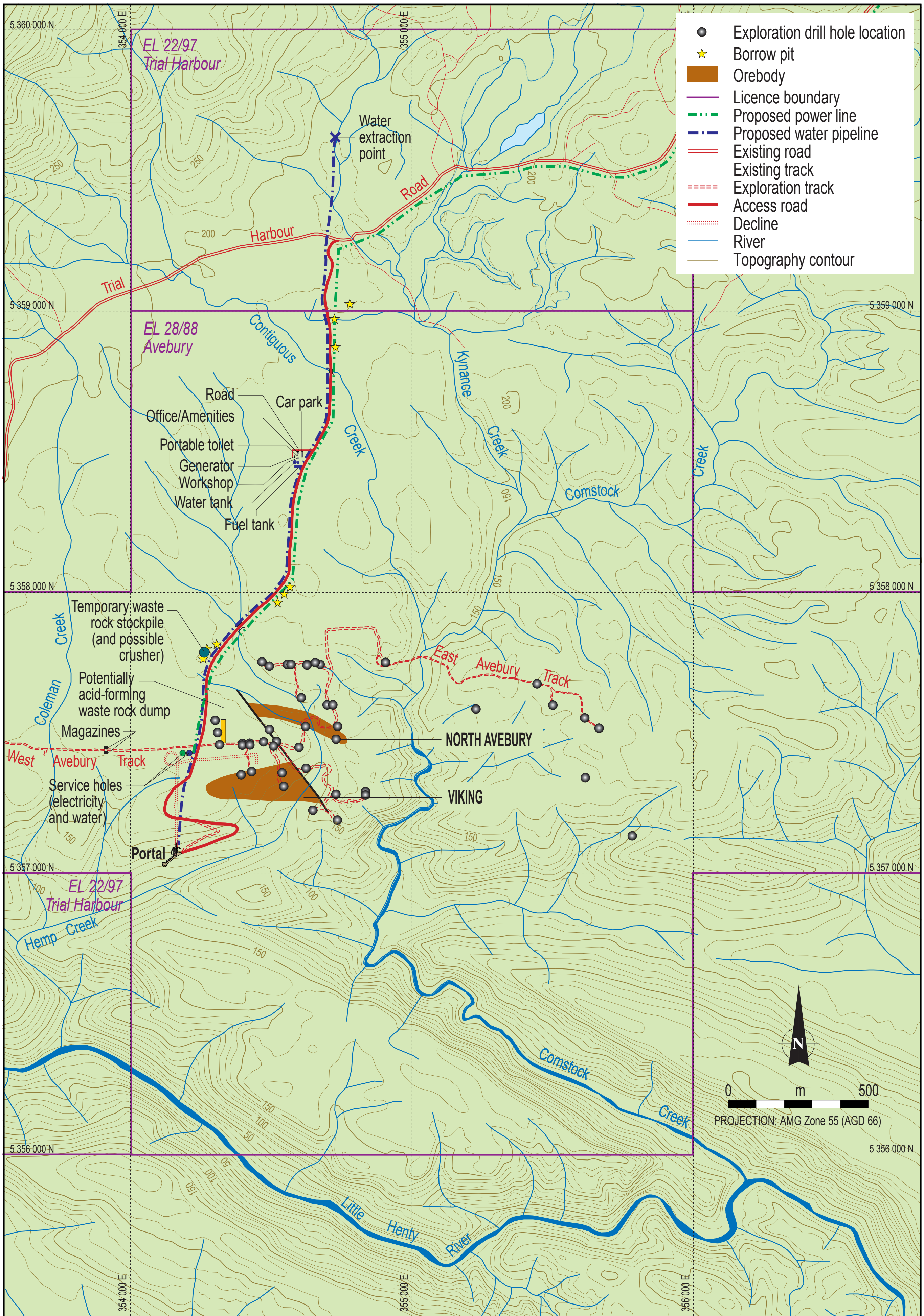
1.6.3 Exploration

To date, Allegiance has completed approximately 20,000 m of core drilling in 41 drill holes into the Avebury deposit (Figure 1.5). Two cross-cuts will be constructed at the bottom of the decline that will allow the extraction of approximately 150 t of mineralisation for metallurgical testwork and drilling for detailed resource and reserve definition (Section 3.3.2).

1.7 Economic Implications

Tasmania is experiencing high levels of unemployment and low levels of economic growth when compared with other Australian states. Mining is a major contributor to both the Australian and Tasmanian economies in terms of private and public revenues and balance of trade.

In 1998/1999, the mining industry contributed $150 million in wages and spent a further $363 million on Tasmanian goods and services. In addition, over $26 million annually was contributed to state and local government revenue in the form of taxes and levies (Mineral Resources Tasmania, 2002). During this time, the mining industry provided direct full-time employment for 3,502 Tasmanians. The current flow-on effect associated with the mining industry in Tasmania is estimated to be between four and five, i.e., for every job created directly by a mine, there are an additional four to five positions created indirectly (Long, pers. com., 2003). This may not necessarily apply to Stage 1 of the Avebury Nickel Project given this Stage of the development does not include ore mining and processing.



NSR Environmental Consultants Pty Ltd

Job No: 938	Allegiance Mining NL	Exploration drill holes	Figure No: 1.5
File No: 938_2_F1.05_HB	Avebury Nickel Project		

Mineral and energy exports in 2001/2002 earned Australia $41.2 billion (Minerals Council of Australia, 2002). The Australian Bureau of Statistics reported Tasmania's expenditure on mineral exploration for the same period as $9.2 million. This represents approximately 1.5% of Australia's exploration expenditure ($582 million) which was 17% lower than the $702 million spent in 2000/2001 (ABS as cited in Mineral Resources Tasmania, 2002 and Minerals Council of Australia, 2002). Despite Tasmania's low expenditure levels, there was significant progress in the exploration conducted by Allegiance such that there is sufficient confidence to apply for the necessary permits and approvals required to develop Stage 1 of the Avebury Nickel Project.

The total cost estimate for Stage 1 of the project is $7.5 million of which $2.5 million will be paid in direct wages and employment-related costs for 25 full-time positions. There are no mineral-related taxes or royalties associated with Stage 1; these will follow with stages 2 and 3.

The development of the Avebury Nickel Project will continue mining's contribution to employment and business opportunities at both national and local levels. Towns near the project, such as Zeehan and Trial Harbour, and other towns in the west coast region, will accrue benefits in the form of wages, employment and increased support for existing industries.

2. Site Description and Existing Environment

This chapter outlines the existing terrestrial, aquatic, socio-economic and historic environments of the Avebury Nickel Project study area.

2.1 Terrestrial Environment

2.1.1 Physical Setting and Land Use

Project Location

The Avebury Nickel Project study area is situated about 8 km west of Zeehan on Tasmania's west coast (see Figure 1.1). The nearest localities are Trial Harbour to the west and Zeehan. The nearest major towns by road are Rosebery to the northeast and Queenstown to the southeast.

The general area has a history of exploration and prospecting since the 1800s, although this was impeded by the rugged terrain and difficult vegetation. Queenstown and Rosebery are historically mining towns and today their economy is still centred on this industry. More recently in 1991, the Henty Gold Mine near Mt. Read and the Anthony Power Development (a hydroelectric power generation scheme) commenced operations.

The township of Zeehan started as a mining town in the 1880s and in 1903 was known as Silver City. With a population of 10,000, it was the third largest town in Tasmania at that time. Although the nearby Renison Tin Mine remains one of the world's largest underground tin mines, Zeehan is now one of the smaller towns in Tasmania.

Physical Setting

The Avebury Nickel Project is located in a landscape of undulating to steeply forested land (eucalypt and tea-tree forest and rainforest) with grassy plateau (buttongrass plains). The study area is bounded to the northwest by steep, forested, mountainous terrain (Mt Agnew at 846 m), to the north-northwest by a gentle ridgeline marking the catchment divide with the Pieman River, to the east by Mount Zeehan (702 m), to the west by coastal dunes and to the south by the incised valley of the westerly-flowing Little Henty River.

The area is incised by a series of subparallel, south-trending tributaries of the Little Henty River, which include Comstock and Contiguous creeks.

Bioregion

The Avebury Nickel Project study area is located within the Tasmanian West bioregion as classified under the Interim Bioregionalisation for Australia (IBRA), one of nine such regions for the state (Environment Australia, 2000). As the name suggests, this bioregion covers much of Tasmania's west coast.

IBRA regions represent a landscape-based approach to classifying the land surface. Specialist ecological knowledge, combined with regional- and continental- scale data on climate, geomorphology, landform, lithology and characteristic flora and fauna were interpreted to describe patterns that eventually formed the 80 IBRA regions. Map regions for Tasmania were aggregated by grouping regions with similar climate, landform, geology/lithology, vegetation and floristics (Environment Australia, 2000).

Land Use

The development area is located within the Municipality of the West Coast and the general area has been zoned 'rural' by the Zeehan Section 46 Planning Scheme No.1 1992. This is a zone in which extractive industries are a permitted land use. Allegiance holds several exploration licences in the Zeehan area as shown in Figure 1.2. The Comstock Zinc Mine is currently being developed on the closest adjoining lease, approximately 2 km northeast of the Avebury Nickel Project.

The Zeehan area and surrounds have been under commercial and recreational land use for many years. Current land uses comprise mineral exploration and mining, general nature conservation, walking, fishing, photography and off-road vehicle driving, particularly on the dunes along the coast.

The project area is within multiple use state forest designated under the *Forestry Act 1920*. Part of this area is classified as informal reserve (stream-side corridor) (Figure 2.1) through Forestry Tasmania's administrative and management process as part of the Comprehensive Adequate and Representative (CAR) Reserve System[1]. These land classifications are recognised and accredited under the Regional Forest Agreement (RFA), which was signed between the Australian and Tasmanian governments in November 1997. The area of state forest east of Comstock Creek has been classed as a high quality wilderness (i.e., wilderness value greater than or equal to 12) area through the RFA process (Figure 2.2) (NSR, 2000). The RFA permits mineral exploration and mining within state forest, informal reserves and wilderness areas (NSR, 2000).

2.1.2 Climate

The Bureau of Meteorology established a meteorological station at the Zeehan Memorial Museum in February 1968. Temperature and wind speed and direction were recorded from 1969 to 1978, while rainfall records commenced in 1968 and continue to be maintained.

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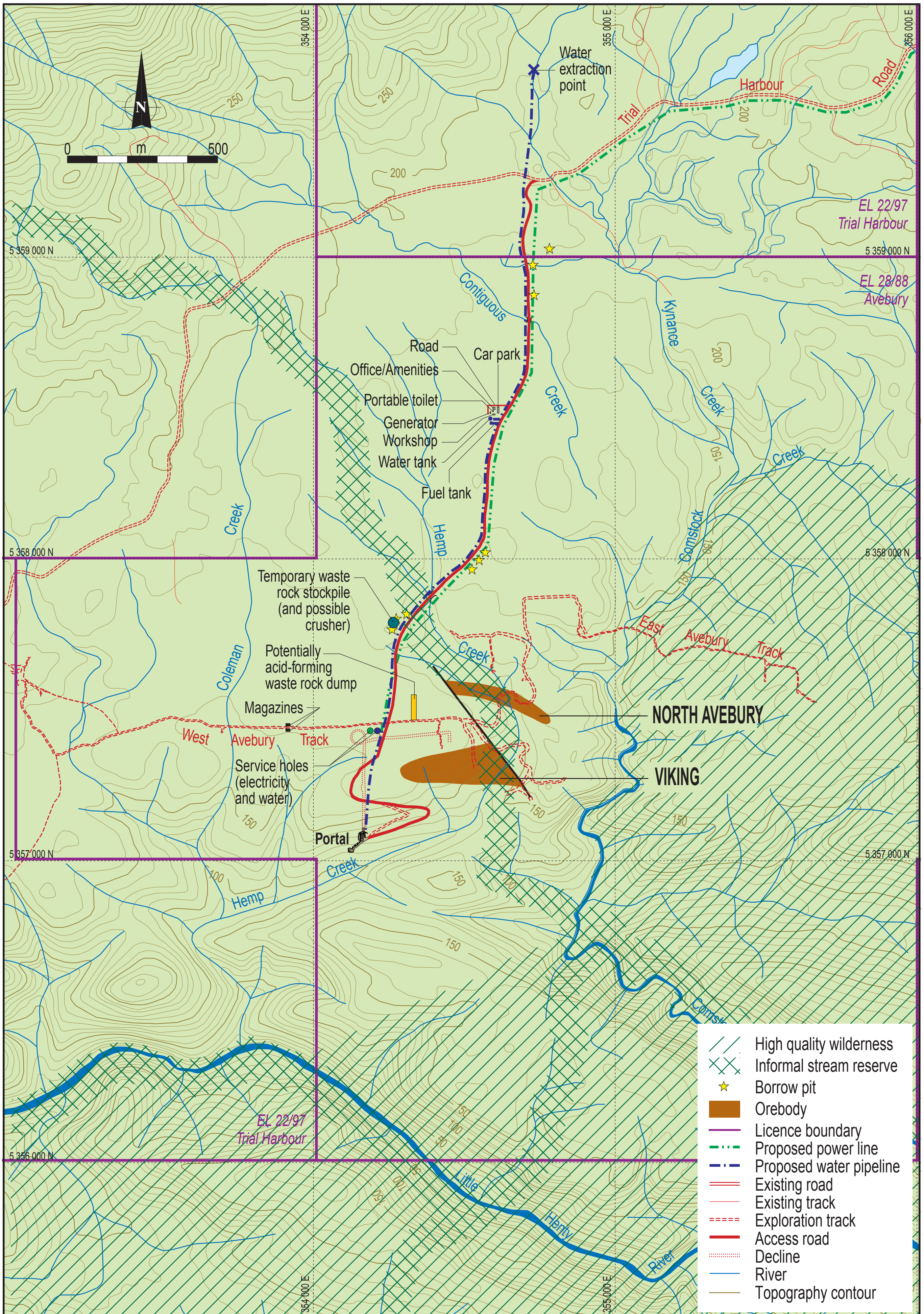
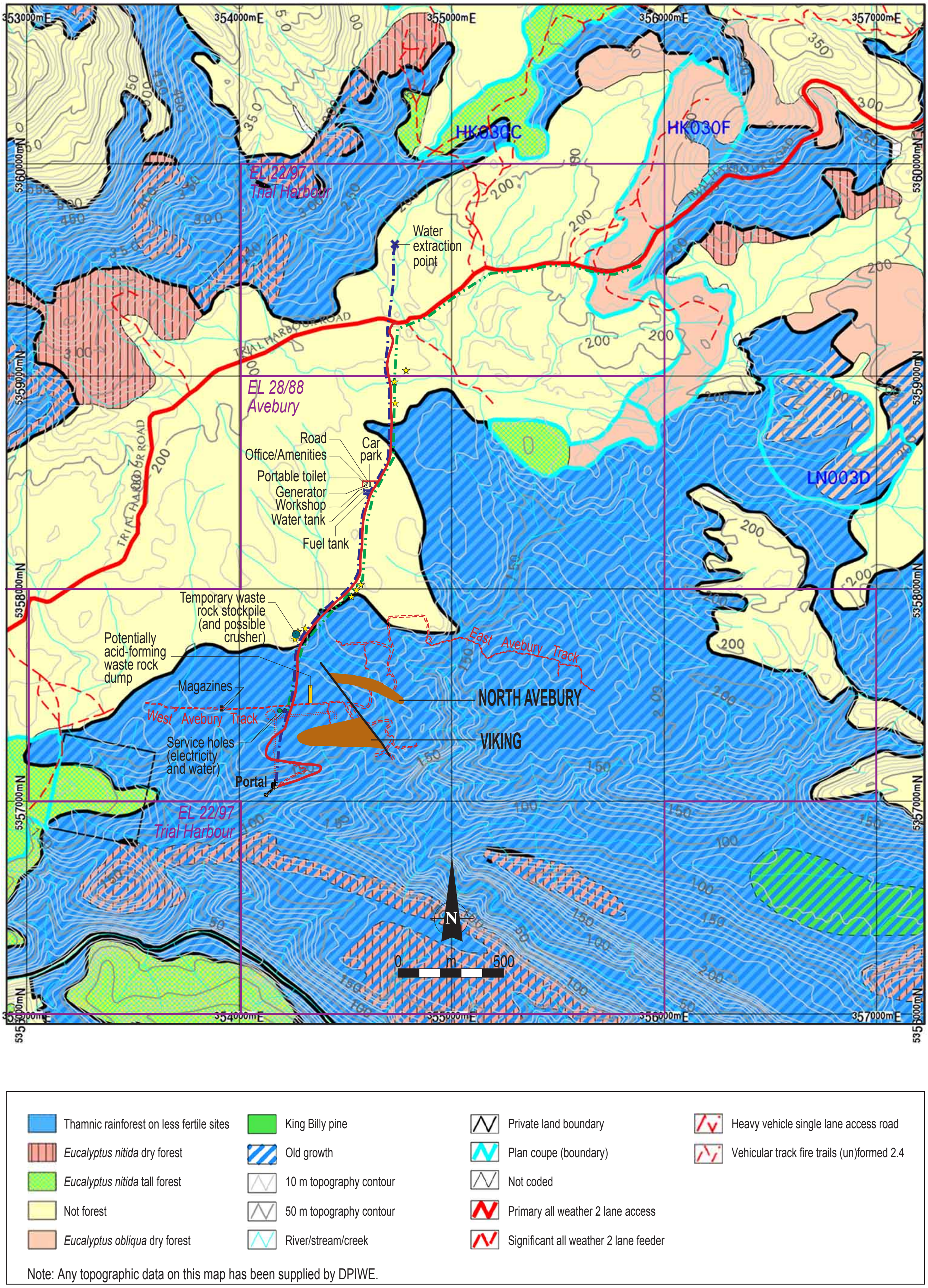
[1] The CAR Reserve System was developed under the National Forest Policy Statement to protect biodiversity, old growth forest and wilderness values (Mineral Resources Tasmania, 1999). It is based on JANIS, the national reserve criteria (Regional Forest Agreement, 1996).



NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Land use	Figure No: 2.1
	File No: 938_2_F2.01_HB	Avebury Nickel Project		



Source: Forestry Tasmania

NSR Environmental Consultants Pty Ltd	Job No: 938 File No: 938_2_F2.02_HB	Allegiance Mining NL Avebury Nickel Project	RFA communities coupe map	Figure No: 2.2

The climate of the project area is characterised by cool temperatures, and high and consistent annual rainfall. Rainfall distribution in western Tasmania is generally high throughout the year, with June to September being the wettest months and December to March the driest. Drought conditions are rare. The rainfall data for Zeehan in Figure 2.3 clearly illustrates this distribution, with an average annual rainfall of almost 2,290 mm.

Southwesterly winds dominate the northwest coast and are strongest (i.e., highest speed) between September and March, with wind speeds often in excess of 30 km/hr. Between April and August, winds from the west are dominant, but not as strong as at other times of the year.

Mean monthly minimum temperatures at Zeehan range from 2.9°C in June to 10.3°C in February and maximum temperatures range from 10.9°C in July to 21.8°C in February (see Figure 2.3). Although not exposed to extreme and persistent winter conditions, the area is subject to an average of 13.8 rain days per month.

2.1.3 Geology

Regional Geology

The Avebury area is underlain by a sequence of Cambrian sediments, mafic agglomerates and conformable ultramafic formations (Figure 2.4).

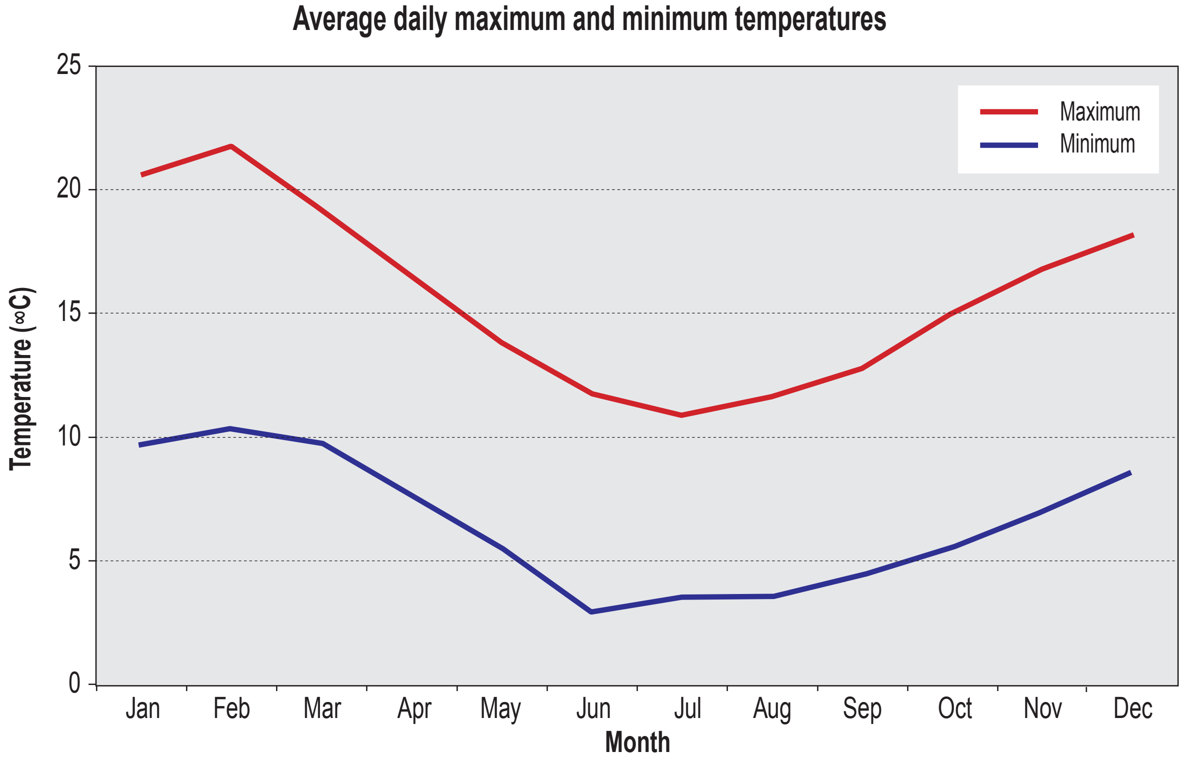
The sequence strikes generally east–west with steep dips to the north. During the Carboniferous period, the area was subjected to a period of tectonic deformation (faulting and folding) which was accompanied by intrusion of the large Heemskirk Granite. This intrusion, and hydrothermal fluids emanating from the intrusion, extensively altered the overlying Cambrian rocks. Sedimentary formations were strongly hornfelsed and the ultramafic formations were altered to serpentinites with diopside-epidote-tremolite–rich units at the margins.

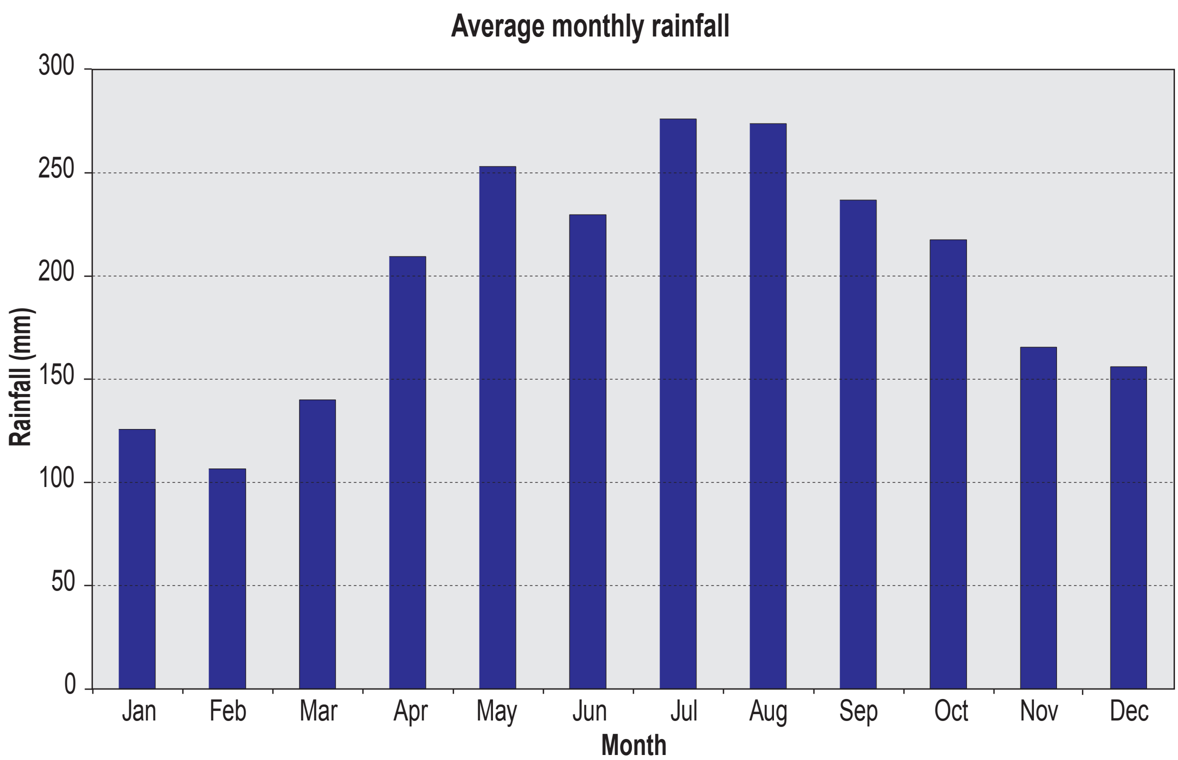
During the alteration of the ultramafics, there was intensive iron metasomatism resulting in the formation of abundant magnetite, and the remobilisation and enrichment of nickel sulfides around the upper margins of the altered ultramafics.

Nickel is present in these marginal zones principally as coarse pentlandite (nickel iron sulfide) associated with magnetite and minor pyrrhotite. A minor amount of nickel is also present in some areas as gersdorfite (nickel arsenic sulfide) and nicolite (nickel arsenide).

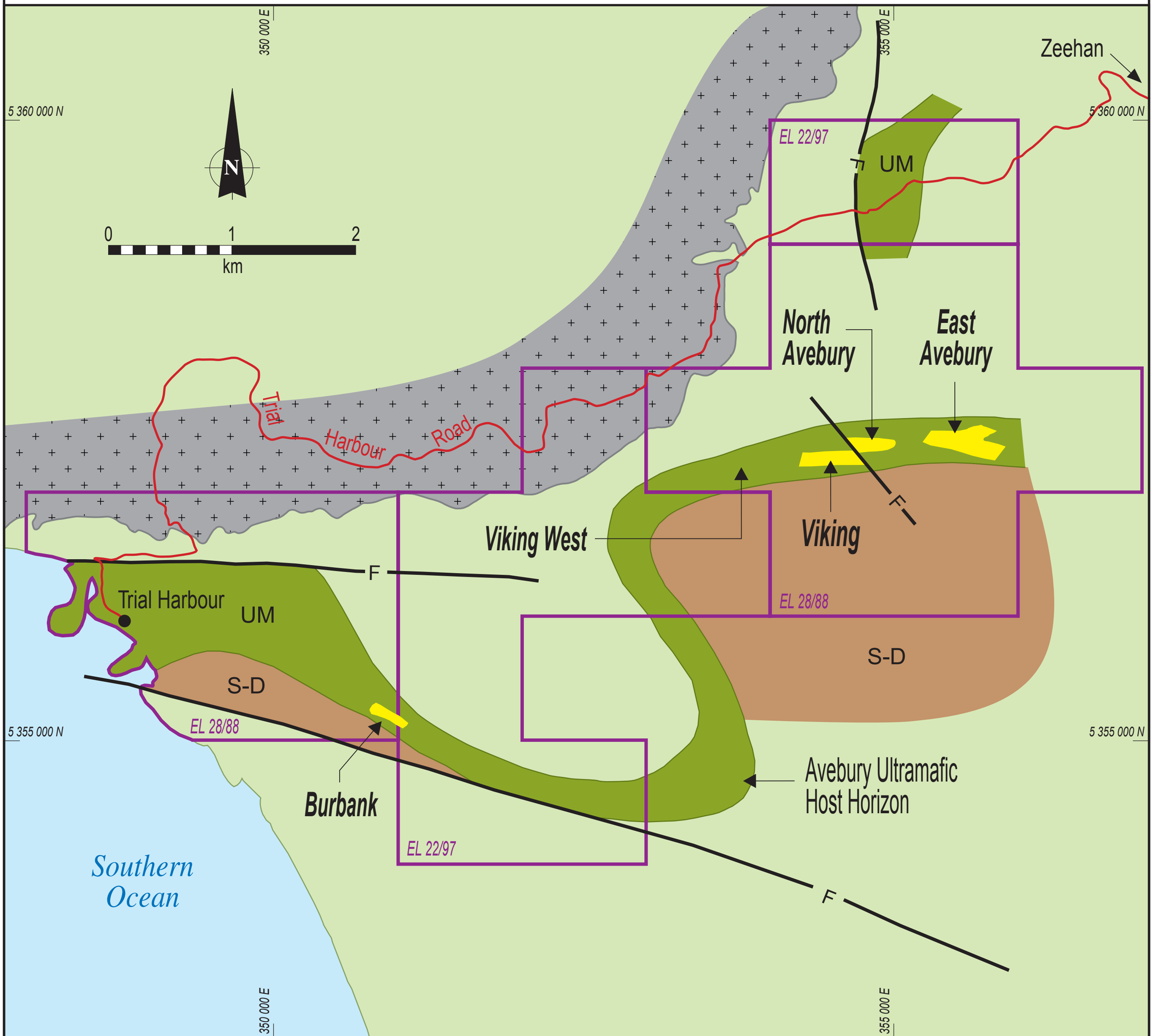
Avebury Deposits

The Avebury deposits are situated within mineralisation over a known strike length of about 500 m and to a depth of 400 m that is concentrated along the top and flanks of a west-plunging anticlinal body of altered ultramafic rocks. The top of the deposit lies some 100 m below surface (Figure 2.5). The nickel sulfides are concentrated with iron and other sulfides in the upper sections of the ultramafic host rocks.





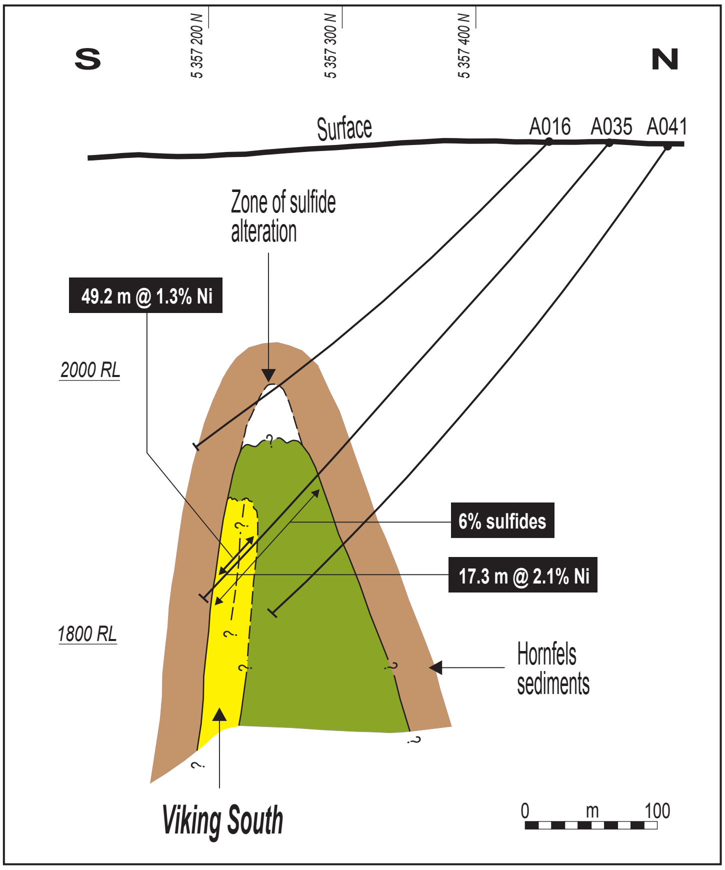
NSR Environmental Consultants Pty Ltd	Job No: 938 File No: 938_2_F2.03_HB	Allegiance Mining NL Avebury Nickel Project	Rainfall and temperature at Zeehan	Figure No: 2.3



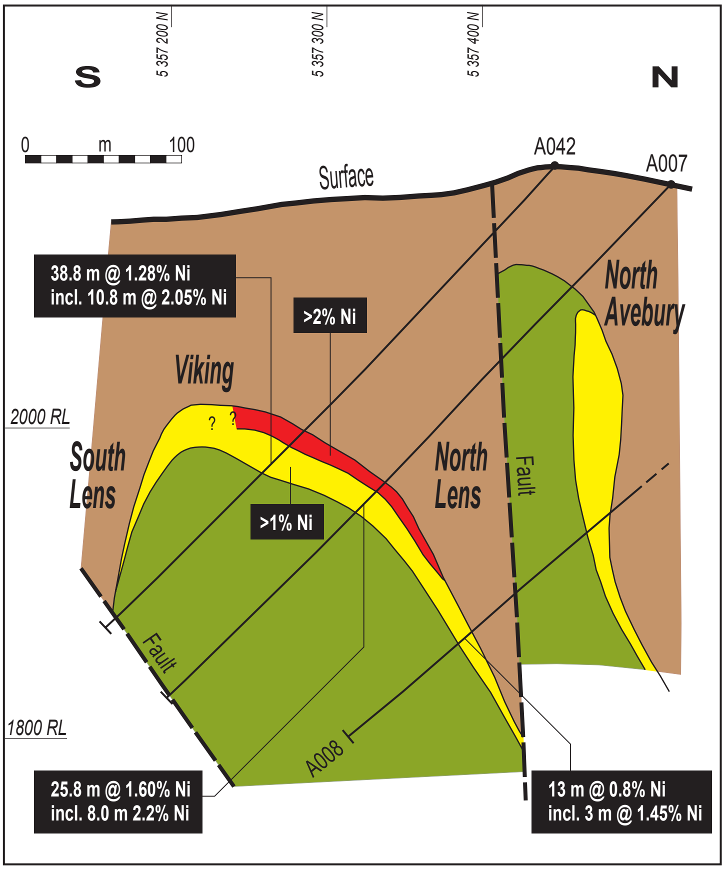
	Granite
UM	Ultramafics
S-D	SilurianóDevonian sediments
	Mineralised zones
—F—	Fault
	Allegiance exploration licence boundary
	Road

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Regional geology	Figure No: 2.4
	File No: 938_2_F2.04_HB	Avebury Nickel Project		

a) Viking deposit



b) Higher grade upper Viking resource



Sediments | Surpentinite | Low grade sulphide mineralisation | Higher grade sulphide mineralisation | ? Geological uncertainty

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Avebury deposit mineralisation	Figure No: 2.5
	File No: 938_2_F2.05_HB	Avebury Nickel Project		

Mineralisation identified to date occurs within two deposits named North Avebury and Viking. The Viking deposit is further subdivided into North Lens and South Lens (see Figure 2.5). One interpretation of the known mineralisation suggests that the Viking and North Avebury deposits are faulted segments of a single parent deposit.

Asbestiform Amphibole

The alteration of the more mafic and ultramafic members of the geological sequence by the intrusion of the Heemskirk Granite (see 'Regional Geology' above) has resulted in the pervasive formation of the amphibole minerals actinolite and tremolite. These two minerals occur dominantly as large coarse felted crystalline masses, intimately intergrown with other minerals within a complex alteration assemblage.

This alteration phenomenon is not confined to the Avebury area, and occurs extensively throughout Tasmania wherever mafic and ultramafic rocks are so altered by later intrusives.

Fifteen drill core samples selected from along the general route of the proposed decline were microscopically examined by MRT for potentially hazardous materials. This identified the presence of trace amounts of asbestiform amphibole, probably actinolite, in most of the samples, along with variable amounts of crystalline silica and mica.

2.1.4 Soils

Very little detailed information is available regarding soils on the west coast of Tasmania (Cotching, pers. com., 2003). The nearest regions to the study area that have had reconnaissance soil surveys completed are the Lagoon and Arthur River areas (1995), while Strahan has detailed soil maps dating back to 1952.

According to Walker et al. (1993), the Avebury Nickel Project study area lies within the soil landscape province of Region VIII, which includes the south-eastern region of the Australian mainland and Tasmania. The study area occurs within the Hunter–Bega–Gordon soil province of Region VIII.

The main factors in soil development of Region VIII include the nature of the parent rock (weathering and transport of weathered materials), topography (slope gradient and position of soils on slopes), landscape stability (history of erosion and deposition), climate (high rainfall) and vegetation (Walker et al., 1993).

The soil landscape of the Hunter-Bega-Gordon soil province is influenced by the erosional landscape of coastal ranges, with high annual rainfall. Soils tend to be more organic and less strongly differentiated, with acid peats up to 50 cm thick in some areas (Walker et al., 1993).

The fine-grained, basic rocks such as basalt (present in the study area) often weather to friable red clays such as krasnozems, chocolate soils and terra rossa soils. Krasnozems also develop over dolerite in high rainfall areas (Walker et al., 1993).

2.1.5 Terrestrial Flora

The following is a summary of information provided in the vegetation, flora and fauna report that was prepared by NSR and is provided in Appendix 3.

Species

A complete flora list cannot be compiled for the study area from the desktop assessment completed for Stage 1 development; this will be achieved with a field survey (Section 4.6.2). The description of vegetation communities in Appendix 3 provides a broad listing of species found within each vegetation type.

Significant Species

No flora species of conservation significance (i.e., threatened[1]), at either the state or national level, are listed for the study area.

Weeds and Pathogens

A search of the GTSpot (2003) database indicates no weedy flora species are present. During the reconnaissance trip however, extensive patches of cutting grass (*Gahnia filum*), which is thought to have been introduced when the area was selectively logged for rainforest timbers in the 1950s and 1960s, were noted along former logging tracks. Vegetation along the Trial Harbour Road contains little or no known priority weed infestations (West Coast Council, Forestry Tasmania and DPIWE, undated).

Signs of *Phytophthora cinnamomi,* (dieback or root-rot), while not noted during the reconnaissance trip, have been recorded elsewhere on the west coast. Mapping records and consultation with DPIWE indicates that no occurrences of *P. cinnamomi* are known in or around the project area (Woolley, pers. com., 2003; Rudman, pers. com., 2003).

Myrtle wilt, caused by the pathogen *Charlara australis*, is endemic to areas vegetated by myrtles (*Nothofagus cunninghamii*). The status of myrtle wilt in the study area is unknown.

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[1] The 'threatened' status in Tasmania includes species listed as extinct, endangered, vulnerable or rare under Schedules 3, 4 or 5 of the *Threatened Species Protection Act 1995*. The 'threatened' status for the Commonwealth includes species listed as extinct in the wild, critically endangered, endangered or vulnerable under Part 13, Division 1, Subdivision A of the *Environment Protection and Biodiversity Conservation Act 1999*. Definitions of the term 'threatened' at the Tasmanian and Commonwealth levels are provided in Attachment 2 of Appendix 3.

Vegetation Communities

Vegetation of the project area can generally be described as comprising predominantly rainforest communities and mixed forest (as the rainforest degrades to wet sclerophyll communities) or a combination of both. The rainforest is a poorer quality, small-crowned, short, thamnic (shrubby) rainforest dominated by myrtle with leatherwood. The understorey comprises younger leatherwood and myrtle with sassafras, plus occasional blackwood and wet fern species.

Specifically, the vegetation of the study area is divided into the following categories, based on TASVEG 2000 classification (GTSpot, 2003). Forest and non-forest vegetation mapped by TASVEG provides a greater level of detail and infill from the RFA mapping conducted in the mid-1990s. Ten vegetation communities have been identified within the area of potential impact (Figure 2.6), out of a possible 50 for the state.

Buttongrass Moorland (Bb)

In western Tasmania, buttongrass moorland forms large tracts of vegetation across flats, without tree cover, and gentle and steep slopes on infertile rocks. Within the study area, buttongrass moorland occupies an extensive part of the study area south of the Trial Harbour Road (Plate 2.1). Buttongrass (*Gymnoschoenus sphaerocephalus*) is the signature species, but the community ranges from pure buttongrass to moorlands with a mixture of buttongrass and low shrub species as well as numerous sedge species. It can be open to very dense but most plants occur within a single stratum.

Melaleuca squamea *with/without Buttongrass on Slopes (Bm)*

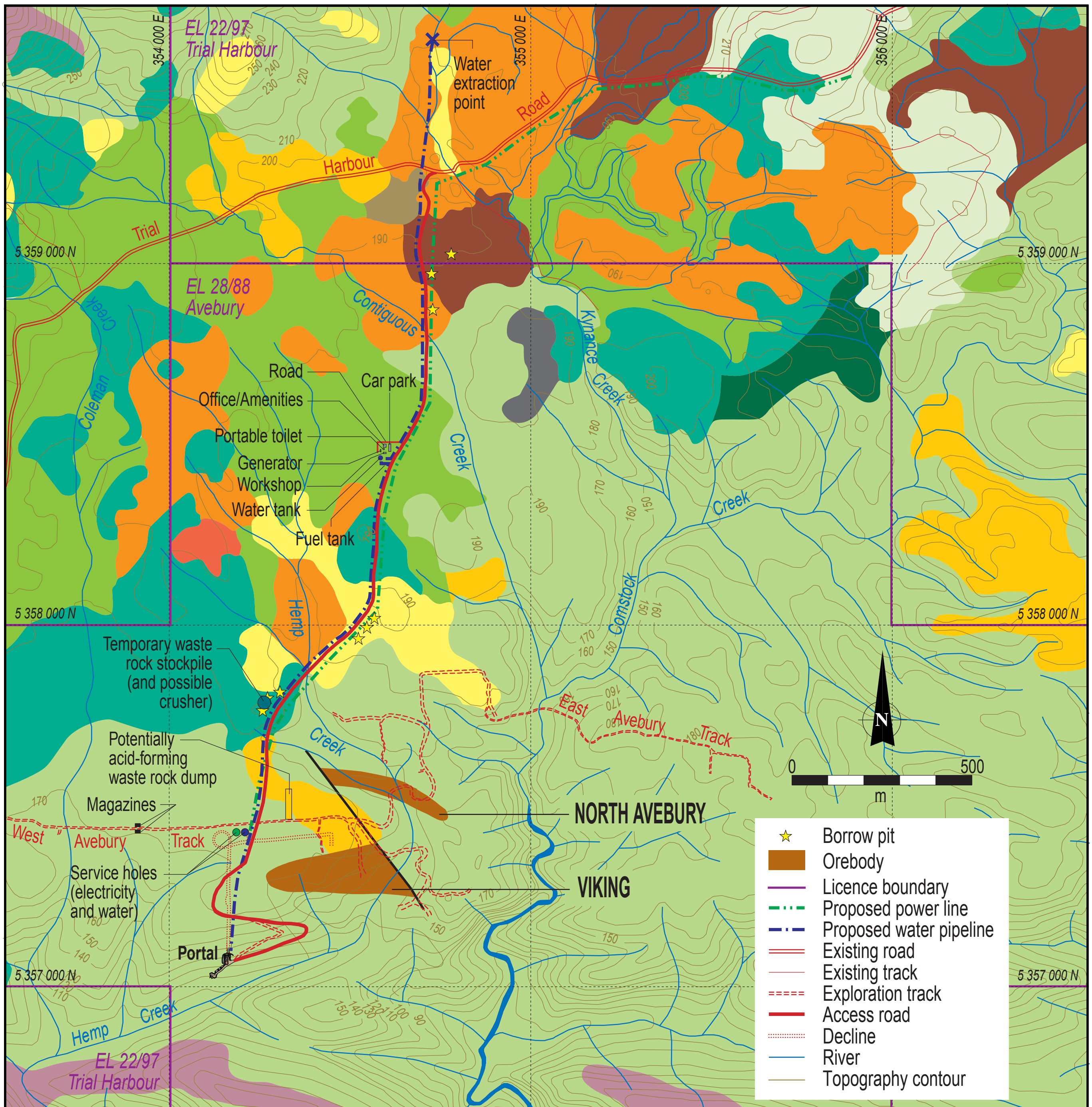
This community occurs on slopes, ridge tops and better-drained flats at all altitudes. There is a small area of this vegetation community south of the Trial Harbour Road.

The vegetation included in this mapping unit is dominated by shrubs (e.g., swamp melaleuca *(Melaleuca squamea*) to 1.5 m) which occur in a distinct layer above any sedges present in the vegetation. This community may be very dense and is transitional between buttongrass moorland and wet scrub.

Short Rainforest (M-)

Short rainforest occupies low to moderately fertile sites and occurs predominantly in the western part of the state. It is the dominant vegetation community of the study area (Plate 2.2). Forestry Tasmania classifies this community as old growth forest (Woolley, pers. com., 2003) (see Figure 2.2). The most common species that may occur as co-dominants include myrtle (*Nothofagus cunninghamii*), celery top pine *(Phyllocladus aspleniifolius*) and leatherwood (*Eucryphia lucida*).

Much of the rainforest in the southwest of the study area was selectively logged and burned in the 1950s and 1960s (Newnham, pers. com., 2003).



Vegetation

Broadleaf shrubbery	*Melaleuca squamea*
Buttongrass moorland	Recently cleared *Eucalyptus obliqua* dry forest
Eucalyptus nitida dry forest	Restionaceae flatland
Eucalyptus nitida wet forest	Short rainforest
Eucalyptus obliqua dry forest	Tea-tree forest
Leptospermum lanigerum scrub	Western wet scrub
Leptospermum lanigerum scrub/sparse *Eucalyptus nitida*	

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Vegetation communities	Figure No: 2.6
	File No: 938_2_F2.06_HB	Avebury Nickel Project		

Plate 2.1
Buttongrass moorland near Trial Harbour Road (foreground), grading to eucalypt forest, with Mt Zeehan in the background.

Plate 2.2a
Short rainforest in the project area, with sparse understorey upslope of Hemp Creek.

Plate 2.2b
Short rainforest in the project area, with dense understorey.

Eucalyptus obliqua *Dry Forest (O) (and recently cleared* E. obliqua *[crO])*

Eucalytpus obliqua dry forest occurs in a small area east of Kynance Creek. Browntop stringybark *(E. obliqua*) is the dominant species. Silver wattle (*Acacia dealbata*) is frequently present in the tall shrub layer. Typically, the understorey is shrubby.

Broad-leaf Shrubbery (Sb)

This community commonly occurs in gullies or on talus (fragmented rock) slopes on mountainsides or boulder fields, usually in very fire-protected situations. Only a small patch of this vegetation occurs in the study area, between two minor tributaries of Hemp Creek.

Dogwood *(Pomaderris apetala*), native olive (*Notelaea ligustrina*) and musk (*Olearia argophylla*) are common in this community, occurring as a dense canopy 4 to 8 m in height, occasionally with scattered emergent eucalypts or other trees. The understorey is often open with mossy boulders and herbs.

Western Wet Scrub with Eucalyptus nitida *(Sn)*

Western wet scrub is abundant in western Tasmania and occurs as scattered large patches of vegetation in the study area and as thickets within the buttongrass moorland. Scattered Smithton peppermint (*Eucalyptus nitida*) are ubiquitous as small trees (up to 8 m but usually no more than 5 m) in the centres of thickets. Up to five species of tea-tree are common in this community.

Leptospermum spp. *Scrub (St)*

This community consists of almost pure stands of *Leptospermum* spp. (up to 8 m but usually 3 to 5 m tall). *Leptospermum* scrub is found as a large patch of vegetation between Hemp and Kynance creeks, adjoining the short rainforest. The community has a closed upper canopy dominated by even-aged *L. lanigerum*, with *Melaleuca ericifolia* an occasional subdominant. The shrub layer is absent, while the ground stratum is usually sparse.

Leptospermum lanigerum *Scrub/Sparse* E. nitida *(St En-)*

While the name of this community indicates sparse *E. nitida* among the tea-tree scrub, the description for this community is the same as that for *Leptospermum lanigerum* scrub.

Retionaceae Flatland (Br)

Information on this vegetation community is not yet available from the Tasmania Parks and Wildlife Service (GTSpot, 2003).

Eucalyptus nitida *Wet Forest (NT)*

A description for this vegetation community is yet to be finalised by the Tasmania Parks and Wildlife Service (GTSpot, 2003).

Significant Vegetation Communities

Of the ten vegetation communities found in the study area, *Melaleuca squamea* (Bm) emerges as the only vegetation community in the study area regarded as having high priority for conservation (i.e., it is bioregionally rare in the Tasmanian West bioregion). According to the mapping information, this vegetation community occurs immediately south of the Trial Harbour Road; however, field verification by Forestry Tasmania indicated that the community mapped is not *Melaleuca squamea*. All other communities are listed as 'not a priority' for the Tasmanian West bioregion (Harris, pers. com., 2003).

No EPBC-listed threatened communities occur in the study area.

The criteria used to review the state conservation status of forest communities are provided in Appendix 3.

2.1.6 Terrestrial Fauna

The following is a summary of information provided in the vegetation, flora and fauna report that was prepared by NSR and is provided in Appendix 3.

Species

A complete fauna list cannot be compiled for the study area from a desktop assessment; this will be achieved with a field survey (Section 4.6.2). From the point localities identified in the study area, the GTSpot (2003) database lists 79 species, all of which are birds. No mammals are recorded from the study area, though an unconfirmed sighting of a Tasmanian pademelon (*Thylogale billardierii*) was made during the reconnaissance trip to the project area.

Significant Species

State-threatened Species

Three species of state significance (i.e., threatened under the *Threatened Species Protection Act 1995*) are listed within the study area, from a point locality on a tributary of Comstock Creek (GTSpot, 2003). These species are listed in Table 2.1 and discussed below.

• *Wedge-tailed Eagle*

The wedge-tailed eagle (*Aquila audux fleayi*) is found throughout, and is an endemic subspecies of, Tasmania. It builds nests in tall eucalypts in areas of mainly old-growth forest and has large home ranges. However, due to state-wide disturbance to nests and breeding adults, breeding success for the species is on the decline. This, combined with shooting, trapping, poisoning, electrocution and collisions with vehicles, has led to a reduction in population size and its listing as vulnerable in Tasmania. Forest clearing for agriculture, forestry and housing is also contributing to the decline in abundance of the eagle (Bell & Mooney, 1999).

Table 2.1 State-threatened species potentially occurring within the study area

Species Name	Common Name	Threatened Status	Year Recorded
Aquila audux fleayi	Wedge-tailed eagle	Vulnerable	1981
Pachyptila turtur subantarctica	Fairy prion southern subspecies	Vulnerable	1977
Halobaena caerula	Blue petrel	Vulnerable	1978

• *Fairy Prion Southern Subspecies*

The fairy prion is a sea bird of southeastern Australia and Tasmania, with the only breeding colonies found on two rock stacks off Macquarie Island. The species digs nesting burrows under cushion plants; however, rabbits cause degradation of burrows and subantarctic skuas, rats and feral cats predate on the young. (Garnett, 1992). Due to the restricted distribution of the species and its oceanic habitat, it is unlikely to occur in the study area.

• *Blue Petrel*

Distributed throughout the world's southern oceans, the blue petrel is an irregular visitor to the seas of southern Australia. The only Australian population is on Macquarie Island (Garnett, 1992) and the bird is unlikely to occur in the study area.

Other Possible State-threatened Species

Other threatened fauna species listed as occurring in the Trial mapping grid of Tasmania include the orange-bellied parrot (historic record from 1981), short-tailed shearwater, hooded plover and migratory waders. These species are listed as occurring either at the coast at Trial Harbour or at the mouth of the Little Henty River (Bryant & Jackson, 1999) both of which are some distance west of the study area. Species that may occur in suitable habitat within the mapping location include the Australian grayling (fish), grey goshawk, and the spot-tailed quoll (Bryant & Jackson, 1999).

Nationally Threatened Species

A search of the *Environment Protection and Biodiversity Conservation Act 1999* online database for nationally threatened species resulted in a list of seven fauna species for the study area (Table 2.2). Descriptions of these species are provided below.

• *Wedge-tailed Eagle*

As per 'State-threatened Species.'

Table 2.2 Nationally threatened fauna species within the study area

Species Name	Common Name	Status
Threatened species		
Aquila audux fleayi	Wedge-tailed eagle	Vulnerable
Lathamus discolor	Swift parrot	Endangered
Dasyurus maculatus maculatus	Spot-tailed quoll	Vulnerable
Prototroctes maraena	Australian grayling	Vulnerable
Terrestrial species covered by migratory provisions of the EPBC Act 1999		
Haliaeetus leucaogaster	White-bellied sea-eagle	Listed - species or species habitat likely to occur in area
Hirundapus caudacutus	White-throated needletail	Listed - species or species habitat likely to occur in area
Wetland species covered by migratory provisions of the EPBC Act 1999		
Gallinago hardwickii	Latham's snipe, Japanese snipe	Listed - species or species habitat likely to occur in area
Species covered by marine provisions of the EPBC Act 1999		
Gallinago hardwickii	Latham's snipe, Japanese snipe	Overfly marine area
Haliaeetus leucaogaster	White-bellied sea-eagle	Listed
Hirundapus caudacutus	White-throated needletail	Overfly marine area
Lathamus discolor	Swift parrot	Overfly marine area

• *Swift Parrot*

Swift parrot breeding is restricted to the east coast of Tasmania, within the range, and coinciding with the flowering in September, of the Tasmanian blue gum (*Eucalyptus globulus*) (Swift Parrot Recovery Team, 2000). The swift parrot then migrates to the mainland in autumn. Loss of mature blue gum and swamp gum trees on fertile soils has led to a decline in abundance of nesting hollows (Threatened Species Network, 2003a). Fewer than 1,000 breeding pairs of swift parrot are thought to survive, and in northern Tasmania, preferred nesting habitat is in old growth *Eucalyptus obliqua* dry forest. Forestry Tasmania has designated suitable habitat adjacent to the study area as logging coupes (Woolley, pers. com., 2003).

• *Spot-tailed Quoll*

The spot-tailed quoll is not listed as threatened under Tasmanian legislation; it only has Commonwealth status. It is the largest marsupial carnivore in Australia. The species is widespread and abundant throughout Tasmania and along the southeast coast of mainland Australia, and is likely to be found in forest areas with large trees, dense understorey, thick scrub cover and fallen branches, primarily in gullies and riparian habitat. Loss and fragmentation to habitat are the key threats to the quoll, as well as competition for food from introduced species. Retention of riparian habitat is thought important to their survival, as is the exclusion of fire from preferred habitat (Threatened Species Network, 2003b). Populations of the quoll in Tasmania appear to have increased from a dramatic decline in the early 1900s (Strahan, 1998).

• *Australian Grayling*

The Australian grayling was formerly very abundant in clear coastal streams and was highly regarded as a sport and table fish. Although still widespread, it is now uncommon. Spawning takes place in clear freshwater in late spring/early summer, with a marine stage following hatching (Fulton, 1990), before returning to fresh water (Cadwallader & Backhouse, 1983). Threats to its survival include barriers to upstream and downstream migration to and from the sea (McDowell, 1996).

• *White-bellied Sea-eagle*

White-bellied sea-eagle adults are largely sedentary (not migratory), defending an area of about 3 km^2 around the nest, with a larger area (about 150 km^2) used for hunting. Sea-eagles feed mainly on fish and other birds, but also eat carrion and small mammals. They nest in large, sheltered eucalypts or rock outcrops. About 200 breeding pairs of sea-eagle are recorded in Tasmania. Although the species is secure in Tasmania (due to its diverse breeding and feeding habits), threats to its status come in the form of shooting, poisoning, tree clearing and disturbance to breeding nests (DPIWE, 2002a), along with degradation of marine and estuarine environments (Wiersma, 2003).

• *White-throated Needletail*

White-throated needletail breed in northern Asia, arriving in Australia about October and leaving between May and August each year. They feed on flying insects (Australian Museum, 2003).

• *Latham's Snipe*

Latham's snipe breed in Japan and arrive in Victoria and Tasmania in late August and depart by the end of February. In Tasmania, Latham's snipe feed in soft soil and mud for seeds, beetles, larvae, pupae, spiders and earthworms in heathy buttongrass plains. The species was historically shot as a game bird (Lane, 1987).

Habitats

Four broad fauna habitat types are present in the study area:

- Temperate rainforest.
- Buttongrass plains.
- Shrubby eucalypt forest.
- Tea-tree and paperbark wet scrub.

A broad outline of the value of these habitats to fauna within the study area is presented in Table 2.3.

Table 2.3 Habitat values of the study area

Habitat	Corresponding Vegetation Community	Location (within study area only)	Structure	Characteristic Fauna Species
Temperate rainforest	Short rainforest (M)	Southern 75%.	Dominated by tall (>20 m) and dense canopy, with patchy dense understorey.	High diversity of birds, high order avian predators (such as eagles and goshawks), mammals such as wallaby.
Buttongrass plains	Buttongrass moorland (Bb) Retionanceae flatland (Br)	Northern part around Trial Harbour Road.	Less than 2 m tall, dominated by buttongrass hummocks and a mix of shrubs, sedges and rushes.	Birds (ground parrots and wrens) and ground-dwelling mammals such as native rats.
Shrubby eucalypt forest	*Eucalyptus obliqua* dry forest (O) *Eucalyptus nitida* wet forest (NT)	Adjacent to rainforest in northern part of study area.	Tall canopy (<20 m) and dense understorey shrubs.	Birds, ground-dwelling mammals, marsupials.
Tea-tree and paperbark wet scrub	*Melaleuca squamea* (Bm) Broad leaf shrubbery (Sb) *Leptospermum* scrub (St) *Leptospermum* scrub/sparse *E. nitida* (St) Western wet scrub with *E. nitida* (Sn)	Patchy through rainforest, scattered throughout buttongrass moorland north and south of Trial Harbour Road.	Closed canopy, usually forming dense thickets several metres high. Some emergent eucalypt species.	Birds (especially those requiring dense vegetation for nesting/predator protection), ground-dwelling mammals such as native rats.

Habitat Quality

Fauna habitat in the study area is of good quality, even though some areas have historically been subject to selective logging and other minor forms of disturbance, such as road building, road maintenance and impacts to aquatic habitat from historic mining upstream from the proposed Avebury Nickel Project development. The area east of Comstock Creek is reserved as high quality wilderness by Forestry Tasmania, indicating its high significance for flora and fauna conservation in the region. Habitat in the study areas is similar, if not the same, to that of the wilderness area, and there are no physical or ecological barriers to movement between the two areas.

The study area contains good habitat availability and diversity, indicated by the following features:

- A mosaic of vegetation types of different age.
- Varied fire regimes.
- Diverse understorey densities through the rainforest.
- Emergent rainforest trees.
- Numerous watercourses.
- Rocky areas.
- Very few invasive species.
- High density of fallen trees and rotting logs.
- High amounts of leaf litter.

2.1.7 Air Quality

Quantitative data on regional ambient air quality has not been collected through the study area. However, the study area is far removed from major industries and major road networks, is largely covered by dense rainforest and grassland vegetation, and experiences significant meteorological conditions (strong winds due to its proximity to the west coast) that combine to provide for good air quality. Highly localised exceptions to this occur from dust generated by traffic along the unsealed Trial Harbour Road, and from the combustion of firewood for the heating of homes in the towns of Zeehan and Trial Harbour.

2.1.8 Roads and Traffic

The only road in the study area is the Trial Harbour Road; access to the Avebury Nickel Project will be via this road (Plate 2.3). It is an unsealed road that serves to connect Zeehan to the coastal community at Trial Harbour, but also has historical significance in that it was the one of the first roads to be constructed in the central west coast region. Trial Harbour Road was critical to the early development of mining fields located around Zeehan.

Traffic on Trial Harbour Road is generally restricted to low speeds due to the unsealed, narrow and windy nature of the road that traverses some difficult terrain. Vehicles are required to slow down considerably to pass oncoming traffic. At present, traffic along the Trial Harbour Road is largely limited to light traffic (two- and four-wheel drive vehicles) movements of permanent residents travelling between Trial Harbour and Zeehan.

Traffic records on Trial Harbour Road from 1998 indicate that the average annual daily traffic (AADT) was about 60 vehicles (Sinclair Knight Merz, 2002). Traffic levels on Trial Harbour Road have increased in the last one to two years, due to increased tourism (such as driving holidays) and surveys and the provision of services for the development of the Heemskirk Wind Farm Project north of Trial Harbour (which is yet to be constructed).

2.2 Aquatic Environment

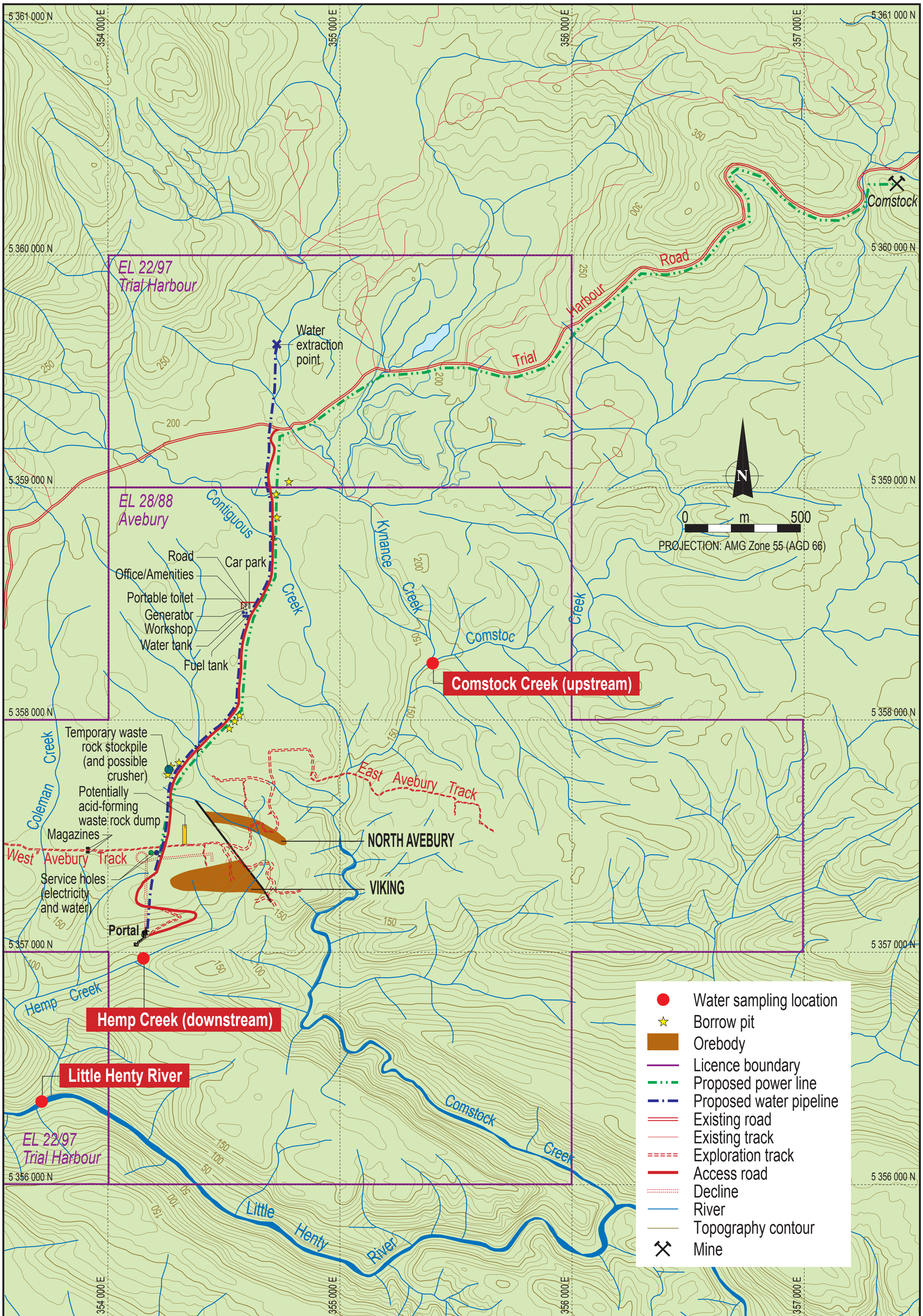
2.2.1 Surface Hydrology

The project area contains four creeks that ultimately drain to the Little Henty River (Figure 2.7):

Plate 2.3
Trial Harbour Road within Avebury Nickel Project study area

Plate 2.4
West Coast Pioneers' Memorial Museum

Plate 2.5
Campervans and trailers touring the west coast, passing through Zeehan



NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Water sampling locations	Figure No: 2.7
	File No: 938_2_F2.07_HB	Avebury Nickel Project		

- Contiguous Creek draining to Comstock Creek (total catchment area of 2 km^2).
- Kynance Creek draining to Comstock Creek (total catchment area of 8 km^2). In low-flow conditions, it is estimated that the discharge of Kynance Creek is 8 L/s at the water abstraction point.
- Comstock Creek draining to Little Henty River (total catchment area of 20 km^2). In low-flow conditions, it is estimated that the discharge of Comstock Creek is 15 L/s at the sampling point.
- Hemp Creek draining to Little Henty River (total catchment area of 5 km^2). In low-flow conditions, it is estimated that the discharge of Hemp Creek is 6 L/s at the sampling point.

The Little Henty River (total catchment area of 831 km^2) rises in the Mt Dundas Regional Reserve and discharges at the coast south of Trial Harbour (DPIWE, 2000), 5 km downstream of Hemp Creek.

These creeks and Little Henty River are generally swift-flowing and, referring to the ecosystem types in ANZECC/ARMCANZ (2000), can be classified as upland rivers and streams. Anecdotal evidence suggests that water levels in these creeks are likely to rise and fall rapidly in response to rainfall in the catchment.

There are no stream gauging stations on the creeks or on Little Henty River. An estimate of the median flow of Little Henty River can be made by comparison to Savage River, approximately 35 km to the north[1]. The median flow of Little Henty River is expected to be about 15 m^3/s and the flow is expected to exceed 4 m^3/s 90% of the time. Little Henty River is expected to be highly seasonal with maximum discharges occurring from June to October and minimum flows from December to April.

2.2.2 Hydrogeology

Core drilling and road exposures suggest the groundwater regime at Avebury is dominated by minor water flows in the transition zone between the shallow regolith[2] and fresh bedrock. The bedrock itself consists of massive, strongly hornfelsed sediments and mafic igneous formations that exhibit only minor and

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[1] The total catchment area of Savage River is 290 km^2, the median flow is 7 m^3/s and the flow exceeds 2 m^3/s 90% of the time (NSR, 1996). Flow in Little Henty River may be estimated using:

$$Q_2 = Q_1 (A_2/A_1)^{0.7}$$

Where Q_1 and Q_2 are the flows in Savage River and Little Henty River, respectively, and A_1 and A_2 are the respective catchment areas.

[2] Regolith is the loose, incoherent mantle of rock fragments, soil, blown sand, alluvium, etc. that rests on the bedrock.

sparse evidence of groundwater movement. However, some water flows are anticipated along the widely spaced, brecciated and clay-filled fault zones.

There are no recognised large subterranean voids or karst zones in the Avebury area.

Low-pressure water has flowed from a drill hole in the vicinity of the decline portal. A sample of this outflow has been used to characterise the groundwater from the area of the decline (see Section 2.2.3). It is believed that this water is from faults intersecting the waterlogged regolith zone above the proposed decline.

2.2.3 Water Quality

Water quality was characterised in samples collected between 10 and 29 January 2003 from Hemp Creek, Comstock Creek and Little Henty River. Three water samples were collected at each site during low-flow conditions. In addition, historical water quality data for Comstock Creek collected in 1997 and 1999 by DPIWE is available (NSR, 2000). A sample of groundwater was collected on 21 March 2003 from the drill hole at the proposed decline portal.

The results of water quality analyses are presented in Table 2.4 (general parameters and nutrients), Table 2.5 (major ions) and Table 2.6 (metals), and discussed in detail in Appendix 4.

These data indicate the following:

- Hemp Creek is pH 6.7 to 7.0, Na and Cl dominated, with low nutrient and metal concentrations that are considered typical of undisturbed upland streams in Tasmania. The median conductivity of Hemp Creek (138 µS/cm) exceeds the default ANZECC/ARMCANZ (2000) trigger value (TV) of 90 µS/cm for the protection of slightly to moderately disturbed aquatic ecosystems.
- Comstock Creek is affected by acid rock drainage (ARD) within its catchment. This is indicated by low pH (median 3.8), high SO_4 concentration (median 130 mg/L), low alkalinity (<1 mg $CaCO_3$/L) and high metal concentrations. Occurrence of ARD in Comstock Creek has previously been documented (DPIWE, 2000).
- Based on ANZECC/ARMCANZ (2000) TVs for slightly to moderately disturbed ecosystems, the key contaminants in Comstock Creek are Zn followed by Cd and Pb. The low pH in Comstock Creek is also likely to be environmentally detrimental.
- Little Henty River (at the sampling site) is dominated by Na/Ca and HCO_3. It contains elevated metal concentrations, most likely as a result of ARD occurring in its catchment.
  - Compared with the potential receiving waters of Hemp Creek, groundwater from the proposed decline portal area may be characterised as follows:

Table 2.4 Water quality - general parameters and nutrients

Lab.No.	Location	Date	Time	pH	Cond	Turb	TSS	O&G	TN	NO_3	NO_2	NH_3	TP	SRP
					µS/cm	NTU	mg/L		µg-N/L				µg-P/L	
40047	Hemp Creek	10/1/03	9:15	6.9	136	11	32	2	110	12	<2	3	<5	2
40167	Hemp Creek	17/1/03	14:00	6.7	138	7.0	6	<1	172	27	<2	4	9	4
40489	Hemp Creek	24/1/03	11:30	7.0	143	2.0	3	<1	134	32	<2	8	<5	3
40048	Comstock Creek	10/1/03	9:15	3.9	288	5.8	6	1	83	7	<2	6	<5	<2
40166	Comstock Creek	17/1/03	11:30	3.8	327	5.0	8	<1	106	11	<2	9	<5	<2
40488	Comstock Creek	24/1/03	10:00	3.8	358	7.8	7	<1	94	8	<2	11	<5	<2
40164	Little Henty River	15/1/03	13:00	6.9	130	1.8	6	<1	196	2	<2	4	<5	2
40487	Little Henty River	22/1/03	15:00	7.8	151	2.0	2	<1	226	<2	<2	7	16	8
40661	Little Henty River	29/1/03	14:00	7.3	160	1.6	<1	<1	169	2	<2	6	7	4
41915	Groundwater	21/3/03	14:00	6.8	324	-	4	-	-	-	-	-	-	-
Average (median)														
Hemp Creek				*6.9*	*138*	*7.0*	*6*	*<1*	*134*	*27*	*<2*	*4*	*<5*	*3*
Comstock Creek				*3.8*	*327*	*5.8*	*7*	*<1*	*94*	*8*	*<2*	*9*	*<5*	*<2*
Little Henty River				*7.3*	*151*	*1.8*	*2*	*<1*	*196*	*2*	*<2*	*6*	*7*	*4*
Default trigger values for Southeastern Australia (Tasmania)														
Upland Rivers				6.5-7.5‡	90	2-25	-	-	480	190†	-	13	13	5

* ANZECC/ARMCANZ (2000).
† NO_3+NO_2.
‡ For Tasmanian lakes and rivers which are humic-rich: 4.0 - 6.5.

Table 2.5 Water quality - major ions

Lab.No.	Location	Date	Time	Na	K	Ca	Mg	Cl	SO_4	HCO_3*	Total Alkalinity	Hardness
				Concentration (mg/L)							mg $CaCO_3$/L	
40047	Hemp Creek	10/1/03	9:15	16.0	1.00	2.35	3.46	30	3.5	11	9	20
40167	Hemp Creek	17/1/03	14:00	16.3	1.14	2.69	3.74	31	4.1	13	11	22
40489	Hemp Creek	24/1/03	11:30	16.1	1.16	2.81	3.84	31	4.1	15	12	23
40048	Comstock Creek	10/1/03	9:15	10.4	0.41	9.67	8.21	21	97	<1.2	<1	58
40166	Comstock Creek	17/1/03	11:30	11.4	0.47	13.1	10.6	21	130	<1.2	<1	76
40488	Comstock Creek	24/1/03	10:00	11.2	0.43	14.0	11.3	21	130	<1.2	<1	81
40164	Little Henty River	15/1/03	13:00	11.2	0.65	7.94	3.62	21	7.4	24	20	35
40487	Little Henty River	22/1/03	15:00	11.8	0.70	10.1	4.30	21	9.0	30	25	43
40661	Little Henty River	29/1/03	14:00	11.6	0.70	11.5	4.62	21	9.3	37	30	48
41985	Groundwater	21/3/03	14:00	22.6	1.98	19.8	13.7	42	9.3	111	91	106
Average (median)												
Hemp Creek				*16.1*	*1.1*	2.69	*3.7*	*31*	*4.1*	*13*	*11*	*22*
Comstock Creek				*11.2*	*0.4*	*13.1*	*10.6*	*21*	*130*	<1.2	*<1*	*76*
Little Henty River				*11.6*	*0.7*	*10.1*	*4.3*	*21*	*9.0*	*30*	*25*	*43*

* Calculated from alkalinity assuming 100% contribution of HCO_3 at pH>6.5.

Table 2.6 Water quality - metals

Lab.No.	Location	Date	Time	Al	As	Cd	Cr	Cu	Fe	Mn	Hg	Ni	Pb	Se	Ag	Zn
				Concentration (µg/L)												
				Unfiltered												
40047	Hemp Creek	10/1/03	9:15	200	<5	<1	1	<1	368	8	<0.05	1	<5	<1	<1	2
40167	Hemp Creek	17/1/03	14:00	222	<5	<1	1	<1	411	-	<0.05	2	<5	<1	<1	6
40489	Hemp Creek	24/1/03	11:30	165	<5	<1	<1	<1	330	12	<0.05	1	<5	<1	<1	2
40048	Comstock Creek	10/1/03	9:15	1270	<5	4	<1	3	1110	2080	<0.05	30	79	<1	<1	5500
40166	Comstock Creek	17/1/03	11:30	1210	<5	4	<1	6	1090	-	<0.05	36	86	<1	<1	6010
40488	Comstock Creek	24/1/03	10:00	1470	<5	4	<1	5	1740	2650	<0.05	38	85	<1	<1	6930
40164	Little Henty River	15/1/03	13:00	144	<5	<1	<1	3	668	-	<0.05	3	9	<1	<1	181
40487	Little Henty River	22/1/03	15:00	124	<5	<1	<1	4	735	99	<0.05	3	9	<1	<1	205
40661	Little Henty River	29/1/03	14:00	77	<5	<1	<1	2	684	76	<0.05	2	<5	<1	<1	184
41918	Groundwater	21/3/03	14:00	50	<5	<1	<1	<1	3200	97	<0.05	<1	<5	<1	<1	8
				Filtered												
40047	Hemp Creek	10/1/03	9:15	174	<5	<1	1	<1	299	5	<0.05	2	<5	<1	<1	2
40167	Hemp Creek	17/1/03	14:00	147	<5	<1	<1	<1	287	-	<0.05	2	<5	<1	<1	4
40489	Hemp Creek	24/1/03	11:30	133	<5	<1	<1	<1	248	10	<0.05	1	<5	<1	<1	2
40048	Comstock Creek	10/1/03	9:15	1280	<5	4	<1	3	723	2060	<0.05	32	77	<1	<1	5540
40166	Comstock Creek	17/1/03	11:30	1180	<5	4	<1	5	462	-	<0.05	36	83	<1	<1	6000
40488	Comstock Creek	24/1/03	10:00	1480	<5	4	<1	5	993	2690	<0.05	38	87	<1	<1	7050
40164	Little Henty River	15/1/03	13:00	100	<5	<1	<1	3	507	-	<0.05	3	<5	<1	<1	148
40487	Little Henty River	22/1/03	15:00	100	<5	<1	<1	2	589	80	<0.05	3	6	<1	<1	185
40661	Little Henty River	29/1/03	14:00	58	<5	<1	<1	2	559	10	<0.05	<1	<5	<1	<1	154
Ambient freshwater water quality guidelines* Slightly-moderately disturbed ecosystems trigger value				55[†]	13[††]	0.2[H]	1[H,‡]	1.4[H]	ID	1900[C]	0.06[B]	11[H]	3.4[H]	5[B,‡‡]	0.05	8[H]

* ANZECC/ARMCANZ (2000). Based on a hardness of 30 mg $CaCO_3$/L. See notes.

  - pH of 6.8 is within the range measured in Hemp Creek.
  - Conductivity of 324 µS/cm is twice the median conductivity of Hemp Creek.
  - Unfiltered[1] As, Cd, Cu, Hg, Pb, Se and Ag concentrations are less than the practical quantitation limit (PQL) in the groundwater and Hemp Creek.
  - Unfiltered Al, Cr and Ni concentrations are the same or lower in the groundwater than Hemp Creek.
  - Concentrations of unfiltered Fe, Mn and Zn are higher in the groundwater than in Hemp Creek.
- Compared with the potential receiving waters of Comstock Creek, groundwater from the proposed decline portal area may be characterised as follows:
  - pH 6.9, higher than the range measured in Comstock Creek.
  - Conductivity of 324 µS/cm is in the range measured in Comstock Creek.
  - Unfiltered As, Cr, Hg, Pb, Se and Ag concentrations are less than the PQLs in the groundwater and Comstock Creek.
  - Unfiltered Al, Cd, Cu, Mn, Ni and Zn concentrations are lower in the groundwater than Comstock Creek.
  - The concentration of unfiltered Fe is higher in the groundwater than in Comstock Creek.

2.2.4 Environmental Objectives

Assessment of water quality data is undertaken by referring to the protected environmental values (PEVs) associated with any particular waterbody (DPIWE, 2000). Once the PEVs have been identified, objectives can be established that will achieve the required level of protection. Objectives vary depending on the particular beneficial uses, with some uses requiring better water quality than others.

The PEVs for surface waters in the West Coast Municipal Area are presented in DPIWE (2000). The PEVs for Little Henty River and Hemp Creek are:

- Protection of modified (not pristine) aquatic ecosystems from which edible fish are harvested.
- Recreational water quality and aesthetics: primary contact[2], secondary contact[1] and aesthetic water quality.

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[1] TSS = 4 mg/L.

[2] Recreation involving bodily immersion/submersion where there is direct contact with water, and includes swimming diving, surfing and water skiing (DPIWE, 2000).

Given that Comstock Creek is impacted by historical mining activity (DPIWE, 2000), the PEVs therefore are:

- Protection of modified (not pristine) aquatic ecosystems from which edible fish are not harvested.
- Recreational water quality and aesthetics: secondary contact and aesthetic water quality.

The protection of aquatic ecosystems generally requires more stringent water quality objectives than for the protection of recreational water quality and aesthetics. Therefore, for the purposes of characterisation of the water quality in the project area, the Australian water quality guidelines (ANZECC/ARMCANZ, 2000) TVs for the protection of slightly to moderately disturbed ecosystems have been used in this assessment (see Section 4.1.3).

As set out in the State Policy on Water Quality Management 1997, water quality objectives are determined by the Board of Environmental Management and Pollution Control, wherever practical and appropriate, based on site-specific information to supplement the latest edition of the Australian Water Quality Guidelines (ANZECC/ARMCANZ, 2000) and any other appropriate and authoritative information.

To support this process, Section 4.1.1:

- Identifies key potential pollutants associated with the Avebury Nickel Project.
- Predicts impacts of the project on PEVs and the spatial extent of these impacts.

2.3 Socio-economic Environment

2.3.1 General

The socio-economic environment was investigated by NSR and is described in Appendix 5. The following draws on the information provided in that report.

The mining industry in Tasmania is a major source of wealth within the state and the township of Zeehan, in particular, is reliant on the mining industry for its survival. There are three major operational mines in the area, namely the Henty Gold Mine, Mt Lyell Copper Mine and Renison Tin Mine.

New industries based around tourism and recreation (four wheel driving, fishing, and walking) are establishing in the area and have developed the need for additional services.

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[1] Activities where there is some direct contact, but it is unlikely that water will be swallowed (e.g., paddling, boating and fishing) (DPIWE, 2000).

Zeehan is the administrative centre for the West Coast and houses the council administration and a number of government agencies.

2.3.2 Demography

Until recently (2001 census data), Tasmania was the only Australian state or territory undergoing population decline in absolute numbers (Hydro Tasmania, 2003). The decline has been attributed to a general decrease in birth rates as well as a net migration deficit as Tasmanian-born residents leave mainly for employment opportunities in major cities on the Australian mainland and overseas (Hydro Tasmania, 2003). Consistent with the rest of the state, the population of Zeehan declined over the 15 years prior to the 2001 census (Table 2.7).

Table 2.7 Population of Zeehan 1986 to 2001

Year	Population	Decrease	% Change Over Time
1986	1,610		
1991	1,132	-478	-29.7%
1996	1,116	-16	-1.4%
2001	892	-224	-20.1%

Source: West Coast Council (2001a), ABS (2001).

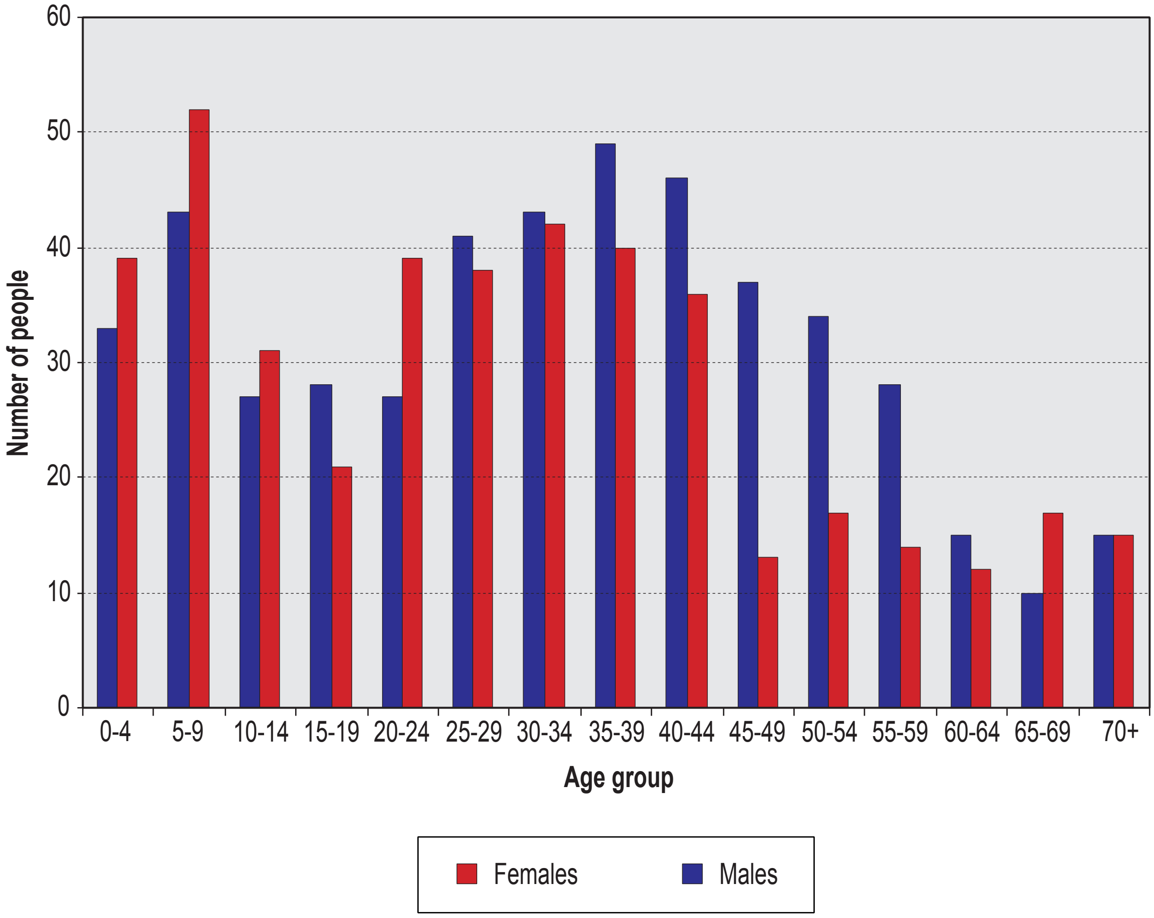
Figure 2.8 shows that a high proportion of the population is aged between 0 to 9 and 30 to 40 years of age. This suggests a predominantly family-orientated population with a high number of dependents.

Each of the individual age classes, with the exception of the 0 to 14, the 20 to 24 and the 65 to 69 classes, are dominated by males (see Figure 2.8). The gender ratio of the population is 53% males versus 47% females.

The population of Zeehan is predominantly Anglo-Saxon. The 2001 census shows that 91% were Australian-born. A small percentage of the population (4%) were of Aboriginal descent and less than 1% were of Torres Strait Island descent. The majority of people are affiliated with some kind of Christian religion (64%), with most following either the Anglican or Catholic Church.

In 2001, 30% of the Zeehan population (over 15 years of age) was qualified beyond secondary school level while 61% had no qualification (Table 2.8).

Trial Harbour is a small coastal settlement located approximately 20 km west of the project area (see Figure 1.1). It has a small permanent population of approximately 40, but during peak holiday seasons, the population increases by up to 200 people. The median age of the permanent population was estimated at 50 years in the 1996 population census for the Granville Harbour and Trial Harbour Collection District (Hydro Tasmania, 2003).



Source: ABS (2001)

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Age and gender of Zeehan population (2001)	Figure No: 2.8
	File No: 938_2_F2.08_HB	Avebury Nickel Project		

Table 2.8 Highest qualification level, 2001 (15 years of age or more)

Qualification	Males	Females	Total %
Postgraduate Degree	6	0	0.9
Graduate Diploma and Graduate Certificate	3	3	0.9
Bachelor Degree	20	14	5.1
Advanced Diploma and Diploma	18	11	4.3
Certificate	92	34	18.9
Not stated	35	26	9.1
Not applicable	193	213	60.8
Total	**367**	**301**	**100**

Source: ABS (2001).

2.3.3 Occupations and Incomes

Occupations

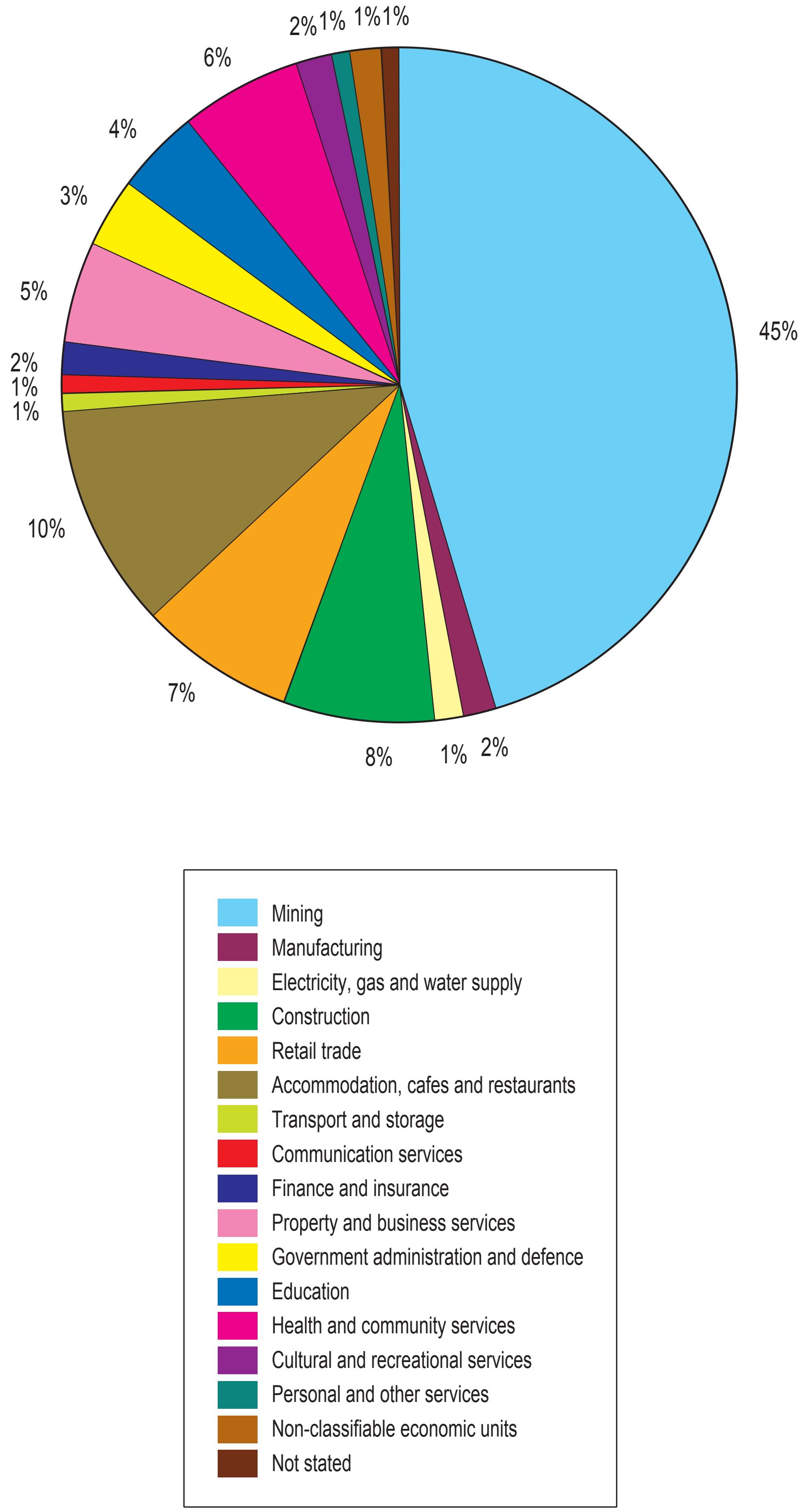
According to 2001 census data, 397 people were employed in Zeehan, representing 87.8% of the labour force[1]. The unemployment rate, therefore, for the same period was 12.2% (ABS, 2001, 2001a). This figure fluctuates throughout the year and is dependent on the tourism industry.

The socio-economic state of the west coast region of Tasmania has suffered due to rationalisation and downturn in both the mining and hydro-electric industries. In the last half of the 1990s, the mining workforce in the west coast region decreased by 25% from 1,206 to 905 (Hydro Tasmania, 2003). Employment distribution in Zeehan highlights the importance of the mining industry to the local economy, with 45% of the workforce directly employed in the mining sector (Figure 2.9). The hospitality industry (i.e., accommodation, cafes and restaurants) is the second largest employer comprising 10% of Zeehan's workforce. This is followed by the construction industry (see Figure 2.9).

Typically, men in Zeehan are employed at the mines, primarily the Renison Mine. Some are employed at the Henty Mine, and fewer still at Mt Lyell. Women are predominantly engaged in services supporting the tourism industry.

The construction of the Heemskirk Wind Farm will provide further employment opportunity for local people when 150 positions become available. More than 50% of personnel will be sourced from existing residents of the west coast area. Once in operation, a small maintenance crew will be required to service the wind farm over its 20- to 25-year lifetime (Hydro Tasmania, 2003).

[1] Labour force is defined, for the population aged >15 years, as those currently employed (full-and part-time) plus those unemployed and looking for work.



Source: ABS (2001)

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Distribution of employment in Zeehan (2001)	Figure No: 2.9
	File No: 938_2_F2.09_HB	Avebury Nickel Project		

Incomes

The average weekly income per household in Zeehan varies depending on whether it is a family[1] or non-family household. The 2001 census revealed that family households, on average, have a higher weekly income than non-family households. The most frequent household income for families is $1,200-$1,499 while the most frequent for non-families is $1-$199 (Figure 2.10).

2.3.4 Community Facilities and Services

The town layout of Zeehan is illustrated in Figure 2.11. Zeehan is relatively self-sufficient in terms of day-to-day services and facilities. However, due to improved transport infrastructure, west coast residents tend to travel to Burnie or Launceston for regular shopping trips and to access specialist health, education and financial services.

In January 2003[2], the following community services and facilities were recorded (Table 2.9).

Table 2.9 Community facilities and services in Zeehan

Service/Facility Type	Facility/Service Available in Zeehan
Health	• Zeehan Nursing Service • Zeehan Medical Centre (general practitioner provided) • Zeehan Neighbourhood Centre Incorporated
Childcare and Education	• Library • Zeehan Child Care Centre • State primary school
Shops and Commercial Services	• 2 small supermarkets • 1 newsagency • 2 milkbars/takeaway shops • 2 coffee shops • 1 pharmacy • 2 hotels • ANZ Bank • 1 craft shop (run by volunteers) • 1 secondhand shop
Local Police and Emergency Services	• Police station • Fire station
Local Industrial Services	• Airfield • Drillers • Welding • 2 petrol stations

[1] Family is defined by the ABS as a two or more persons, one of whom is at least 15 years of age, who are related by blood, marriage (registered or de facto), adoption, step or foster, and who are usually resident in the same household.

[2] NSR reconnaissance trip.

Table 2.9 Community facilities and services in Zeehan (cont'd)

Service/Facility Type	Facility/Service Available in Zeehan
Recreational Facilities	• Swimming pool • Squash courts • Tennis courts • Sports oval • Golf course
Cultural/Entertainment Facilities	• Catholic Church • St Luke Church • Lions club • RSL
Waste Disposal Facilities	• West Coast Council

Services provided in Burnie, Rosebery, and Queenstown are listed in Table 2.10.

Table 2.10 Community facilities and services available outside of Zeehan

Service/Facility	Location Service/Facility Available
High school	Rosebery, Queenstown
Specialty shops and services not in Zeehan	Queenstown, Burnie
Specialist medical services such as dentist, optometrist	Queenstown, Burnie
Hospitals	Rosebery, Queenstown

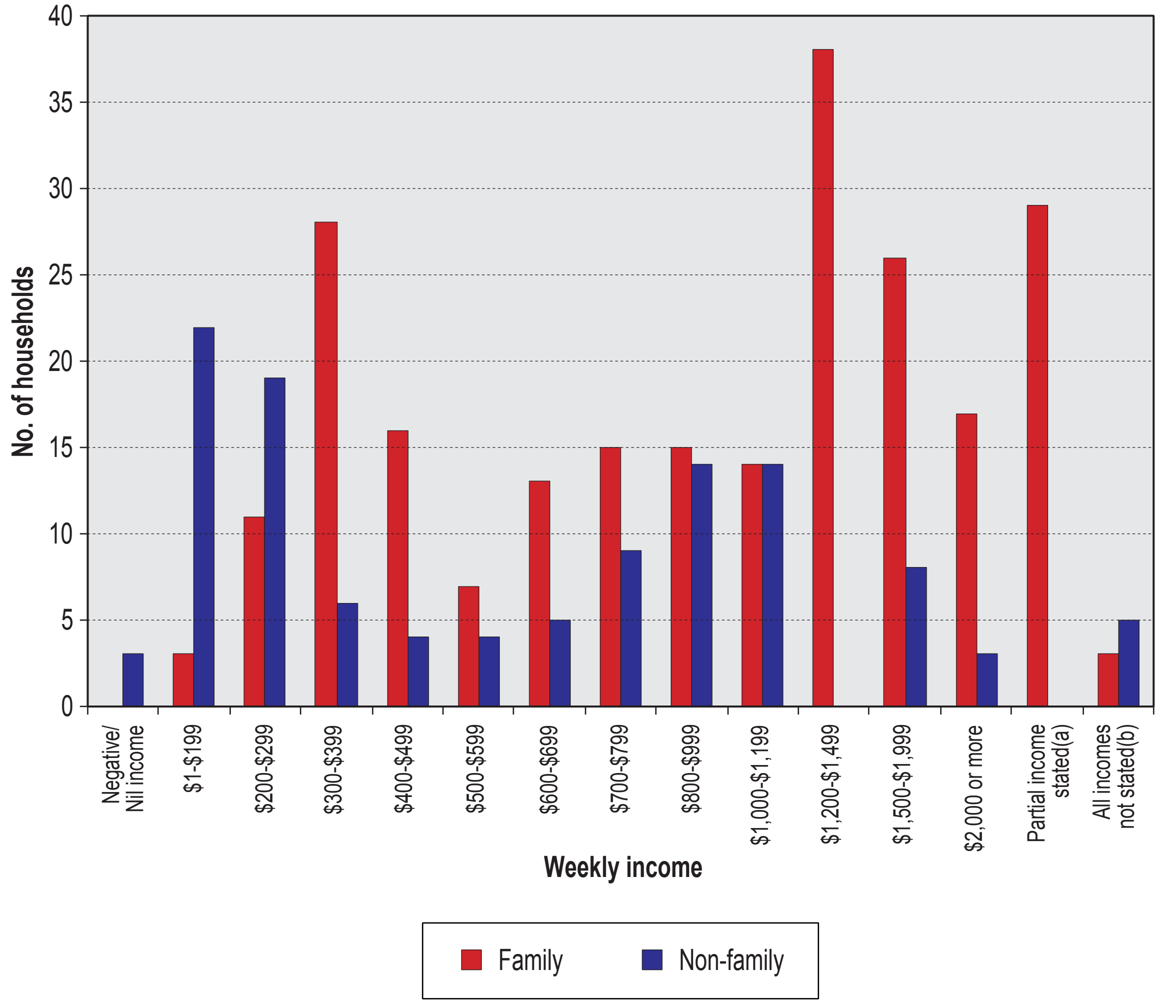
Source: Keating pers. com. (2003).

Trial Harbour has no commercial services or facilities. It has a recreational oval with a shed maintained by the Trial Harbour Progress Association. The community and the local fire fighters use the shed for meetings. There is also a history room that is run voluntarily by two of the permanent residents.

The town of Zeehan is connected to the state electricity grid, whereas electricity for Trial Harbour is supplied by diesel-powered generators and wind energy.

Zeehan has a sewerage and water scheme that has capacity to support up to 2,000 people. Trial Harbour has a rudimentary water supply and sullage system run by the Trial Harbour Progress Association. These services are only equipped to accommodate the current population (i.e., 40) and do not have capacity for expansion.

Since the 1960s, there has been substantial investment in the local road network providing direct highway connections between Smithton, Devonport, Burnie, Launceston and Hobart and the west coast. The only vehicle access to Trial Harbour is from Zeehan via the Trial Harbour Road. There are two railways on the west coast; the TasRail railway line connecting Melba Flats and Burnie, and the Abt Wilderness railway line, which is a tourist railway that runs between Queenstown and Strahan. The TasRail railway line provides a connection for mines and processing works to the Port of Burnie.

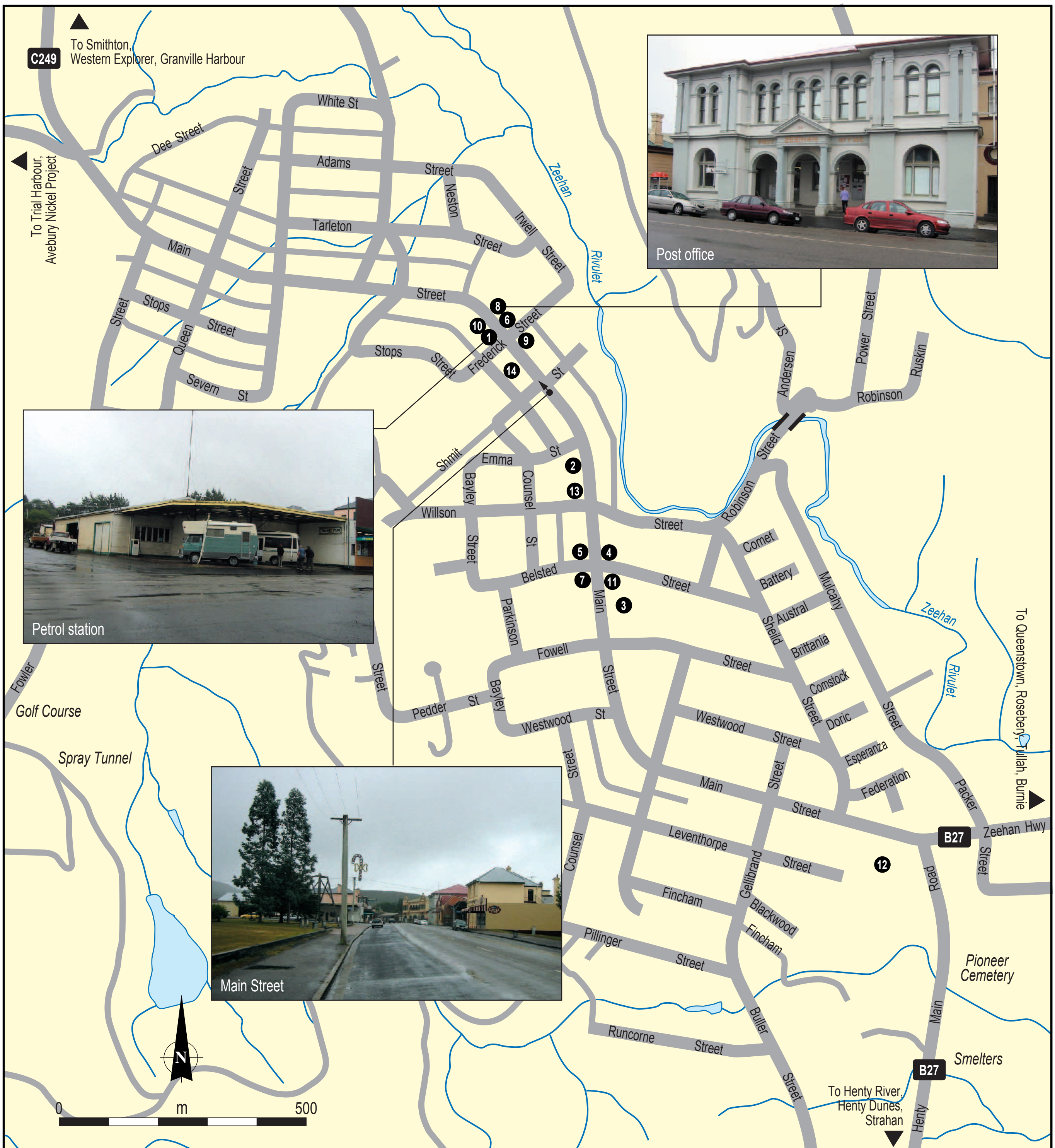


a) Includes families where at least one, but not all, member(s) aged 15 years and over did not state an income and/or at least one member aged 15 years and over was temporarily absent.

b) Includes households where no members present stated an income.

Source: ABS (2001)

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	**Weekly household income by household type in Zeehan (2001)**	Figure No: **2.10**
	File No: 938_2_F2.10_HB	Avebury Nickel Project		



Key

1 - Petrol station
2 - West Coast Council
3 - Primary school
4 - Police station
5 - Fire station
6 - West Coast Pioneers' Memorial Museum
7 - Medical centre
8 - Post office
9 - ANZ Bank
10 - Silver City Info/Tour
11 - Library
12 - Heemskirk Motor Hotel
13 - Cecil Hotel
14 - Howard Park

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Town layout of Zeehan	Figure No: 2.11
	File No: 938_2_F2.11_HB	Avebury Nickel Project		

There are three ports in operation on the west coast: Strahan, Trial Harbour and Granville Harbour. The latter two are limited to servicing the fishing industry. The Port of Strahan services the fishing and tourism industry.

Licenced airfields are located in Zeehan, Strahan and Queenstown. None of these provide regular connections and they are used mostly for private and charter aircraft. The airfields are used by the State Emergency Services, Parks and Wildlife Services and Forestry Tasmania, as well as mineral exploration companies.

Telephone, mobile phone and facsimile services are available in Zeehan.

2.3.5 Tourism

The town of Zeehan has approximately 90,000 to 100,000 visitors each year. One of the more popular destinations is the Pioneers' Memorial Museum (Plate 2.4), attracting 25,000 visitors annually.

The tourist season runs from September through to April, with peak numbers occurring between January and March. Over the four-month period from September 2002 to the end of December 2002, tourist numbers increased by 23% from 2001. This is thought to reflect the establishment of a daily ferry from Melbourne to Tasmania (Halton, pers. com., 2003).

Tourists who visit Zeehan usually come from Melbourne and travel to Cradle Mountain, Strahan and Queenstown to visit the Gordon River and the newly re-opened Abt Wilderness railway. The Gordon River cruise is a major drawcard and 73% of all visitors to the west coast go on the cruise. Tourists who visit Zeehan normally complete a circuit around Tasmania taking in southern, eastern and the northern parts of the state (Plate 2.5).

Tourists also visit Zeehan to pursue activities such as fishing, walking, and four wheel driving and stay in Zeehan when Strahan is fully booked.

With its operational port, Trial Harbour is also a popular place for fishing. Trial Harbour attracts a substantial number of weekender and holiday visitors.

2.4 Archaeology and Heritage

2.4.1 Aboriginal Heritage

The following is a summary of information provided in the Aboriginal heritage desktop assessment that was prepared by consultant Steve Stanton (Appendix 6).

Consultation

The Tasmanian Aboriginal Land Council (TALC), as Aboriginal community representatives, was consulted about Stage 1 of the Avebury Nickel Project to ensure that the Aboriginal community's cultural heritage interests are maintained and protected.

Archaeological Sites

Inspection of the Tasmanian Aboriginal Site Index (TASI) reveals there are no recorded sites within the study area. The surrounding country contains evidence of Aboriginal cultural heritage resources in the form of stone artefact surface scatters and shell middens that are concentrated near the coast, to the west of the study area. In order of proximity to the study area, the closest previously identified sites are:

- Stone artefact scatters (TASI 7763 & 7764) which were identified by Stanton (1997) during a survey of the Trial Harbour area in relation to the establishment of treatment ponds for septic waste. These sites are over 5 km to the west of the study area.
- Five artefact scatters and seven shell middens are recorded and registered during a TALC project in the Trial Harbour area; all are located over 5 km from the proposed mining site.
- An artefact scatter (TASI 198) and rock engravings (TASI 33), all of which lie close to the high water mark at Trial Harbour.
- An artefact scatter (TASI 2353) located near the Little Henty River, about 6 km southwest of the study area.
- An artefact scatter (TASI 4102) located approximately 10 km east of the study area.

Archaeological Site Distribution Patterns

While no regional assessment has been undertaken for the west coast of Tasmania, the results of assessments in other areas of the state provide a useful guide to previous Aboriginal use of the area and the likely patterns of site distribution in various landscapes. The Dunnett (1994) northern region survey included a sample survey of inland areas of northwest Tasmania. The terrain that occurs within the study area is similar to some of the landscapes investigated during Dunnett's assessment. The results of his assessment, therefore, provide a useful guide in terms of predicting both the type and extent of potential sites within the study area.

Dunnett found that while the density of artefacts and sites varied, they can be found anywhere in the region. He also found a higher incidence of sites and artefacts in the western portion of the northern region. These sites occurred at locations between the coast and elevations of 900 m above sea level (asl), and were often associated with the availability of raw materials for stone artefact manufacture, or other resources. The results of studies in other areas of Tasmania (e.g., Kee, 1990) suggest that artefact scatters are likely to occur on floodplains, terraces and undulating flats associated with rivers and smaller watercourses. Drier and well-drained locations are also likely to contain sites, particularly where they afford good access to fresh water.

There are also non-predictable Aboriginal sites, such as areas where local conditions have now changed, for example, where vegetation types or tree lines may have been different during previous climatic regimes, or prior to European modification of the landscape. Earlier landscapes may have been suitable for occupation by Aboriginal people or used for extraction of resources (e.g., plant foods or stone for artefact manufacture).

While prior studies have not defined site distribution patterns for the west coast region, the results of these studies in other regions of Tasmania suggest there is potential for sites to be present within the study area. The terrain of the study area appears to contain landforms that studies in other regions have shown are suitable for Aboriginal occupation or resource extraction (e.g., benches adjacent to watercourses, plains and marshy areas). There is also the possibility that sites are present based upon the premise that they may occur at random locations throughout the entire Tasmanian landscape.

2.4.2 Non-Aboriginal Heritage

The following is a summary of information provided in the historic heritage desktop assessment that was prepared by consultant Ian Terry (Appendix 7).

Local History

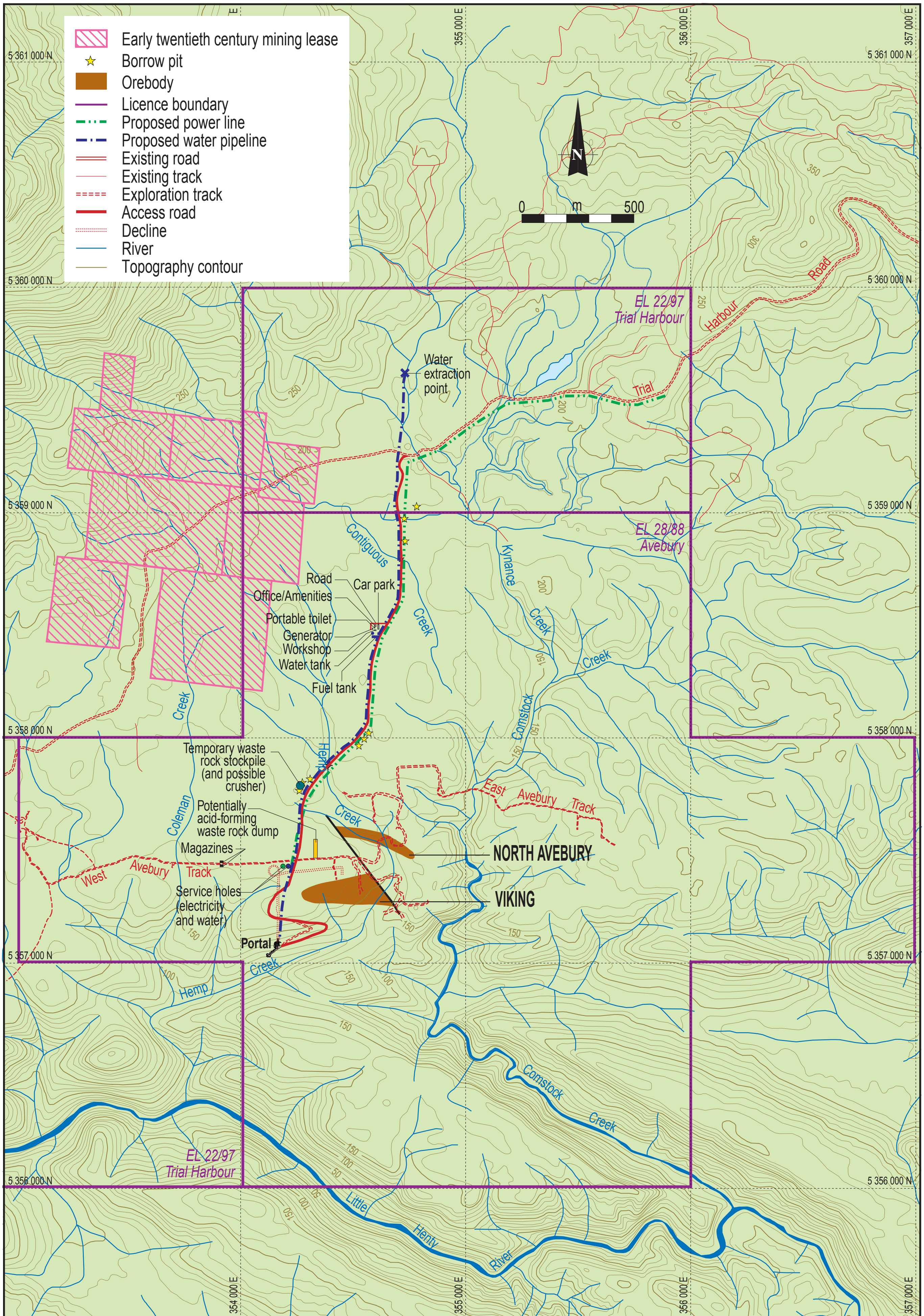
Parts of Tasmania's west coast were prospected through the 1870s. After surveyor Charles Sprent cut a track from the Pieman River to the Heemskirk region in early 1876, the Merediths, Donellys and Moores secured mining leases in the Pieman–North Heemskirk region (Binks, 1989). By the end of the decade some fifty companies had taken out leases on the Heemskirk field (Scripps, 1990).

The west coast region's first attempts at systematic mining occurred in the South Heemskirk area during 1880 to 1881 (close to the northwest corner of the study area) (Binks, 1988). Extensive prospecting in this region culminated in the discovery of rich silver ores at Zeehan in 1882 (Binks, 1989).

In 1882, the overseer of roads to Trial Harbour, John Clay, recommended the cutting of access tracks between the Heemskirk and West Coast ranges. R.H. Carlisle, a Heemskirk mine manager, won the tender. The tracks were marked by blazing trees, and started at the Mt Agnew huts close to the current Trial Harbour Road (Binks, 1988).

Carlisle's track was superseded in 1885 by a lower level bridle track. Trial Harbour Road, as it currently exists, generally follows the alignment of the 1885 track, and was constructed between 1886 and 1888. It was a difficult track, originally constructed of corduroy (a construction of logs laid together transversely) on swampy ground, over which all early mining equipment to Zeehan had to be conveyed. Wrecked carts with broken axles were a common sight along its length (Binks, 1988).

Although the study area was almost certainly prospected between 1877 and 1905, few mining leases have been taken out in the study area. Leases secured included four tin mining leases and one general mining lease granted and voided between 1905 and 1912 (Figure 2.12). These leases were short-lived and were probably only very lightly worked, if at all. The tin sought was alluvial in nature and any activity that may have occurred probably left few substantial remnants.



NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Approximate location of early twentieth century mining leases	Figure No: 2.12
	File No: 938_2_F2.12_HB	Avebury Nickel Project		

A water right was secured along Colemans Creek in October 1969 that covered five acres crossing the Trial Harbour Road on the western edge of the study area and was later forfeited in October 1976 (Mineral Resources Tasmania, 2002).

Several other mining leases were taken out in the northeast corner of the study area between 1975 and 1991. Given the almost-contemporary nature of these leases, they are considered to be unlikely to contain historically significant remnants related to the period of their working and were not examined.

Several sawmills operated in the region between the 1940s and 1960s. A log landing, constructed of earth and logs, is located about 40 m east of the Trial Harbour Road adjacent to the study area.

Historic Significance

No sites within the study area are currently listed in local, state or national heritage registers. The following assessment of historic significance is therefore based on the professional opinion of the heritage consultant.

Trial Harbour Road

The Trial Harbour Road was one of the first roads to be constructed in the region. It was critical to the early development of the central west coast's first successful mining field located at Zeehan. All mining equipment to Zeehan was initially carried along this road until the construction of the Zeehan–Strahan railway in the early 1890s. The road may contain evidence of early road construction techniques including culverts, bridges and retaining walls. It may also contain remnants of wrecked nineteenth century vehicles and/or mining equipment.

The Trial Harbour Road is considered to be of state significance because it:

- Was the first road route to the late nineteenth century mining town of Zeehan.
- Demonstrates late colonial governmental responses to providing transportation links to a remote mining town (critical to the development of the colony's late nineteenth century economy).
- Demonstrates the responses of late nineteenth century road builders to difficult environmental and topographic constraints.
- Demonstrates late nineteenth century road building technologies and techniques.

Early Twentieth Century Mining Leases

Mining or prospecting activity that occurred in the region during the early twentieth century is likely to have been low level. Evidence of shallow shafts, costeans[1], small-scale mining equipment and some domestic remnants such as basic huts and/or garbage dumps may remain.

[1] Trenches or small pits cut across a rock outcrop to expose the full width of an orebody.

The early twentieth century mining leases could be considered to be of local significance because they can contribute to our understanding of early twentieth century prospecting and subsistence mining activity in a remote area.

Log Landing

The logging ramp indicates that logging occurred in or adjacent to the study area and may indicate the presence of other associated sites nearby, such as abandoned logging equipment. Log landings are common throughout Tasmania and are considered to be of low historic significance.

Historic Sensitivity

The study area is located in a region of late nineteenth century mineral activity, which was crucial to the economic development of the colony. As such, any remnant historic features from the period 1877 to 1912 in the region are potentially of historic heritage significance[1], in that they are able to inform present and future generations about the early history of prospecting and mining activity of the region. While mining activity levels appear to have been generally low within the study area, there are two areas of historic heritage sensitivity identified in the study area:

- A 20-m-wide corridor along the Trial Harbour Road.
- The northwest quarter of the study area (which also contains the log landing).

Mitigation measures associated with the management of these areas are discussed in Section 4.7.

[1] See Appendix 7, page 11 for the definition of historic significance under Tasmanian legislation.

3. Development Description

3.1 Project Components

Stage 1 of the Avebury Nickel Project will be constructed within Exploration Licence (EL) 28/88 which will become part of the proposed Stage 1 mining lease area (see Figure 1.2), the application for which will be lodged with the government in May 2003.

Three components are associated with the development (Table 3.1) (see Section 1.2.1 and Figure 1.3)

- Construction of the access road.
- Viking decline and portal development.
- Supporting and ancillary infrastructure.

Table 3.1 Summary of project components

Component	Area (ha)
Access road	9.6
Portal	0.5
Supporting infrastructure/facilities	1.9
Total	**10.5**

3.1.1 Access Road

A 3-km access road from Trial Harbour Road to the decline portal will be constructed in two phases, the total area of which will occupy approximately 9.6 ha of land (this includes clearing for the water and power lines and passing bays).

The first phase will involve upgrading the existing exploration track, that extends from Trial Harbour Road to the portal, to a standard sufficient to sustain traffic requirements for installation of the required supporting infrastructure and commencement of the box-cut and decline.

The second phase will involve additional upgrading of the access road with suitable development waste associated with construction of the decline (Section 3.2.4).

3.1.2 Viking Decline and Portal

The Viking decline portal will be located approximately 1.5 km south-southwest of the plateau infrastructure area on the northern side of the Hemp Creek valley (see Figure 1.3). A total area of 0.5 ha will be required for this facility. Construction of the Viking decline and portal will take place in two phases:

- Development of a box-cut at the decline portal (Section 3.3.1).
- Construction of the decline accessing the Viking orebody (Section 3.3.2).

The box-cut is required to ensure that the decline is constructed in stable ground and construction will commence once the phase 1 upgrade for the access road to the decline portal has been completed.

Construction of the decline will commence as soon as the box-cut has been developed. Totalling approximately 1,100 m, the decline will allow development of two cross-cuts into the upper levels of the mineralisation.

3.1.3 Supporting Infrastructure

Infrastructure development will be focussed in two areas, i.e., at the decline portal and on the plateau north of the portal. Electricity, water supply, workshop and offices, ablutions, explosive and fuel storage facilities will be provided.

The plateau facilities (electricity, water tanks, offices and car park, workshop and fuel tank) will be located along the access road approximately 1 km south of Trial Harbour Road (see Figure 1.3) and will occupy an area of 1.9 ha. These facilities will be required to provide infrastructure support during the construction of the decline. Development of these facilities will commence as soon as the phase 1 upgrade for the access road has been completed.

There will be a short-term requirement for an electricity generator and compressor at the portal during the development of the first leg of the decline, i.e., a two- to three-month period. After this, during construction of the second leg of the decline, these services will be provided from the plateau facilities via services holes (see Figure 1.3). The only remaining service at the portal will be the underground water supply (Section 3.2.2).

Two waste rock dumps are required as part of decline development. A temporary dump will be located along the access road approximately half way between the portal and the plateau infrastructure site. The potentially acid-forming waste rock dump will be located along an existing exploration track off the West Avebury Track (see Figure 1.3).

3.2 Infrastructure

3.2.1 Energy Supply

Plateau

Initially, temporary power will be supplied to the plateau supporting and ancillary infrastructure area by a 250-kW diesel power generator (see Figure 1.3). The generator will be used for the first three months of Stage 1 development until an electricity supply from the main grid is established.

Mains power will be provided by extending the existing 22-kV line from the Comstock Mine (see Figure 1.3) along Trial Harbour Road to the Avebury access road. The line will then follow the access road to the plateau infrastructure area (see Figure 1.3).

A pole-mounted transformer (22 kV/11 kV), temporary sub-station and an 11 kV/415 V transformer will be installed and power (11 kV) will be carried from the pole transformer to the mine via poles and then down a services hole to the decline. This will eliminate the need to clear an easement through the rainforest to the portal site.

Portal

Power will be required underground for drilling, pumping and ventilation. During construction of the first leg of the decline, power will be supplied by a 500-kVA diesel generator situated at the portal that will be fuelled on a daily basis by a small tank mounted on a 4WD vehicle. Power will be reticulated underground by cables hung from the roof of the decline.

Once power from the main grid has been connected to the decline via a services hole, the generator will be removed and the compressor at the portal will be replaced by an electric underground facility.

3.2.2 Water Supply and Management

Water Supply

Potable water will be drawn from Kynance Creek approximately 300 m upstream of Trial Harbour Road and gravity fed to a 20,000-L, above-ground fibreglass or poly tank (see Figure 1.3). Flow control will be achieved using a float valve mounted on the tank and supply regulated by a pressure pump. Water will be reticulated for the following uses:

- Potable water for the office complex.
- Ablution facilities.
- Initial underground water supply.
- Workshop washdown.
- Fire fighting services.

Water to the underground workings (decline development) will be reticulated by a poly pipe laid along the access road to the portal. Once the decline has advanced, most underground water requirements will be met by recirculating decline groundwater discharge. Any additional requirements will be piped directly underground down a services hole, eliminating the need for a pipeline down the steeper section of the road to the portal. Once the services holes have been established, the surface water pipeline will be removed.

The water tank will be configured so that a secure fire water store is maintained irrespective of other water use. Half the tank (10,000 L) will be available for fire fighting services.

It is estimated that the water demand from Kynance Creek will be 3,000 L/day for personnel requirements and 2,000 L/day for initial underground water, fire and washdown requirements, totalling 5,000 L/day.

Waste Water Management

Waste water will be generated principally from the shower units. Waste water will be collected in a 5,000-L tank and disposed of twice weekly (or as required) by a registered waste removal company to the West Coast Council wastewater treatment facility in Zeehan. The waste removal company will hold an approved Waste Transport Business Environment Protection Notice (WTB-EPN) issued under the EMPCA.

3.2.3 Sewage

Plateau

Toilet facilities will comprise one trailer-mounted toilet. Provision will be made for weekly emptying and cleaning of the unit at the West Coast Council wastewater treatment facility in Zeehan. The waste removal company will hold an approved WTB-EPN.

Portal

Similarly, a single trailer-mounted toilet will also be positioned near the portal. Provision will be made for emptying and cleaning the facility in conjunction with the toilets from the office building in the supporting and ancillary infrastructure area. The toilet can be located underground if required. Excess mine water discharged to the water treatment system, and thereafter Hemp Creek (or if required Comstock Creek (Section 4.1.2)), will be monitored for faecal coliforms to monitor for potential human sewage contamination.

3.2.4 Road Access

The first 2.5 km of the access road south of the Trial Harbour Road will traverse relatively flat country with two minor stream crossings over Contiguous and Hemp creeks. The final 0.5 km will descend the Hemp Creek valley to the portal site with local grades up to 10%.

The access road will be constructed to a Class 2 standard road in accordance with the Forest Practices Code (Forestry Tasmania, 2000). The principal specifications for such a road are:

- 1,000 to 2,500 t traffic per week.
- All weather surface.
- 5.5 m pavement.
- 0.6 m shoulders.
- Maximum gradients of 10%.

Forest Clearance

Prior to widening and upgrading of the existing exploration track, salvageable timber will be identified by Forestry Tasmania. This timber will be selectively felled and stockpiled for early removal by Forestry Tasmania.

The southern kilometre of road passes through mixed eucalypt, blackwood, myrtle and sassafras forest that was selectively logged in the 1950s and 1960s and partially burnt. The final leg of the access road will have to depart from the existing access track in order to maintain a safe truck-operating grade of 10%. This departure is shown in Figure 1.3.

Topsoil and Vegetation Clearing

Topsoil will be defined as the top layer of fertile soil, including all plant matter, which can be respread over disturbed surfaces to support regrowth of the natural vegetation. Road clearing will be undertaken by excavator. Topsoil and associated vegetation will be stripped and, wherever possible, topsoil will be immediately placed on areas requiring rehabilitation. If this is not possible, topsoil will be stockpiled along either side of the road in flat areas or on the downhill side of the road in the steeper southern section for use in later rehabilitation works (Figure 3.1).

Topsoil dumps will be formed on flat ground, with as little compaction as possible, in ‘finger’ mounds generally no more than 0.6 m high and 30 to 40 m long to maintain the fertility of the soil and minimise rehandling requirements.

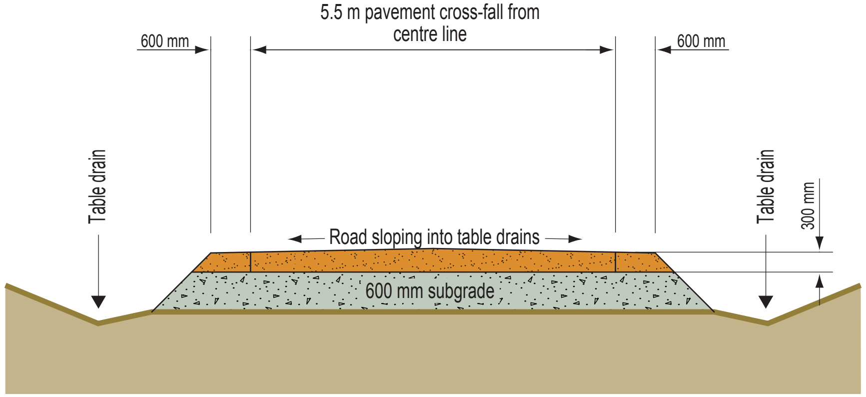
Vegetation clearing associated with road construction will be minimised to reduce soil disturbance. Cleared shrubs and trees will also be stockpiled and used to control surface runoff and erosion. A Forest Practices Officer will be consulted to ensure that appropriate measures are taken to avoid the spread of myrtle wilt. Trees adjacent to the road clearing that have a significant probability of falling onto the road, will also be removed and stockpiled.

Creek Crossings and Road Drainage

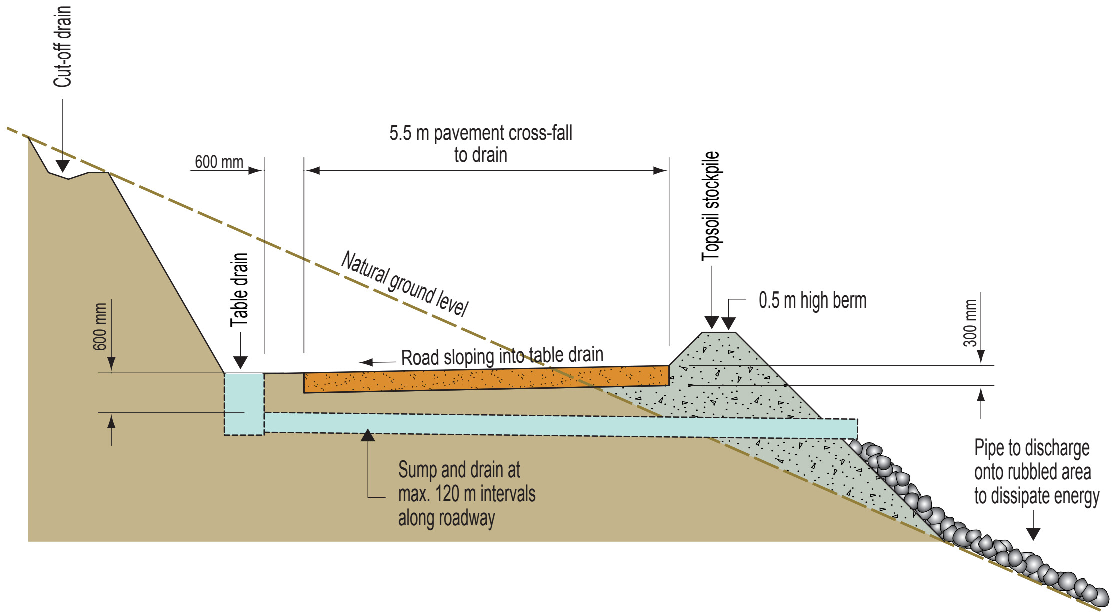
The two main creek crossings associated with the access road will involve installing culverts, within fill from the borrow pits, at Hemp and Contiguous creeks. The catchment areas upstream of the two creek crossings are approximately 50 ha and 200 ha, respectively.

The road will be designed to approach both creeks at right angles and culverts will be installed for both creeks in accordance with the Forest Practices Code. Special attention will be given to ensuring the culverts have fish-friendly bio-baffles and are set marginally below the creek bed level to facilitate movement by aquatic fauna.

Where possible, table drains will be installed along both sides of the access road. Table drain culvert pipes or spoon drains will be spaced at appropriate intervals for the grade of the road, as nominated in, and in accordance with, the Forest Practices Code, to divert drainage into the surrounding standing vegetation. The table drain will be diverted 50 m in advance of the creeks to drain water off the side of the road into standing vegetation. On the steeper section of road leading to the decline portal, the surface will be sloped from the base of a berm on the outer side of the road back into the table drain at the base of the batter. Water will flow along these drains to culvert pipes, spaced at a maximum of 120 m intervals, where it will pass under the road and discharge into standing vegetation on the downhill side of the road. If necessary, measures will be implemented to dissipate energy of the runoff, such as



Typical section through access road



Section through steeper section of the access road from the plateau to the portal

Note: Roads to be constructed to Forest Practices Code 2000.

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placing bundles of cleared vegetation (e.g., tea-tree) and silt fences at the end of spoon drains and culverts to filter sediment collected in the runoff from the road (Section 3.4.3). Catch drains may be required above the road in places.

Vegetation disturbance through the informal streamside reserve on the west side of Hemp Creek will be minimised by felling vegetation parallel to the road route and away from the creek.

There will be approximately eight smaller water crossings that will be constructed by installing small culverts.

Road Construction Materials

Construction of the exploration access track to the Trial Harbour Road revealed that the northern kilometre of the road route is very flat and difficult to drain effectively, with very hard and highly irregular fresh rock (which can't be broken with an excavator) underlying shallow peat.

To make this section of the road suitable for phase 1 access, the road will need to be top-dressed with local rock in order to elevate the surface for suitable drainage and to provide a driveable surface. Therefore, it is planned to 'pop' (blast) some areas of the road surface and develop a series of borrow pits 300 m south of Trial Harbour Road, and to the south of the flat section immediately adjacent to the access road, for this purpose. An estimated 5,000 t of rock would be required. Blasting would not be required for the borrow pits and these areas are not visible from the Trial Harbour Road.

The second phase of access road construction will involve the use of waste rock generated from development of the decline and the decline portal box-cut, where such material is classified as competent and non-acid forming. The total amount of rock generated is estimated to be 100,000 t.

Determination of the suitability and management of waste rock for road construction is described more fully in Section 3.4.1.

Borrow pits created to source top dressing material for the access road will be rehabilitated (see Section 5.14).

3.2.5 Ancillary Facilities

Office and Ablutions Buildings

This will consist of three transportable buildings that will house male and female change rooms, showers, crib room, lamp room and general offices, and first aid facilities. The area will be covered to provide protection from weather.

Surrounding surfaces will be covered with rock screenings to reduce the potential for sediment in surface runoff.

Car Park

Provision has been made for parking of 10 cars in a small cleared area north of the office building adjacent to the access road.

Surrounding surfaces will be covered with rock screenings to reduce the potential for sediment in surface runoff.

Workshop Stores Building

A workshop/stores building will be erected near the office facility. It will have a concrete floor and containing walls to hold any spills. A concrete forecourt washdown facility will slope to a drain and carry washdown to an oil trap and from there to a settling pond (Section 3.4.3).

Fuel and Oil Storage

A 10,000-L diesel fuel tank will be installed adjacent to the workshop and will be bunded in accordance with AS1940-1993 to contain spills. Initially, there will be two generators operating on site (see Section 3.2.1) and the tank will be filled twice a week by a small-sized road tanker. Once main power replaces the two generators, the tank will require filling once every one to two weeks.

Fuel distribution from this main tank to the portal and underground will be by a small tank mounted on a 4WD vehicle.

Various types of clean oils (e.g., hydraulic, engine and gear box oil required by underground equipment) will be stored in small drums as delivered by the supplier. Container sizes will vary from 20-L to 200-L steel drums. The total quantity of clean oil on site at any time is estimated to be less than 600 L.

A waste oil area will also be located within the fuel storage bund. All waste oils, grease and degreasers will be stored centrally, but separately, in steel drums at this location for collection and disposal by a licenced contractor (who holds a WTB-EPN) on a fortnightly basis (or as required) (Section 3.4.5).

Compressor

Compressed air is required underground for a variety of drilling and ground support operations. For the initial leg of the decline, compressed air will be supplied by a diesel-powered compressor located near the portal. The compressor will be bunded to provide protection from fuel spills and oil leakages. It will be refuelled on a daily basis by the same 4WD vehicle refuelling the generator (see sections 3.2.1 and ‘Fuel and Oil Storage’ above).

Once mains power is connected to the decline via a services hole, the portal compressor will be replaced by an electric underground facility.

3.3 Decline Development

3.3.1 Portal Box-cut

The portal site will be cut into the side of the hill at a grade of 1:100 until a suitable solid excavation face is established. The box-cut will be excavated as a series of top-down benches (5 m in height) and dug out with a loader or excavator. Once the initial material is removed, blasting may be required.

Waste rock from the box-cut will be used to top dress the access road (phase 1) from the portal area uphill towards the plateau.

It is envisaged that an area of approximately 20 m x 50 m will be exposed to form a suitable and stable portal site for the decline entrance. Sufficient room on either side of the portal is essential for surface facilities described in Section 3.2.5.

A 55° overall face angle will be excavated at the intersection of the box-cut face and competent portal face (at least 10 m in height). The face will be reinforced with rock bolts, mesh and shotcrete over a 3 to 4 m area around the portal (decline opening). Once development of the initial decline is complete, the need for extra support in the form of steel sets and/or cable bolts will be considered. After a stable opening is achieved, a permanent concrete collar will be formed around the entrance.

3.3.2 Decline Development

Decline

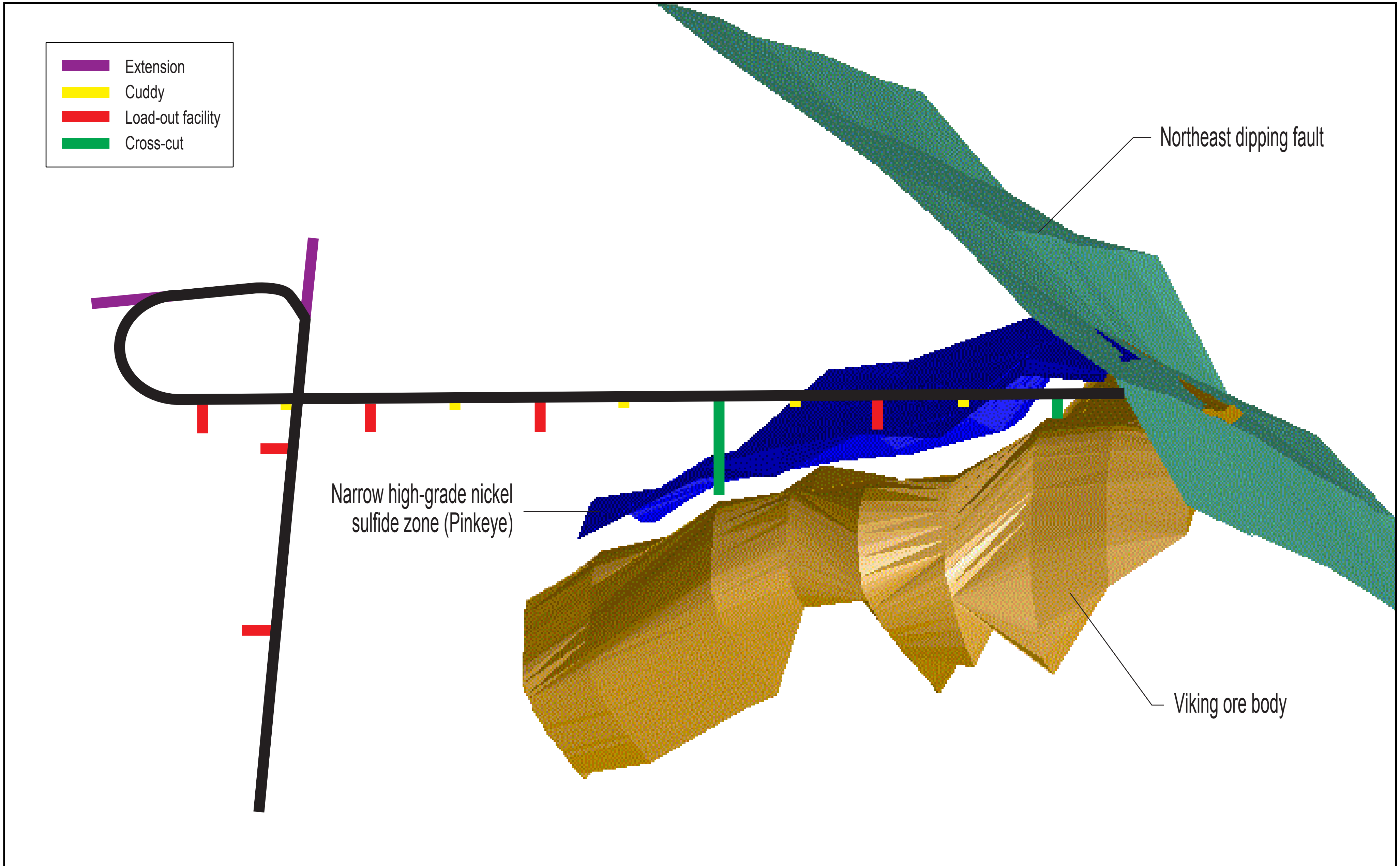
A 5 m x 5 m decline at a gradient of –1:7 is proposed. The decline comprises two legs; the first leg from the portal is to be approximately 300 m in length and the second is approximately 800 m (Figure 3.2). Gradients around corners are designed at –1:9.

Decline development will be by conventional drill and blast tunnelling techniques using an electro-hydraulic twin boom jumbo, a 6 to 7 m^3 front end loader and 30 to 50 t off-highway dump trucks. Following blasting, a front end loader will load broken rock into a truck at one of six load-out stockpiles. Load-out stockpiles are 20 m long excavations off the side of the decline that will be developed at intervals of 100 to 115 m. The trucks will then transport the rock to the surface (Section 3.4.1).

Five diamond-drill cuddys (4 m x 5 m x 4 m) will be established every 50 m along the second decline leg (see Figure 3.2) to facilitate the drilling program.

Provision will also be made for future decline extensions. Two extension legs, each 30 m long, will be constructed off the western decline loop between the first and second legs (see Figure 3.2).

Compressed air and water services will be provided using 100-mm and 50-mm extruded poly piping hung from the roof of the excavation.



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Schematic of decline

Figure No: **3.2**

Cross-cuts

Once the decline has accessed the cross-cut locations within the hanging wall of the Viking orebody, two cross-cuts will be driven across to the footwall contact of the ore zone (see Figure 3.2). The cross-cuts will be at least 60 m long and 5 m x 5 m to allow truck access if necessary. Cross-cut development is expected to intersect the 'Pinkeye' orebody which exists as a narrow band of ore off-set up to 30 m from the hanging wall of the Viking orebody. A bulk sample of approximately 150 t of mineralisation will be excavated and transported to an off-site facility for metallurgical assessment. This will involve about eight trips (20-t trucks) along the Trail Harbour Road over a one-week period at the end of Stage 1 development.

Drilling and Blasting

Drilling and blasting will be required during underground decline development using conventional burn-cut tunnelling techniques. Drilling will be performed by the jumbo unit and charge-up and blasting activities performed by the forklift or equivalent utility vehicle. Conventional dry ammonium nitrate fuel oil (ANFO), packaged emulsion and non-electric detonators are to be used as the blasting agent and accessories. Non-electric initiation using fuse and detonator is the preferred and safest initiation method.

3.3.3 Transport Requirements

Transport requirements associated with the project are quantified in Section 3.3.4. All equipment will be brought in along Trial Harbour Road from Zeehan to the project site. In addition, it is anticipated that salvageable timber identified by Forestry Tasmania will be transported off site during October and November 2003 in 20-t truck loads. This may represent one truck every second day for one month.

3.3.4 Vehicle and Equipment Requirements

Vehicles and equipment required for the project is summarised below. These represent trips to and from the project site.

Infrastructure and Road Development

- Mobilisation and demobilisation[1] of excavator and daily support 4WD vehicle for a six-month period during construction of the access road.
- 20 low-loader trips over a two-month period with infrastructure items, including office and workshop buildings, generators and compressors.
- Vehicles necessary to construct power line (construction of the power line is not the responsibility of Allegiance).

[1] Mobilisation and demobilisation occurs once and involves two trips, one to the site at the start of the project and one from the site at the end of the project.

- 2 x 20-t truck trips per day over a two-month period for general infrastructure requirements, including transport of culvert pipes, power cabling and water pipelines.
- One concrete truck every second day over two-month construction period.
- 4 x light service vehicle trips per day for two-month period.

Viking Decline Development

Various items of equipment will need to be mobilised and demobilised to the project area for construction of the Viking decline. This will be done by low-loader and include:

- Drilling jumbo.
- Underground loader.
- Two underground trucks.
- Surface loader.
- Excavator.

In addition, 2 x 20-t surface trucks that will be able to access site under their own means will distribute road-building materials.

During construction of the box-cut and the Viking decline, various service vehicles will be required to regularly access the area:

- 6 x light service vehicle trips per day from Zeehan.
- 1 x 20-t diesel fuel truck per week.
- 1 x 20-t explosives truck per week.
- 1 x 10-t waste removal vehicle per week.
- 8 x 20-t trucks transporting the bulk sample.

3.3.5 Ventilation

No provision has been made for primary ventilation (i.e., ventilation raise and circuit with surface air fans and exhaust) development. Secondary ventilation (i.e., individual fan(s) installed underground) will be established using a 1.2-m diameter ventilation fan and ventilation tubing.

3.3.6 Magazines

The magazine will be located on an existing exploration track 1.3 km southwest of the supporting and ancillary facilities and 500 m northwest of the Viking decline portal (see Figure 1.3). There will be two units: one for explosives (5 to 6 t of ANFO and 2 t of packaged explosives) and the other for detonators (1,000 to 2,000). Each unit will be waterproof and fitted with lightning protection.

The magazines are required by regulation to be a minimum of 50 m apart and surrounded by a 50 m zone cleared to bare earth. Weathered rock and soil cleared from the site will be used to construct the magazine bunding to a height of 1 to 2 m. The magazine site will be about 1 ha in size.

Cleared vegetation[1] will be stockpiled as described in Section 3.2.4.

3.3.7 Mine Closure and Rehabilitation

In the event that a decision is reached not to continue the Avebury Nickel Project beyond Stage 1 development, closure and rehabilitation would be undertaken by Allegiance as follows.

Additional details regarding mine closure and planning are provided in the Mine Closure and Rehabilitation Plan (Section 5.14).

Stockpiled Waste Rock

All stockpiled waste rock would be returned underground.

Mine Services

All underground mine services and equipment, such as air lines, ventilation ducting, power cabling, underground pumps and transformers would be removed from the decline and taken from the project area for either sale or use on other projects.

Decline Portal and Box-cut

The decline and box-cut would be retained and made safe. The portal would be appropriately sealed to prevent unauthorised access but to allow ingress by bats if there is evidence that they are using the decline as habitat.

Infrastructure

On closure, all infrastructure would be removed from the project area for either sale or re-use on other projects. All concrete structures would be broken up and removed from site, and the borrow pits and excavations would be backfilled, profiled and rehabilitated. The area would be appropriately fertilised and seeded in accordance with the Mineral Exploration Code of Practice (Tasmania Development and Resources, 1995).

Roads

Culverts along the access road from the Trial Harbour Road to the decline portal would be removed and creek crossings re-established to original profiles. Existing exploration tracks and the access road would be rehabilitated by replacing and reprofiling topsoil and vegetation stockpiled along the roads.

If necessary, the reprofiled tracks and access road would be appropriately fertilised and seeded in accordance with the Mineral Exploration Code of Practice (Tasmania Development and Resources, 1995).

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[1] Forestry Tasmania will identify salvageable timber.

3.4 Wastes

3.4.1 Waste Rock

The composition and variability of waste rock from development of the decline has been evaluated to determine the potential to produce acid and hence release dissolved metals.

Modelling indicates that approximately 100,000 t of development waste rock will be extracted. Waste material from portal and decline development will comprise siltstone (10%), mafic agglomerate (4%) and hornfels (86%).

Geochemical testing (Appendix 8) indicates that, of the 15 samples analysed, nine were classified as non-acid–forming, two as potentially acid-forming (PAF) and four were designated as uncertain, but possibly low capacity PAF material (Table 3.2). Management and monitoring strategies will be required to minimise the potential for impacts from the possible formation of acid rock drainage.

Table 3.2 Classification of expected waste rock at Avebury by potential acid-forming characteristics

ARD Classification	t	%	Management Requirement
PAF	3,000	3	Excluded from use as road base; prevent oxidation
Non-acid–forming (NAF)	92,000	92	Suitable for use as road base
Marginal (PAF but low capacity likely)	5,000	5	Blend with NAF material; suitable for use as road base

Kinetic net acid generation (NAG) testing confirmed that PAF material is likely to be acid-generating but that the initial pH buffering provided by the acid-neutralising capacity could delay the onset of acid conditions. Although the extent of this lag is difficult to predict, a period of several months and possibly longer is expected.

A key aspect of the waste management strategy will involve routine examination of rock types to identify PAF material during decline development. This will be undertaken by a geologist and will involve visual assessment in conjunction with drill core information that has allowed Allegiance to identify the zones containing sulfidic material.

All suitable (competent and non-acid–forming, and marginal material after blending) waste rock from the box-cut and the decline development will be used for construction of the second phase of the access road and for the plateau infrastructure site.

Initially, waste rock suitable for road construction will be stockpiled in one of two temporary surface stockpiles. A 1,000-t stockpile will be located at the portal where material will be stockpiled for a maximum of 24 hrs. This stockpile will only be required during the first 200 m of decline development before loading bays are constructed and underground trucks are commissioned. Up until this point, a loader will transport the waste rock to the portal stockpile. Once underground trucks are operating, the portal stockpile will probably no longer be required and underground trucks will transport waste rock to the other 2,000-t temporary waste rock stockpile (maximum plan area of 0.5 ha if a crushing plant is required). This stockpile will be located approximately 750 m north of the portal near the plateau infrastructure area and material will be stockpiled for a period of up to 2 weeks (see Figure 1.3). Non-acid–forming waste rock (material with a sulfur content of ≤0.2%S) and marginal waste rock (material classified as low capacity PAF (sulfur content of 0.2 to 0.5%S)), that is blended with NAF rock such that the resulting material is NAF, will then be used for construction of the phase 2 road as required. Larger sized material will be used as base course and small material, which may require on-site crushing and/or screening, for top dressing. If required, i.e., routine examination indicates that there is more PAF material than expected, alternative rock for road construction purposes will be sourced from borrow pits adjacent to the access road.

Management of waste rock is further discussed in Section 5.4. When PAF material is identified during construction of the decline, it will be managed as described below.

Management of Acid Rock Drainage

Management of PAF and marginal material will involve one or more of the following strategies:

- Minimising the rate at which sulfidic materials oxidise to form acid by limiting the exposure of sulfides to atmospheric oxygen.
- Reducing the infiltration of water to the extent that the total load of sulfide oxidation products (e.g., acid and metals) released to the environment is minimised.
- In situ neutralisation of acid rock drainage by the blending of acid-generating materials with acid-consuming materials.

This will be achieved by blending[1] NAF and marginal rock (estimated to be 97% of the total waste rock) for use in road construction (which may occur naturally as the material is excavated) and minimisation of oxidation and water infiltration through selective placement of PAF material (estimated to be 3% of the total waste rock) below surface and the use of low-permeability clay barriers.

Potentially acid-forming waste material will be identified during decline development (see above) and transported to the PAF waste rock dump which will be located on an existing exploration track that was developed on thick, dense clays

[1] The feasibility of blending will be determined during the detailed planning stage, taking into account the mining schedule and the relative amounts of each rock type. If blending is not feasible, marginal material will be placed in the below-surface PAF waste rock dump.

(see Figure 1.3 and Figure 3.3: 1a and 2a). A 150-m trench approximately 5 m deep will be progressively excavated in the clay with the clay stockpiled on the surface adjacent to the trench (see Figure 3.3: 1b and 2b). Potentially acid-forming material will be dumped into the trench and thin layers of the stockpiled clay placed onto the PAF material to form intermediary sealing layers. Once the trench is full, a final thin layer[1] of clay will be placed over the PAF material to form a natural low permeability layer (cover) (see Figure 3.3: 1c). A new section of the trench will then be dug further north along the track and the process will begin again (see Figure 3.3: 2c). Truck movements to excavate the trench and dump the waste will help to compact the clay cover over the preceding section. Once the entire trench is filled, most[2] of the remaining stockpiled clay will be placed over the entire cover, compacted and contoured to form a small mound to minimise water ponding on the cover and allow runoff to flow into the surrounding standing vegetation. The cover will then be revegetated. The design of the below-surface PAF waste rock dump, including thickness of the final cover and required compaction[3] of the clay, will be finalised during the detailed design phase of the Stage 1 project. At this time it will be possible to undertake a survey to confirm that adequate quantities of clay are available.

Although not anticipated, if more than 3,750 m^3 of PAF material is extracted during decline development or the survey indicates that there is insufficient clay in the first trench, additional trenches will be excavated adjacent to the first as required.

This below-surface dump design, incorporating the low-permeability, compacted clay barriers, combined with effective control of surface drainage designed to shed surface water, will minimise the interaction between sulfidic material, oxygen and water. Surface water quality sampling will be undertaken to monitor the performance of the PAF waste rock dump (Section 5.15).

3.4.2 Mine Water

During construction of the decline, it is estimated that groundwater will be generated at approximately 600 L/min. This water will be pumped from the underground workings to a mine water treatment facility at the decline portal (see Figure 1.3).

Analysis of the groundwater indicates that once silt, oil, grease and iron have been removed, the water will be of suitable quality for direct discharge to Hemp Creek or, if required, Comstock Creek (see Sections 2.2.3 and 4.1.2). Accordingly, the

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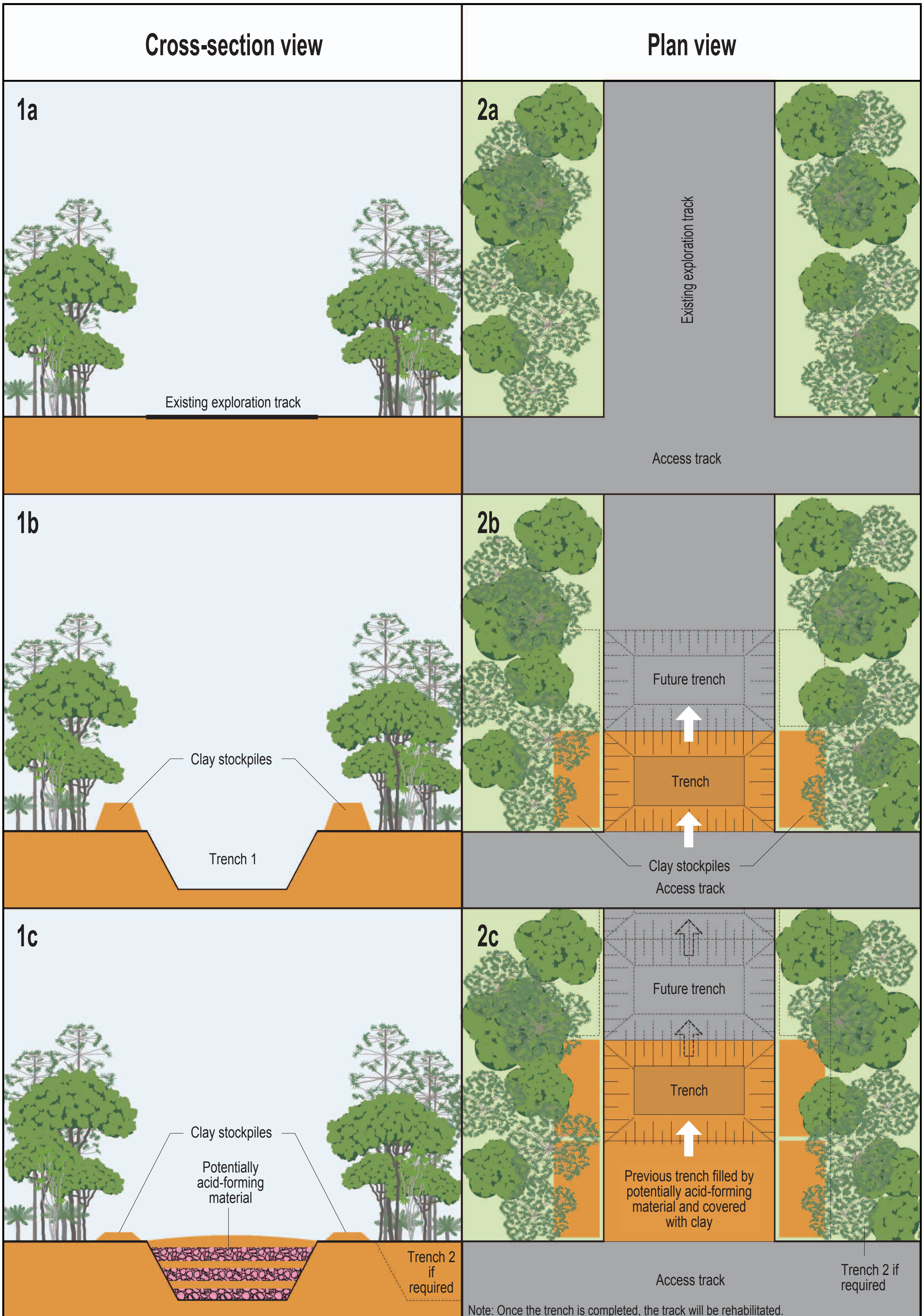
[1] Initially, not all of the clay will be placed over the PAF material. Only a thin layer will be laid so that trucks can drive over the area to access the next section of the trench.

[2] A small stockpile of clay will remain and, if required, will be used elsewhere on the site.

[3] As a minimum, the clay cover will be compacted to a coefficient permeability of 10^{-8}m/s and have a degree of saturation ≥85%.



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Schematic of below-surface PAF waste rock dump

Figure No: 3.3

mine water treatment facility has been designed to remove silt, oil and grease. In addition, due to naturally occurring elevated concentrations, iron will be removed via an aeration process.

A series of three cascading ponds (5 m x 5 m and 2.5 m deep) will be constructed. The water will be aerated as it flows over the 2-m drops between the ponds (i.e., there will be two small waterfalls). Iron released in the aeration process will settle in the ponds. Water in the third and final pond will be directed to a vertical flow settler to remove silt and a triple interceptor trap to remove oil and grease.

Following treatment, water required for the drilling jumbo and two core drill rigs will be recirculated back underground into the decline. Excess water will be discharged via a pipe directly to Hemp Creek (or if required Comstock Creek), at a maximum rate of approximately 10 L/s.

Silt and precipitated iron that accumulate over time in the mine water treatment facility will be periodically excavated and disposed of in the acid-forming waste rock dump. Oil and grease will be removed by a licensed contractor and holder of an approved WTB-EPN, along with similar material from the plateau facilities, on an as required basis.

Expected water volumes and the design, capacity and efficiency of the mine water treatment facility will be reviewed, with a view to enhancing performance of the facility, during the detailed design phase of the project.

3.4.3 General Site Runoff

Surface water runoff will be managed through the implementation of clean and dirty water drainage systems (Figure 3.4).

Clean Water Cut-off Drains

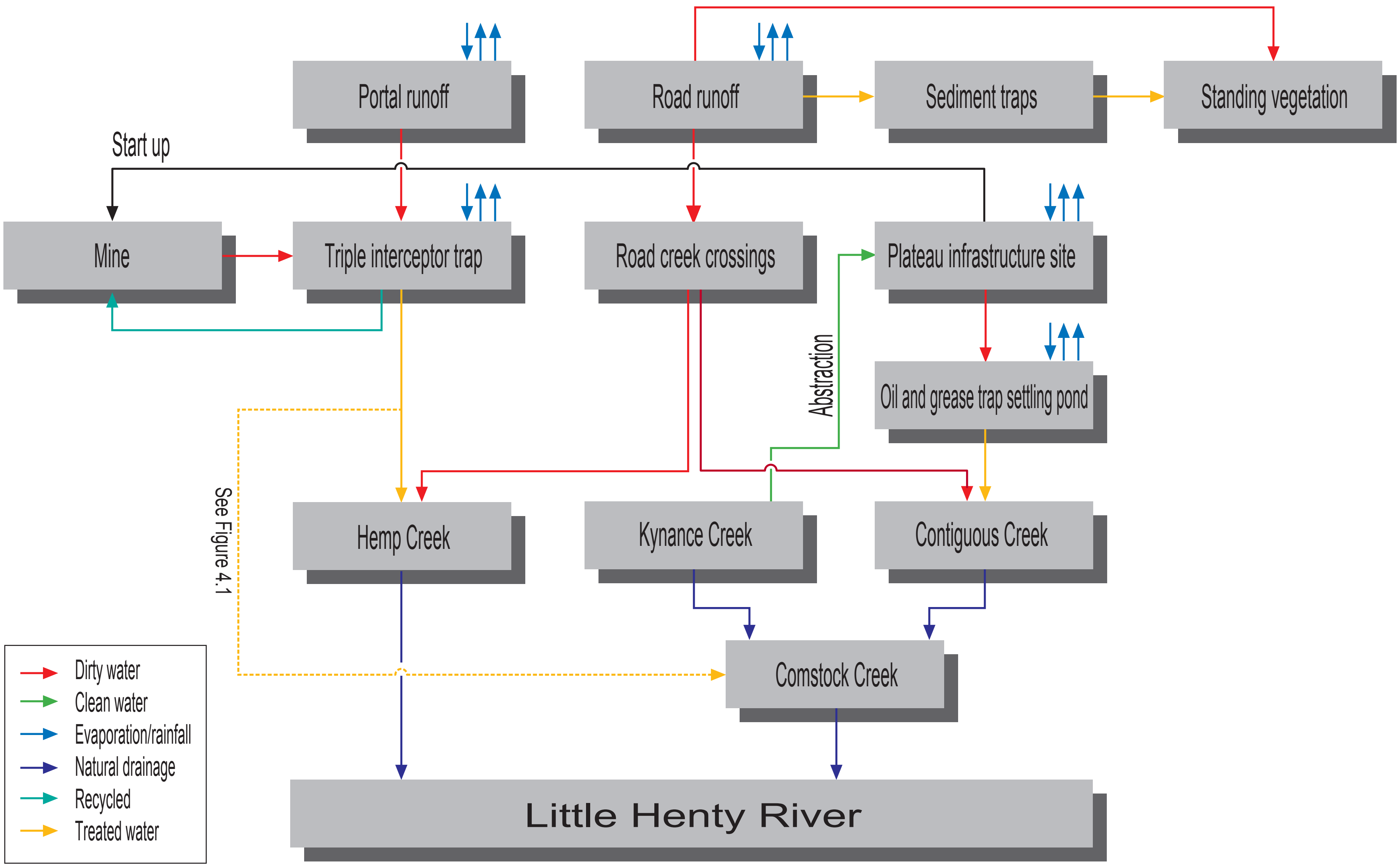
Prior to the commencement of excavation, shallow cut-off drains will be formed around the portal area to intercept clean runoff and direct it to surrounding undisturbed vegetation and natural water courses before it reaches the disturbed working areas. These drains will be maintained and modified as necessary as development progresses.

Clean water flows from the slopes above the steeper section of the access road leading down to the portal will also be intercepted and directed to surrounding vegetation.

It is not anticipated that cut-off drains will be required at the plateau infrastructure site since the site was chosen for its level location.

Dirty Water Management

Surface water flowing across working areas of the infrastructure site, waste rock dumps (temporary and acid-forming) and portal area will collect a sediment load which must be reduced to acceptable limits before the water reaches the natural



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water courses. To reduce the sediment load in dirty water collected from these working areas, water will be directed to sediment traps where sediment will be allowed to settle. Excess non-turbid water will overflow to the surrounding vegetation through cleared vegetation debris and silt fences, if necessary, to further reduce sediment load. These structures will be monitored and replaced when laden with sediment. Sediment in silt traps will be periodically excavated and placed in the acid-forming waste rock dump. The location and size of sediment traps will be finalised during the detailed design phase of the project.

The following dirty water runoff controls will be implemented:

- *Plateau Infrastructure Site*. This area will be contoured to direct any runoff into a drain that will be constructed downstream of the site. Water from the drain will be directed to a settling pond that will have baffles to slow water movement and allow sediment to drop out. Water from the settling pond will overflow into the surrounding vegetation via a suitably constructed outlet.

- *Wash Bays*. A maintenance vehicle workshop located in the infrastructure area as part of the workshop will have a wash bay and oil trap, with the water underflow reporting to the settling pond. All used oil (separated in the oil trap) will be collected and stored in drums for removal off site by the fuel supplier.

- *Portal Site*. Runoff from the portal site will be managed by directing it to the mine water treatment facility (see Section 3.4.2).

- *Temporary Waste Rock Dump Stockpile*. Runoff from the stockpile will be controlled and directed to a sediment trap from where water will overflow into the surrounding vegetation.

- *Acid-forming Waste Rock Dump.* The PAF waste rock dump will be located in an area in which there is very little surface runoff. Given that PAF material will be stored below surface and within compacted clay (see Section 3.4.1), there will be no specific dirty water runoff measures implemented other than ensuring that the final clay cover is contoured with a small slope to prevent ponding of water on the dump (i.e., the clay cap will act as a water shedding cover).

3.4.4 Solid Waste

Solid non-hazardous wastes such as those listed and quantified in Table 3.3 will be collected and stockpiled separately at the plateau infrastructure site prior to removal off site.

Table 3.3 Estimated quantities of solid waste generated

Waste Type	Quantity
Cans, plastic and glass containers	200-L drum per week
Paper and plastic packaging	200-L drum per week
Domestic waste	200-L drum per week
Tyres and batteries	Small numbers over life of project
Drill steels and scrap steel	1 truck over life of project

Where waste can not be collected by the supplier, a licenced contractor will be contracted to remove waste and transport it to Zeehan for disposal.

Transport, storage and handling procedures are described in sections 4.4.2 and 5.5.

3.4.5 Hydrocarbon Waste

Fuel (diesel), oil and grease will be required for the Avebury Nickel Project operation, and as described in Section 3.2.5, will be delivered to the plateau infrastructure site from where it will be distributed to the portal and underground workings as required.

Waste oil and degreasers will be collected in separate receptacles and transferred to a designated area in the bunded fuel storage facility in the workshop at the infrastructure site. Oil filters, grease and absorbent materials will be collected in a 200-L drum and stored in the bunded fuel storage facility in the workshop prior to removal off-site to an approved disposal site. Where hydrocarbon waste can not be collected by the supplier, a licenced contractor holding an approved WTB-EPN will be contracted to remove waste and transport it to an approved disposal site on the north coast.

Hydrocarbon contaminated soil will be collected and stored centrally at the plateau infrastructure site in a bunded area that is either lined or treated so that the concrete is impervious to the hydrocarbons. Once a truckload accumulates, a licenced contractor, who holds an approved WTB-EPN, will collect the waste for disposal at the Port Latta treatment facility.

Transport, storage and handling procedures for hazardous materials are described in sections 4.5.2 and 5.5.

3.5 Landform Modifications

Through the use of culverts (i.e., associated with the access road) and appropriate siting of facilities (infrastructure, decline and portal, waste rock dumps) there will not be a need to divert or re-align the natural drainage. Storm water and runoff controls will divert water into vegetation or existing natural drainage lines; no modifications to drainage patterns will be required.

As discussed in Section 3.3.7, on closure, surplus waste rock will be placed underground and tracks, roads and infrastructure areas reprofiled such that the final land form resembles the original landform as closely as possible.

3.6 Workforce

Construction of the decline will create approximately 25 full-time jobs:

- Decline development crews (12 people).
- Core drillers (8 people).
- Manager, geologists, technicians (5 people).

Stage 1 development will be a 24-hour, 7-day per week operation achieved with three crews of four.

In addition to these full-time positions, a similar number of part-time support positions will be created to address the following requirements:

- Surveyors (decline and drill hole surveys).
- Analytical (rock and core assaying).
- Consultants (geotechnical, mining, environmental, infrastructure design, metallurgical).
- Infrastructure maintenance (roads, buildings).
- Metallurgical test work.
- Project assessment.

Allegiance's employment policy will be to employ locally from the west coast region wherever the appropriate skills and support facilities are available on a cost-competitive basis. Because the west coast region is a traditional mining area, it is envisaged that many of the full and part-time positions will be filled locally.

Where specific services and skills are not available on the west coast, the company policy will be to meet such needs in the first instance from Tasmanian-based organisations prior to sourcing them nationally.

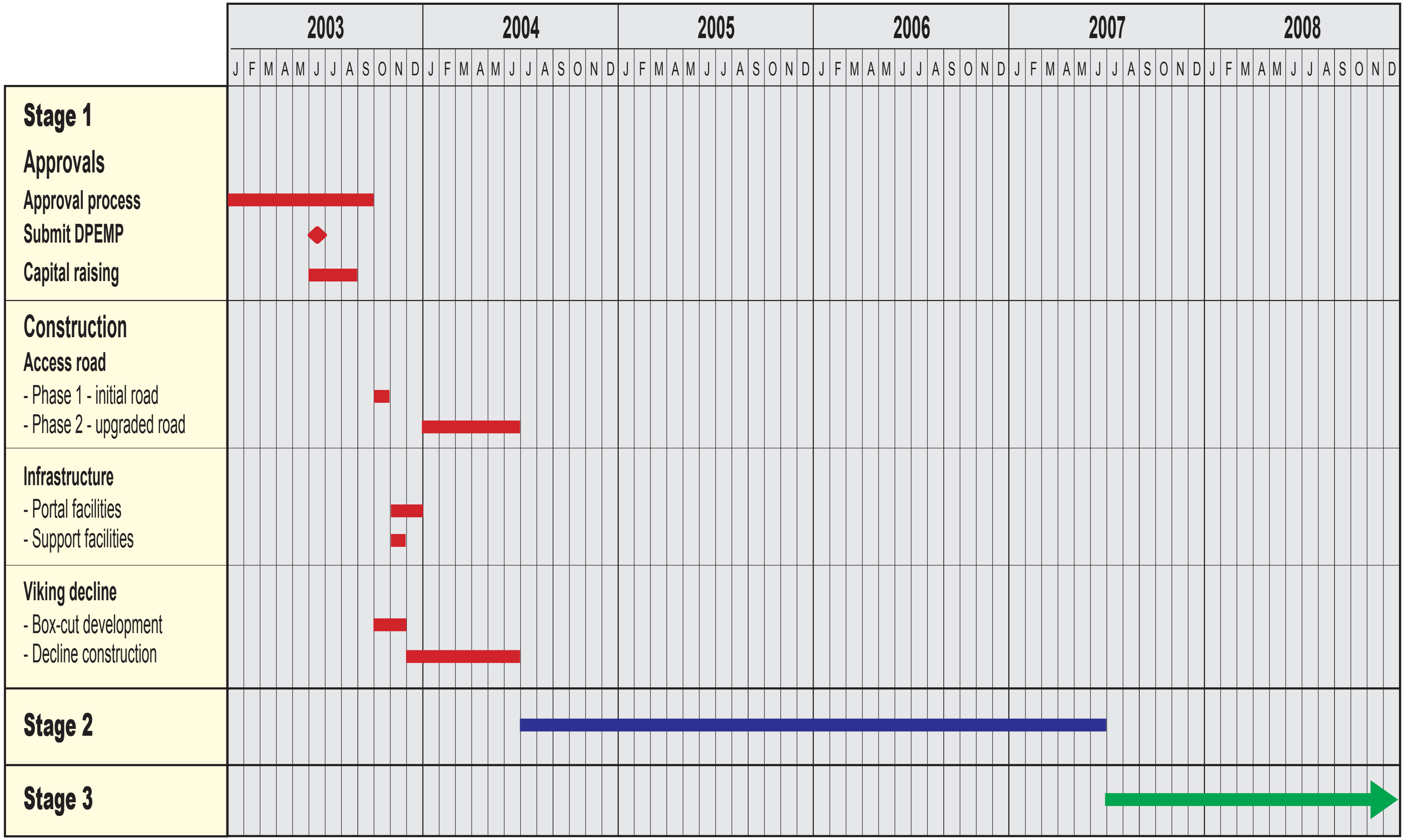
Allegiance's goods and services policy will similarly be to source all requirements locally, either on the west coast or from within Tasmania where available and cost competitive.

Reflecting these policies, it is estimated that the majority of the full-time and part-time positions created will be filled from the Zeehan and west coast areas.

3.7 Development Schedule

Scheduling for development of the three principal components associated with Stage 1 of the Avebury Nickel Project is shown in Figure 3.5.

Development is scheduled for completion within nine months of commencement. Construction is currently scheduled to commence in October 2003, and will be completed by the end of June 2004.



NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Development schedule	Figure No: 3.5
	File No: 938_2_F3.05_HB	Avebury Nickel Project		

4. Potential Environmental Impacts

The Avebury Nickel Project's environmental and socio-economic impact is due to a number of factors inherent in the development of such a project in this particular setting. This chapter presents the potential issues and a brief summary of avoidance, mitigation and management measures that Allegiance will implement to reduce the negative impacts and maximise the positive impacts associated with Stage 1. Detailed avoidance, mitigation and management measures are discussed in Chapters 3 (Project Description) and 5 (Environmental Management Plan). While a particular provision of an act or regulation that is relevant might be mentioned in this chapter, performance standards are generally detailed in Chapter 5. This chapter finally provides an assessment of the residual impacts of the project, taking into account the avoidance, mitigation and management measures that will be implemented.

4.1 Aqueous Emissions and Abstraction

4.1.1 Potential Issues

General

The State Policy on Water Quality Management 1997 aims to:

> ….maintain or enhance water quality and further the objectives of Tasmania's Resource Management and Planning System.

The policy recognises that it may be necessary to discharge pollutants (taking into account mixing zones where appropriate) and, on such occasions, the policy objective is to:

> ….ensure that diffuse source and point source pollution does not prejudice the achievement of water quality objectives and that pollutants discharged to waterways are reduced as far as is reasonable and practical by the use of best practice environmental management.

The key issue is preventing or minimising impacts on PEVs (protection of aquatic ecosystems and recreational values, see Section 2.2.4) from potential stressors such as:

- Alterations to environmental flows.
- Suspended solids and sedimentation.
- pH.
- Conductivity.
- Oil and grease.
- Inorganic nitrogen[1].

[1] Ammonia, nitrate and nitrite.

- Deoxygenation.
- Metals.

Environmental Flows

Altered water flows may occur as follows:

- Kynance Creek due to abstraction of approximately 0.06 L/s (5,000 L/day) (see Section 3.2.2). In the unlikely event that no groundwater is intersected in the upper sections of the decline, additional water, approximately 0.5 L/s, may be abstracted from Kynance Creek.

- Hemp Creek (or Comstock Creek (Section 4.1.2)), due to discharge of excess treated mine water at a maximum rate of approximately 10 L/s (approximately 860,000 L/day).

Suspended Solids and Sedimentation

Increased total suspended solid (TSS) concentrations may occur in streams in the project area as a result of erosion/runoff (particularly at stream crossings). Excess mine water discharged to Hemp Creek (or Comstock Creek) may also contribute suspended solids and precipitated iron oxides. Sedimentation may occur due to increased loads of solids reporting to the streams.

Given the early stage of project development, it is not possible to predict sediment loads from the sediment traps, stream crossings or discharged excess mine water. However, it is expected that the greatest loads will occur during construction of stream crossings and these loads will diminish over time as erosion control measures become effective.

pH

Decreased pH may occur in Hemp Creek as a result of ARD from:

- The temporary potentially acid-forming (PAF) waste stockpile.
- Decline development.

Should the decline be abandoned at the completion of Stage 1, the pH of the ground water flow, which appears to develop at the regolith/fresh rock interface, and so is unlikely to come into contact with PAF material, is not expected to change.

Conductivity

If relatively high conductivity excess mine water is discharged to Hemp Creek, conductivity may increase in that creek.

Oil and Grease

Oil and grease may enter streams in the project area from:

- Roads.
- Plateau infrastructure area.
- Discharged excess mine water.

Inorganic Nitrogen

Inorganic nitrogen from explosives residues may be discharged in excess mine water to Hemp Creek (or Comstock Creek).

Deoxygenation

Oxidation of Fe in discharged excess mine water may decrease oxygen concentrations in Hemp Creek (or Comstock Creek).

Metals

Metal concentrations in watercourses may increase due to:

- ARD from the temporary PAF stockpile or decline.

- Discharged excess mine water. As discussed in Section 2.2.3, the concentrations of unfiltered Fe, Mn and Zn are higher in the groundwater than in Hemp Creek (see Table 2.6), while only the unfiltered Fe concentration is higher in the groundwater than in Comstock Creek.

4.1.2 Avoidance, Mitigation and Management

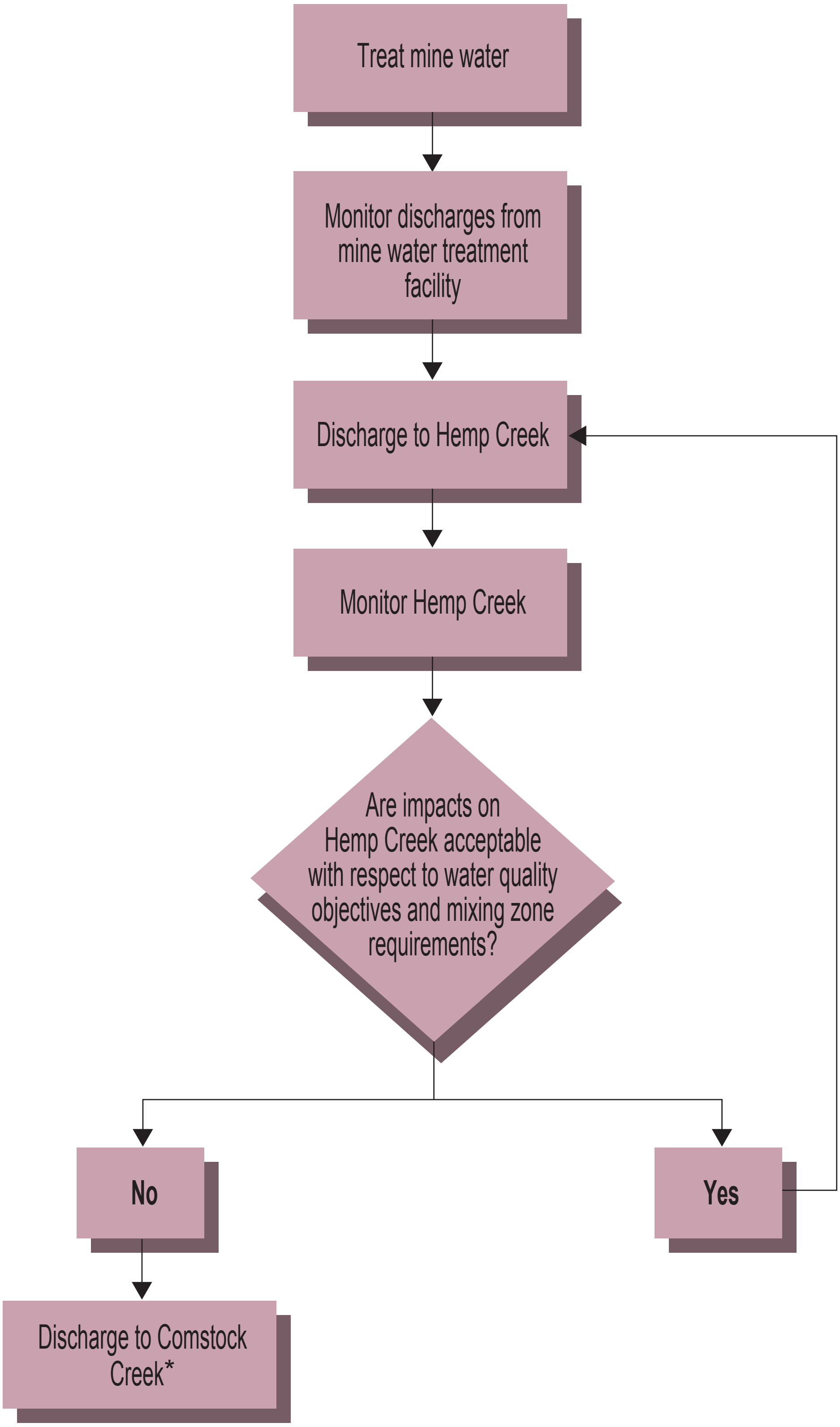
General

The site-specific Water Management Plan detailed in Section 5.2 will ensure that potential impacts are minimised. As discussed in Section 5.15, monitoring will be undertaken to determine what, if any, impacts occur.

Excess treated mine water will be discharged to Hemp Creek with the mixing zone (as described in Section 20 of the State Policy on Water Quality Management 1997) initially extending from the discharge point to Little Henty River (1,000 m). The length of the mixing zone will be redefined (i.e., shortened) once sufficient monitoring data has been obtained after the discharge commences. If monitoring of the discharged water and Hemp Creek indicates that the water quality objectives set by the Environmental Management and Pollution Control Board are not met, and in agreement with DPIWE, excess treated mine water will be discharged to Comstock Creek. The anticipated approach to this decision process is shown in Figure 4.1.

Environmental Flows

Mine water will be recycled after treatment and used for decline development. Recycling will minimise the abstraction requirement from Kynance Creek and the discharge volume to Hemp Creek (or Comstock Creek).



*Discharge to Hemp Creek will resume when conditions allow following discussion with DPIWE

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Mine water discharge decision process	Figure No: 4.1
	File No: 938_2_F4.01_HB	Avebury Nickel Project		

Suspended Solids and Sedimentation

Site-specific measures that will be undertaken to avoid, mitigate and manage impacts to PEVs from suspended solids and sedimentation include:

- Construction of the road during drier months.
- Alignment of the road to minimise the number of stream crossings.
- Construction and maintenance of drains, including along roads, to direct sediment-laden water to sediment traps, which then drain to standing vegetation wherever possible.
- Installation of culverts at stream crossings.
- Minimisation of vegetation clearance.
- Construction and maintenance of clean water diversion drains upstream of disturbed areas.
- Treatment of excess mine water prior to discharge to:
  - Precipitate dissolved Fe.
  - Remove suspended solids.

pH

The PAF waste stockpile will be managed to prevent the formation of acid by encapsulating PAF material within clay (see Section 3.4.1).

The occurrence of significant ARD in the decline during Stage 1 is considered to be unlikely since groundwater flowing into the decline is not expected to come into contact with PAF material. Therefore, no particular mitigation measures related to ARD are required for the mine water. This will be confirmed by monitoring during development of the decline (see Section 5.15).

Oil and Grease

The following measures will be taken to avoid oil and grease entering the mine water:

- Underground vehicles and machinery will be properly maintained to prevent oil leaks.
- Maintenance of vehicles (with the exception of the jumbo driller) will be carried out at the plateau infrastructure site workshop, not underground.

If oil and grease are present in the mine water, they will be removed in the water treatment facility by a triple interceptor trap.

As discussed in Section 3.4.3, water from the wash bay will report to an oil trap and water underflow will report to the settling pond.

Other avoidance, mitigation and management measures for the control of oil and grease underground are discussed in Section 4.5.2.

Deoxygenation

Mine water will be oxygenated in the water treatment facility to precipitate dissolved Fe prior to discharge of the excess.

Metals

Dissolved iron contained in mine water will be precipitated in the water treatment facility prior to discharge, with the precipitate being retained in the treatment facility. This will ensure (State Policy on Water Quality Management 1997, see Sections 2.2.4 and 4.1.1):

> ….that pollutants discharged to waterways are reduced as far as is reasonable and practical by the use of best practice environmental management.

The effectiveness of iron removal will depend on the detailed design of the treatment facility. The design of the treatment facility, including cascades, ponds and baffles, will determine oxidation rates, water residence time, water speed, solids removal efficiency. These factors will be optimised during the detailed design phase which will include empirical tests using groundwater to determine iron precipitation kinetics and behaviour of the precipitate.

The temporary PAF stockpile will be managed to prevent the formation of acid and subsequent leaching and release of metals.

4.1.3 Predicted Residual Impacts

Environmental Flows

Abstraction from Kynance Creek represents <1% of the flow in low-flow conditions (approximately 8 L/s). It is possible, although unlikely, that additional abstraction will be required if no groundwater is intersected in the upper sections of the decline. In this case, abstraction would represent up to 7% of the flow in low-flow conditions in Kynance Creek. No impacts to PEVs resulting from changed flow regime are predicted in Kynance Creek in either case.

The volume of excess mine water discharged to Hemp Creek will vary, as will the natural flow in Hemp Creek (for example during rainfall). In the worst-case scenario, the discharge of treated mine water (10 L/s) may represent 63% of combined flow in Hemp Creek (which has a base low-flow of 6 L/s) immediately downstream of the discharge point. However, the maximum discharge is likely to occur only during rainfall events when the flow in Hemp Creek is much greater.

The impact on aquatic ecosystems of periodically increased flows in Hemp Creek cannot be accurately predicted; however, it is expected to be low and only occur in the mixing zone. No impact in terms of the relevant PEVs is predicted. Biological monitoring of Hemp Creek will be undertaken (see Section 5.15) and, if required, appropriate mitigation measures imposed, e.g., discharge excess mine water to Comstock Creek.

The estimated low flow (90th percentile exceedence) for Little Henty River is 4,000 L/s (see Section 2.2.1). The maximum discharge of mine water is 0.3% of this flow and there will be no impact on PEVs in Little Henty due to changes in flow regime.

If discharge of excess mine water to Comstock Creek, rather than Hemp Creek, is required, the discharge of treated mine water (10 L/s), the worst-case scenario, may represent 40% of combined flow in Comstock Creek (which has a base low-flow of 15 L/s) immediately downstream of the discharge point. Given the degraded nature of this stream, no additional impacts in terms of the relevant PEVs are predicted.

Suspended Solids and Sedimentation

Suspended solids in excess mine water that are not trapped in the mine treatment facility will be discharged to Hemp Creek (or Comstock Creek). It is not possible to accurately predict TSS concentrations or loads in the discharged excess mine water.

As discussed in Section 4.1.2, dissolved Fe will be precipitated from mine water in the water treatment facility. Although not expected, excess mine water discharged to Hemp Creek may still contain higher dissolved iron concentrations than Hemp Creek. This could result in discolouration of the water and/or streambed and reduction in the dissolved oxygen concentration in the stream (discussed below). Hemp Creek will initially be inspected daily for discolouration and for the formation of orange iron precipitates (see Section 5.15). If discolouration or iron precipitates are observed in Hemp Creek, management actions will be taken to decrease dissolved iron concentrations in the treated excess mine water (e.g., increasing aeration in the water treatment facility) or discharge to Comstock Creek. Therefore, minimal short-term impacts to PEVs in Hemp Creek due to the formation of iron precipitates may occur.

Given that the maximum discharge of mine water is 0.3% of low-flow conditions in Little Henty River, no impacts to the river's PEVs are predicted due to formation of iron precipitates.

If discharge of treated excess mine water to Comstock Creek is required, the concentration of Fe in the discharged excess mine water is expected to be less than the concentration currently occurring in Comstock Creek (median 1,110 µg/L).

Runoff discharged from sediment traps, which are likely to have low suspended solid concentrations, will generally be to areas of standing vegetation located away from streams. Therefore, this runoff is not expected to significantly increase TSS concentrations, turbidity or sedimentation in any creeks.

Elevated TSS concentrations are expected in stormwater runoff at stream crossings, particularly during and immediately after construction. Elevated TSS concentrations are expected to occur immediately downstream of the stream crossings and during periods when the TSS in the receiving streams is elevated due to natural runoff.

Some temporary road-derived sediment deposition may occur immediately downstream of stream crossings during construction. However, this deposited sediment will be largely removed during high flow. Therefore, no impacts to PEVs of streams in the project area or Little Henty River due to sediment in runoff are predicted.

pH

No impacts to PEVs of streams in the project area or Little Henty River due to changes in pH are predicted.

Conductivity

During high-flow discharge of treated mine water (10 L/s, conductivity 324 µS/cm) and low-flow in Hemp Creek (6 L/s, median conductivity 138 µS/cm), the conductivity of Hemp Creek downstream of the discharge is predicted to be 216 µS/cm. This is a worst-case scenario.

As discussed in Section 2.2.3, the conductivity of Hemp Creek is naturally higher than the ANZECC/ARMCANZ (2000) default TV for Tasmanian upland rivers and streams (90 µS/cm). Where site-specific information is available, the guidelines recommend using the 80th percentile of the reference data as a trigger value. However, Hart et al (1991) indicate that direct adverse biological effects are expected in streams if salinity is allowed to increase to around 1,000 mg/L (approximately 1,500 µS/cm).

Therefore, although the impact on aquatic ecosystems of periodically increased conductivities in Hemp Creek cannot be accurately predicted, it is expected to be low. No impact on water quality in terms of recreational water quality and aesthetics is predicted.

During maximum excess mine water discharge and minimum flow in Hemp Creek and Little Henty River, the conductivity in Little Henty River is predicted to increase by <1%. Therefore, PEVs in Little Henty River are not predicted to be impacted.

The conductivity of groundwater and Comstock Creek are similar and, if discharge of excess mine water to Comstock Creek is required, no impacts to PEVs due to conductivity are predicted.

Oil and Grease

The concentration of oil and grease in discharged excess mine water will be low due to the removal of the oil and grease in the triple interceptor trap. Concentrations will be monitored but impacts on Hemp Creek (or Comstock Creek) or Little Henty River PEVs due to oil and grease are not expected (see Section 5.15).

Inorganic Nitrogen

Inorganic nitrogen concentrations in mine water resulting from underground blasting cannot be predicted, although as a single-heading mine development, blasting only twice daily, it is expected that nitrogen concentrations will be low. Therefore, it is not possible to predict inorganic nitrogen loads in the discharged excess mine water. Primary productivity will be monitored in Hemp Creek (or Comstock Creek) by measuring chlorophyll-a concentrations. Nitrate, NO_2 and NH_3 concentrations will also be monitored (see Section 5.15). No impacts to PEVs in Little Henty River due to inorganic nitrogen are predicted

Deoxygenation

The oxygen concentration in Hemp Creek (or Comstock Creek) will be measured daily (see Section 5.15). If reduction in oxygen concentrations occur, management actions will be taken to decrease dissolved iron concentrations in the treated excess mine water (e.g., increasing aeration in the water treatment facility). Therefore, minimal short-term impacts to PEVs in Hemp Creek (or Comstock Creek) due to reduction of oxygen concentrations may occur.

Metals

Residual impacts due to metals relate to discharge of excess mine water to Hemp Creek from the water treatment facility.

The unfiltered concentration of Mn in groundwater (97 µg/L) is significantly below the ANZECC/ARMCANZ (2000) TV for slightly to moderately disturbed ecosystems (1,900 µg/L). Therefore, Mn is very unlikely to cause adverse toxicological effects in Hemp Creek and no impacts on the PEVs due to Mn in Hemp Creek and Little Henty River are predicted.

The water hardness-adjusted ANZECC/ARMCANZ (2000) TV for Zn for the median hardness (22 mg $CaCO_3$/L) in Hemp Creek is 6.1 µg/L. The Zn concentration in groundwater (8 µg/L) marginally exceeds this TV. However, given that the TV for the groundwater hardness (106 mg $CaCO_3$/L) is 23 µg/L, the additional hardness (i.e., Ca and Mg) added to Hemp Creek by the groundwater will ameliorate any Zn toxicity. Therefore, Zn is very unlikely to cause adverse toxicological effects in Hemp Creek and no impacts on the PEVs due to Zn in Hemp Creek and Little Henty River are predicted.

No direct toxic effects are predicted due to elevated dissolved iron concentrations in Hemp Creek. Indirect impacts due to possible Fe precipitation are discussed in the Suspended Solids and Sedimentation and Deoxygenation sections above.

If treated excess mine water is discharged to Comstock Creek, no direct toxic effects are predicted due to the low metal concentrations in the discharge relative to those in the creek.

Summary

Impacts to PEVs in the mixing zone in Hemp Creek are predicted to be small. Management actions will be taken if water quality objectives set by the Environmental Management and Pollution Control Board for discharged treated excess mine water or Hemp Creek are not met. This may involve discharge of this water to Comstock Creek. No impacts are predicted if treated excess mine water is discharged to Comstock Creek.

Residual impacts to PEVs of streams in the project area may occur immediately downstream of the stream crossings (particularly in the initial period following construction).

No impacts to PEVs are predicted in Little Henty River.

4.2 Atmospheric Emissions

4.2.1 Potential Issues

General

Atmospheric emissions associated with Stage 1 of the Avebury Nickel Project include:

- Exhaust fumes (containing carbon dioxide, carbon monoxide, nitrogen dioxide and particulate matter) from vehicles and heavy machinery, including:
  - Drilling jumbo.
  - Underground loader.
  - Underground trucks (2).
  - Surface loader.
  - Excavator.
  - 20-t surface trucks for distributing road-building materials (2).
  - Light service vehicles (6).
  - 20-t diesel fuel truck.
  - 20-t explosives truck.
  - 4WD vehicles.
- Exhaust fumes (containing carbon dioxide, carbon monoxide, nitrogen dioxide and particulate matter) from two 250-kW diesel-powered portable generators (at the plateau and the portal) for the first three months of development.
- Dust from the following construction activities:
  - Vegetation and topsoil removal.
  - Vehicle and plant travel over unsealed road surfaces.
  - Bulk sample transport.
  - Wind erosion from exposed soil surfaces, soil stockpiles and the waste rock stockpiles.

  - Earthworks for the construction of on-site facilities.
  - Blasting for the portal and decline development.

- Trace amounts of asbestiform amphibole, probably actinolite, within dust generated from construction activities. All forms of asbestos below 3 µm in diameter and greater than 8 µm in length are potentially carcinogenic. The risk of cancer increases as fibre diameter decreases and with increased exposure to asbestos (NOHSC, 1995). Airborne emissions may occur in three areas:
  - Within the decline.
  - Around the surface crushing facility.
  - Along the access road.
- Exhaust fumes (from underground machinery) from the decline ventilation circuit.
- Greenhouse gases generated from the above-listed activities.

Greenhouse Gases

The Greenhouse Effect

The 'greenhouse effect' is the result of atmospheric gases absorbing terrestrial radiation whilst permitting incoming solar radiation to pass through the atmosphere. These greenhouse gases 'blanket' the earth, maintaining ambient temperatures. Greenhouse gases include carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), nitrous oxide (N_2O) and fluorocarbons (FC). Human activities that have contributed to the greenhouse effect include burning fossil fuels (such as coal for electricity and petrol and diesel for vehicle travel), vegetation clearing, expansion of farming activities (methane generation from rice paddies and stock), and industrial processes. Debate about whether human activities have accelerated the greenhouse effect ('enhanced greenhouse effect'), resulting in climate change (notably warmer average ambient temperatures and an increase in sea levels) continues within the scientific community.

At the 1992 Earth Summit in Rio de Janeiro, Australia signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) (State of the Environment Advisory Council, 1996), the main objective of which is to stabilise emissions of greenhouse gases at a level that would prevent dangerous human-induced interference with the climate system (AGO, 1998). As a signatory, Australia is required to produce and regularly update national greenhouse gas inventories, as published by the Australian Greenhouse Office. These are used to estimate Australia's performance in reducing greenhouse gas emissions.

In December 1997, more than 160 nations met in Kyoto, Japan, to negotiate binding limitations on greenhouse gases for the developed nations, pursuant to the objectives of UNFCCC in 1992. The outcome of the meeting was the Kyoto Protocol, in which the developed nations agreed to limit their greenhouse gas emissions, relative to the levels emitted in 1990. Australia was granted the differential target of an 8% increase on 1990 levels (385 million tonnes (Mt) of CO_2

equivalent (Mt CO_2-*e*)) by 2010, based on the economic cost of implementing such targets (AGO, 1998).

In 1996, the National Greenhouse Strategy (NGS) was launched and is currently the primary mechanism for fulfilling our international obligations.

Australia's Current Situation – Mining and Transport

Australia's National Greenhouse Gas Inventory shows that, in 2000, Australia emitted 535 Mt CO_2-*e*, comprising 71% CO_2, 22.6% methane, 6% nitrous oxides and 0.4% other gases (AGO, 2002). The stationary energy sector[1] was responsible for 89.3% of these national emissions.

Estimated emissions from the manufacturing and construction subsector of the stationary energy sector (which includes direct emissions from fuel combustion in manufacturing, construction and non-energy mining, including both stationary equipment and mobile equipment, such as earth moving and mining equipment) were 52.5 Mt CO_2-*e* in 2000 (AGO, 2002). This equates to 9.8% of Australia's total greenhouse gas emissions.

In 2000, the transport sector accounted for 76.3 million tonnes of Australia's total net greenhouse gas emissions, representing 14.3% of Australia's total emissions. Road transport, including cars, trucks and buses, contributed 90.2% of transport emissions (AGO, 2002).

Issues for the Avebury Nickel Project

Greenhouse gas emissions associated with Stage 1 of the Avebury Nickel Project will be generated from transport traffic, fuel combustion activities from stationary sources (such as the portable diesel-powered generators), and methane from decomposing vegetation after clearing. These emissions are short term and will not be large contributors to Australia's total emissions, therefore (as agreed with DPIWE), it is not considered relevant to estimate the annual greenhouse gas emissions generated on site for Stage 1 development (Mitchell, pers. com., 2003). This will become relevant to stages 2 and 3, should the project continue beyond Stage 1. Greenhouse gas emissions are discussed from a qualitative perspective in Section 4.2.3.

4.2.2 Avoidance, Mitigation and Management

Soil disturbance during construction activities creates dust in a manner similar to that for current road building practices of the state road authority and Forestry Tasmania in forestry land in the local area. Dust control by watering may be applicable to construction activities and will be carried out as appropriate.

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[1] Emissions from this sector are almost completely carbon dioxide (98.9%), with some methane (0.7%) and nitrous oxide (0.4%) being generated during combustion. Stationary sources include stationary energy, transport and fugitive emissions from fuel.

Existing knowledge of the area suggests the distribution of amphibole minerals is erratic and pervasive in the nickel sulfide resource zones and the surrounding rock, therefore, it is not possible to design a decline that avoids these alteration zones. Airborne concentrations of asbestiform amphibole and crystalline silica will be monitored through a high volume air sampling program to ensure levels do not exceed human exposure standards, as outlined in the Exposure Standards for Atmospheric Contaminants in the Occupational Environment - Asbestos (NOHSC, 1995). To minimise dust generation in the decline (and the potential to inhale dust containing asbestos), wet drilling only will be used as will development face sprays. In addition, respirators will be used until adequate ventilation is established. Rock with high concentrations of amphibole will not be fed to the crusher. A geologist will log rock for sulphide content and assess the presence of asbestiform amphibole. If rock suspected to contain asbestiform amphibole is found, it will be further tested by a laboratory to confirm this assessment. Uncrushed rock with a high amphibole content will be used for the road base along the access road, while the road will be top dressed only with rock containing low amphibole concentrations.

Project equipment, machinery and vehicles will meet exhaust air quality standards in the normal manner for all vehicles sold in Australia and will comply with the Environment Protection (Vehicle Emission) Regulations 1992. Vehicles and machinery will be fitted with the appropriate emission control equipment, and maintained and serviced frequently.

Travel logistics will be planned to minimise the frequency of travel between the project area and Zeehan.

A total fire ban on the lighting of all fires in the mining lease area will be in place for the life of the project. This will avoid the generation of greenhouse gases and nuisance smoke from the burning of vegetation debris.

Topsoil and waste rock dumps will be constructed in accordance with the Minerals Exploration Code 1999 and located in sheltered areas, protected by the surrounding vegetation.

The site-specific Air Quality Management Plan detailed in Section 5.3 will ensure that potential impacts are minimised.

4.2.3 Predicted Residual Impacts

Construction is planned to commence in September/October 2003 after the wet winter months when the west coast of Tasmania generally receives most of its rainfall. The unsealed Trial Harbour Road also will be drier and dust may be an issue at this time of the year. However, currently, dust is rarely generated on the Trial Harbour Road and on the few days when dust can be expected, it is likely that it will be intercepted within the project area and the immediate surrounds of the road by dense vegetation.

The impacts from dust generation and exhaust emissions from construction machinery, equipment and vehicles are predicted to be minor, localised and temporary. Impacts after mitigation measures have been implemented are considered negligible because the activities are distant from sensitive receptors such as residential dwellings (concentrated in Zeehan and Trial Harbour, at least 6 km away) with the intervening topography (undulating hills) minimising the chance of widespread transportation of dust. Western Tasmania's high average annual rainfall (even outside of the winter months) will also help to control dust generation during construction.

The potential for exposure to trace amounts of asbestiform amphibole within dust will be managed according to established exposure standards (Exposure Standards for Atmospheric Contaminants in the Occupational Environment - Asbestos (NOHSC, 1995)) to minimise the risk of asbestos-related health issues with respect to construction personnel.

Stage 1 development of the Avebury Nickel Project will not impact on commitments within the National Greenhouse Strategy or on Australia's international agreement and obligations. Greenhouse gas emissions from traffic, portable diesel-powered generators and methane emissions from cleared vegetation will be comparable to domestic and light commercial activity that is not subject to greenhouse gas emissions quantification or controls.

The site-specific Air Quality Management Plan detailed in Section 5.3 will ensure that impacts to air quality are minimised through active management during project development.

4.3 Noise Emissions and Vibration

4.3.1 Potential Impacts

Existing background noise in the project area depends on wind direction and includes:

- Breaking waves at the coast.
- Running water in rivers and creeks.
- Wind in the vegetation.
- Intermittent road traffic.

In general terms, it is the increment above background noise that determines noise nuisance. Potential sources of noise and vibration that will be present during Stage 1 of the Avebury Nickel Project include:

- Use of machinery for the construction of the access road (e.g., excavators and loaders).
- Ventilation fans.
- Vehicle movements to the project area associated with various aspects of the operation (e.g., delivering of equipment, supplies, removal of wastes).
- Reversing alarms.

- Generators.
- Drilling and blasting operations for portal and decline development.

In terms of blasting, safety, as well as damage to buildings by vibration and overpressure, is a potential concern.

4.3.2 Avoidance, Mitigation and Management

The project is located in a remote area approximately 8 km and 6 km, respectively, from each of the nearest settlements of Zeehan and Trial Harbour. The majority of the development (i.e., the decline development) is underground. Deliveries of equipment and supplies to site will take place during the day, when background noise is higher.

Noise and blasting impacts will be monitored by complaint. If necessary, additional mitigation measures will be introduced. Strict management of blasting procedures will be undertaken to mitigate the impact from blasting activities. This will address both the design and implementation phases of the blasting process.

A ventilation fan will be located at the portal, near the bottom of the Hemp Creek valley.

4.3.3 Predicted Residual Impacts

Underground drilling and blasting-related noise for decline development will be negligible as they are underground activities. Drilling and blasting-related noise at the surface associated with the initial stage of portal development will be minimised by its location at the base of the Hemp Creek valley. It will only be audible in the immediate vicinity of the development by Allegiance personnel in the nearby offices (Mitt, pers. com., 2003).

Additional noise generated from road and infrastructure construction on the surface will be minimal. Increments to noise above background levels are attenuated by distance travelled over land and topography. This increment usually does not extend to more than 1 to 2 km from a mine. Therefore, there is a sufficient buffer due to the remote setting of the project such that it will not cause significant noise impacts to the local communities.

The effects of ground vibration and blasting pressure will be localised and will not be experienced by the local communities (Mitt, pers. com., 2003).

Extra vehicle movements and associated noise through Zeehan during the day will not be distinguishable from existing background noise.

4.4 Solid Waste Disposal

4.4.1 Potential Issues

Domestic and industrial (non-hazardous) wastes such as packaging, tyres, batteries and general refuse will be generated during Stage 1 (see Section 3.4.4).

The effective management of wastes is a fundamental requirement of ecologically sustainable development. Inert and putrescible wastes, if not managed effectively, can pose significant health, environmental (contamination of land and water) and aesthetic risks.

4.4.2 Avoidance, Mitigation and Management

Allegiance will implement a recycling and waste minimisation program adopting the standard waste minimisation principles of:

- Avoid.
- Reuse.
- Reduce.
- Recycle.
- Treat.
- Dispose.

Allegiance will also ensure a high level of staff, employee and contractor awareness of these principles.

In general, all waste (both recyclable and non-recyclable) will be segregated and collected in individual receptacles from the portal area and will be transferred to a larger segregated storage area at the plateau infrastructure site, prior to removal off site. Waste will be removed on a continual basis and will not be allowed to accumulate unnecessarily.

Personnel will be trained to ensure proper identification, segregation and labelling of waste.

The site-specific Solid Waste Management Plan detailed in Section 5.5 will ensure that these materials are managed in an environmentally sound manner.

4.4.3 Predicted Residual Impacts

The Avebury Nickel Project will not produce large quantities of inert and putrescible waste.

The adoption of mitigation and management measures outlined in Section 4.4.2 and described in detail in Section 5.5 will ensure that risks to health and the environment are either removed or minimised.

4.5 Hazardous Materials

4.5.1 Potential Issues

A number of hazardous materials will be used during Stage 1 of the Avebury Nickel Project and careful management is required if personnel, the community and the environment are not to be exposed to their potentially harmful effects.

The main hazardous materials that will be used include:

- Explosives.
- Fuel and lubricating and hydraulic oils for vehicles and equipment.

Explosives will be used for blasting rock during the portal and decline development. The use of explosives presents a major safety hazard to the workforce and general public if not transported, stored and handled with care. Impacts from explosives usually result from blasting effects including damage to infrastructure from vibrations, and noise disturbance.

Fuel such as diesel, and lubricating and hydraulic oils, will be used for construction equipment and vehicles. Refuelling and maintenance will be required on site, therefore on-site storage of hazardous materials will be necessary. This subsequently introduces the potential risk of spillage, resulting in the contamination of land and water, and an increased risk of fire.

Estimated volumes of explosives and hydrocarbons stored on site are provided in sections 3.2.5 and 3.3.6

4.5.2 Avoidance, Mitigation and Management

Transport, storage and handling of explosives will comply with the relevant legislation and codes. Only appropriately trained and licenced operators will handle explosives. Explosives will be stored in secure, licenced magazines away from direct heat and ignition sources.

Minimum practical bulk quantities of fuel, lubricants and oils will be ordered and stored in drums and surface tanks with impervious bunds to contain spillages. Runoff from the workshop will be collected in an interceptor trap to remove oil and grease (see Section 3.4.3).

Equipment and machinery will not be refuelled or serviced within 50 m of watercourses. Hydrocarbon spill kits will be located at designated points underground and on the surface to clean up any spills that may occur. Hydrocarbon-contaminated materials will be stored appropriately for disposal off site by the supplier or licenced contractor.

At closure, as described in the mine closure and rehabilitation plan (see Section 5.14), suspected residual areas of soil contamination will be assessed in accordance with the NEPM (1999) and state requirements for assessment of site contamination and the best practicable option for disposal/treatment implemented.

Relevant personnel will be trained in fuel handling, spill containment and clean-up procedures as well as incident notification requirements during environmental inductions provided prior to the commencement of construction.

The site-specific Hazardous Materials Management Plan and Emergency Response Plan detailed in sections 5.6 and 5.7, respectively, will ensure that hazardous materials are managed to minimise risk to personnel, the community and the environment.

4.5.3 Predicted Residual Impacts

Mitigation and management will remove or minimise potential risks associated with transport, storage, use and handling of hazardous materials such that impacts to land and water will be negligible. Similarly, the safety of employees and the community will not be compromised.

4.6 Flora and Fauna

4.6.1 Potential Issues

Vegetation and Habitat Loss

A total of about 12 ha of native vegetation will be cleared for Stage 1 of the Avebury Nickel Project. This comprises the access road between Trial Harbour Road and the portal (9.6 ha, including 1.5 ha for overtaking bays), the portal area (0.5 ha) and a clearing for surface infrastructure facilities (1.9 ha).

Table 4.1 indicates clearing associated with each vegetation type (see Section 2.1.5).

Table 4.1 Loss of vegetation in each vegetation community

Vegetation Community	Vegetation Code	Approximate Vegetation Loss (ha)		
		Road*	Portal	Facilities
Buttongrass moorland	Bb	1.1	0	0.4
Melaleuca squamea	Bm	0.1	0	0
Restionaceae flatland	Br	0.6	0	0
Short rainforest	M-	2.9	0.5	1.0
Eucalypt. nitida wet forest	NT	1.2	0	0.5
Western wet scrub	Sn	0.8	0	0
Leptospermum lanigerum scrub, sparse *E. nitida*	St En-	0.5	0	0
L. lanigerum scrub	St	0.9	0	0
TOTAL		**8.1**	**0.5**	**1.9**

* Figures do not include the 1.5 ha of vegetation clearing required to construct vehicle overtaking bays. The location of these bays will not be known until the detailed design phase of the project.

Table 4.2 indicates clearing associated with each habitat type (see Section 2.1.6).

Table 4.2 Loss of vegetation from each habitat type

Vegetation Community	Vegetation Codes	Approximate Habitat Loss (ha)		
		Road*	Portal	Facilities
Temperate rainforest	M-	2.9	0.5	1.0
Buttongrass plains	Bb, Br	1.7	0	0.4
Shrubby eucalypt forest	O, NT	1.2	0	0
Tea-tree and paperbark wet scrub	Bm, Sb, St, St En-, Sn	2.3	0	0.5
TOTAL		**8.1**	**0.5**	**1.9**

* Figures do not include the 1.5 ha of vegetation clearing required to construct vehicle overtaking bays. The location of these bays will not be known until the detailed design phase of the project.

Habitat Fragmentation

An inability for fauna to move across habitat barriers, such as roads, can result in decreased or fragmented home ranges. Some animals will not cross such features, particularly if they are wide, due to the lack of vegetation, which makes them more vulnerable to attack from predators. A fragmented home range can result in loss of foraging resources, access to mating partners, or access to prime breeding or nesting areas.

Habitat fragmentation can also lead to a change in the environmental conditions along the access road (such as increased levels of light, wind and temperature), which favour the establishment and spread of ‘edge’ species. Edge species are mainly exotic flora and fauna that thrive in disturbed fragmented environments, such as grassy weeds and birds such as noisy minors.

Weeds and Plant Pathogens

Weeds

Existing weed levels along Trial Harbour Road and throughout the study area are generally low, though cutting grass (*Gahnia filum*) is found throughout the study area in localised large patches along former logging tracks. Soil disturbance as a result of vegetation clearing and road and infrastructure building will provide an opportunity for the invasion of environmental weeds from surrounding regions, predominantly through the introduction of foreign soil and seed from construction vehicles and equipment.

Pathogens

Forestry Tasmania advises that, despite the fact there are no current records of cinnamon fungus (*Phytophthora cinnamomi*) in the study area or its immediate vicinity, *P. cinnamomi* may already exist in the area given the high annual rainfall, land use patterns (i.e., forestry) and distribution of the pathogen along the west coast (Woolley, pers. com., 2003), and the fact that buttongrass moorlands in western Tasmania are particularly susceptible to the fungus (DPIWE, 2002b).

Myrtle wilt incidence has increased due to human activities, such as logging, vegetation thinning and road construction in myrtle-dominated rainforest

(Australian Paper, 1999; Packham, 1994). The disease develops through the infection of stem or root wounds via air (wind dispersal) or water-borne inoculum. The most prominent disease symptom is wilting of the tree crown, with eventual death (Australian Paper, 1999). In undisturbed forest, myrtle wilt acts primarily to facilitate stand rejuvenation (Packham, 1994).

Developing Stage 1 of the Avebury Nickel Project could:

- Introduce the pathogens into the project area.
- Spread the pathogens if they already exist in the project area.
- Provide conditions conducive to their proliferation, e.g., disturbed and boggy soils and damaged trees.

Threatened Species

Threatened Flora Species

No known Commonwealth- or state-listed threatened flora species occur in the project area.

Threatened Fauna Species

Nine Commonwealth- and state-listed fauna species occur or may occur in the project area (Section 4.2.2; Appendix 3). Vegetation clearing has the potential to modify their feeding, nesting or breeding habitat.

Traffic Collisions

Construction-related traffic through the study area may lead to collisions with fauna.

Collision with and Electrocution on Powerline

The installation of a 22-kV overhead distribution line from Trial Harbour Road to the substation may result in injury or death to birds and arboreal mammals as follows:

- Direct collision with the overhead line.
- Electrocution when birds perch on line or use support poles as a nesting substrate.

Sedimentation of Waterways

Disturbance to soils from construction activities may result in increased soil erosion and transport of soil to local waterways, such as Hemp, Contiguous, Kynance and Comstock creeks. This can affect water quality parameters such as total suspended solids, pH and dissolved oxygen, which can alter the quality of habitat for freshwater fish and invertebrate species. For example, excess soil input into creeks may fill waterholes which are otherwise favourable sites for fish breeding and egg laying.

4.6.2 Avoidance, Mitigation and Management

Most impacts to flora and fauna can be minimised by avoiding areas of highest conservation significance and minimising the extent of vegetation clearing. Infrastructure facilities will be sited to minimise vegetation clearing in general and avoid rainforest clearing specifically. Old logging tracks are used as the basis for the new access track.

A flora and fauna survey will be conducted prior to the commencement of the project to identify any threatened species. Management implications arising from the survey will be incorporated into the detailed operating environmental management plan that will be prepared prior to construction (Section 5.8)

In recognition of the project area being managed by Forestry Tasmania, all clearing and road construction will be undertaken in accordance with the Forest Practices Code (Forestry Tasmania, 2000).

Washdown of heavy vehicles and equipment for weeds and pathogens will take place at Zeehan before entry to the project area, in order to minimise the risk of spread of weeds and pathogens into the study area. Concurrent with the flora and fauna survey, a survey for vegetation displaying symptoms of dieback (*P. cinnamomi*) will be conducted. Weed and pathogen washdown of heavy vehicles and equipment will take place again before they leave the project area at the end of Stage 1.

Reducing the potential for myrtle wilt to express itself will be achieved by minimising damage to retained trees, felling dead trees before live trees, minimising damage to the roots of retained trees and avoiding piling cleared vegetation against retained trees (Gatehouse, pers. com., 2003).

Fish-friendly (bio-baffle) culverts will be installed at the two creek crossings (Kynance and Contiguous creeks) to minimise stream bed disturbance and associated creek siltation, to preserve the water quality required for the Australian grayling and allow for its upstream and downstream migration.

Appropriate speed limits will be established along roads to enable vehicles to avoid colliding with ground-dwelling fauna emerging from vegetation. To minimise potential impacts to avian fauna, consultation with Hydro Tasmania will determine if there is a need to install bird flight diverters (orange-coloured 'squiggles' with large heads and tapering tails) on the overhead power distribution lines.

The site-specific Flora and Fauna Management Plan detailed in Section 5.8 and Weed and Pathogen Management Plan in Section 5.9 will ensure that impacts to vegetation communities, habitat and threatened species are managed in a sensitive manner.

4.6.3 Predicted Residual Impacts

Vegetation and Habitat Loss

In total, about 12 ha of vegetation will be lost for construction of the infrastructure areas and the upgrade and widening of the existing access track. In the regional context, this represents a very minor vegetation loss; there are thousands of hectares of buttongrass plains and rainforest surrounding the study area. Natural regeneration of vegetation, and ultimately rehabilitation, will compensate for vegetation lost during clearing.

Records from the GTSpot database suggest over 95% of the vertebrate species in the area are avian, which are unlikely to be significantly impacted by the low level of habitat fragmentation of the forest environment. The large canopies of the rainforest tree species (together with the narrow width of the access road) will assist in retaining a high degree of forest connectivity between each side of the access road, allowing ease of movement of fauna (especially birds and arboreal mammals) that are normally unable or unwilling to move across wide open barriers.

The main impacts of habitat fragmentation resulting from road construction will be to ground-dwelling mammals that rely on ground cover for predator protection.

Weeds

Trial Harbour Road verge, in the vicinity of the project area, remains relatively intact with few weeds. The current Avebury access track (and future access road) is largely inaccessible (due to the 4WD terrain and restricted access); this reduces the number and variety of weeds that can be brought in to the area by vehicles. It is not anticipated that there will be a high level of weed invasion along the access road verge or into more densely vegetated areas.

Pathogens

Dieback

Given that there are no records of dieback in the study area, that there is only a small area of vegetation susceptible to dieback, and that washdown procedures for heavy vehicles and equipment will be implemented prior to entry to the project area, it is unlikely that dieback will be introduced to, or spread from, the project area.

The minimal disturbance of trees in the study area would reduce the likelihood of *P. cinnamomi* existing, surviving and proliferating in the primarily rainforest environment. It requires warm, moist soils to reproduce and spread, hence the temperate rainforest communities are at least risk.

The area of buttongrass moorland/heath close to the Trial Harbour Road, dominated by grassy and sclerophyllous species, is susceptible to *P. cinnamomi*, particularly because many species within the shrub and herbaceous families Dilleniaceae, Epacridaceae, Fabaceae, Proteaceae and Rutaceae (DPIWE, 2002b) and genus *Epacris* are susceptible to the fungus (Environment Australia, 2002) and can be found in this vegetation community.

Myrtle Wilt

Tree-clearing activities that lead to tree stem and branch wounds have the potential to artificially elevate the incidence of myrtle wilt in myrtle beech (*Nothofagus cunninghamii*). Washdown procedures and measures outlined for the storage of cleared vegetation will help to minimise the spread of myrtle wilt.

Threatened Species

Threatened Fauna Species

• *State-threatened Species*

Fairy prion southern subspecies (*Pachyptila turtur subantarctica*) and blue petrel (*Halobaena caerula)*

These species are oceanic birds with no nesting, breeding or feeding requirements within the vegetation of the study area. Therefore these species will not be impacted by the proposed development.

Wedge-tailed eagle (*Aquila audux fleayi*)

The species emerges as the only fauna species of state significance occurring in the study area that has the potential to be impacted. Suitable habitat (in the form of old growth rainforest) and nesting habitat for this species is found throughout the study area, with the last recorded sighting in the study area occurring in 1981 (GTSpot database). Although several hectares of suitable habitat will be cleared for road and infrastructure development, this is unlikely to impact on the species because:

- The area affected is a very small portion of a large area of surrounding suitable habitat.
- The range of individual birds is large. Their varied diet of fish, reptiles, birds and mammals, together with large home ranges (varying between 30 km^2 to 1,200 km^2) (Bell & Mooney, 1999), ensures that localised effects to predator habitats do not effect their survival in the area. Thirteen hectares of vegetation clearance represents a 0.4% loss of habitat from a 30 km^2 area.

• *Nationally-threatened Species*

Wedge-tailed eagle (*Aquila audux fleayi*)

As per ‘State-threatened Species’.

Swift parrot (*Lathamus discolor*)

As the breeding range for the species is outside the study area, and only very small patches of suitable *E. obliqua* forest occur in and around the study area, it is unlikely the species will be impacted by clearing for the Avebury Nickel Project.

Spot-tailed quoll (*Dasyurus maculatus maculatus*)

Suitable habitat for the quoll exists in the study area. The development of the access road is not likely to significantly fragment or otherwise impact suitable riparian or gully habitat (access road only crosses the riparian corridor of Contiguous Creek in the forested area), and its nocturnal nature minimises the chance of death from collision with construction traffic. Expansive areas of suitable habitat occur in and around the study area and throughout the west coast that provides habitat for the quoll, and although listed as nationally threatened, the quoll is abundant throughout Tasmania (Strahan, 1998).

Australian grayling *(Prototroctes maraena)*

Australian grayling favour clear water. Significant disturbance to waterways (in the form of increased turbidity) during construction of the Avebury Nickel Project is unlikely given the management measures to be employed and the thick riparian vegetation that will filter much of the excess sediments from run-off water. Portal construction will not occur within 50 m of Hemp Creek.

White-bellied sea eagle *(Haliaeetus leucogaster)*

No marine or estuarine habitat exists within the study area. Tall eucalypts (see Section 2.1.6 for habitat requirements) are rare in the study area due to the prevalence of rainforest vegetation, short dry eucalypt forest and wet scrub. The white-bellied sea eagle is not likely to be impacted by the proposed development.

White-throated needletail *(Hirundapus caudacutus)*

The Avebury Nickel Project is not likely to impact on feeding resources or roosting habitat of the white-throated needletail given the abundance of required resources in the area (see Section 2.1.6).

Latham's snipe *(Gallinago hardwickii)*

Latham's snipe will not be impacted by the Avebury Nickel Project given that it does not breed in Australia. Only a very small amount of its preferred feeding habitat in Tasmania, buttongrass plains, will be cleared (1.5 ha). Extensive areas (i.e., thousands of hectares) of buttongrass plains occur in the region.

Traffic Collisions

Given the low number of trucks and 4WD vehicles that will be using the access road, the low frequency of traffic movement and the short duration of the Stage 1 development, it is not likely that collisions between fauna and traffic will significantly impact local fauna populations. The noise and vibration (low frequency and monotonic in nature) from haulage trucks and 4WD within the study area may also act as a deterrent to fauna crossing the road during haulage.

Collision with and Electrocution on Powerline

Given that the overhead line is planned to be a single conductor only, the main risk of large birds, such as raptors, being caught between multiple conductors (i.e., distance between conductors less than wingspan) is reduced to nil. The height of the support poles will also be low compared to the forest vegetation (but high in comparison to the buttongrass moorland), so avian species foraging among the tree tops or above the trees are less likely to come into contact with the power line.

Sedimentation of Waterways

The likelihood of significant impacts to aquatic biota from soil erosion will be very low due to mitigation and management measures that will be implemented for the development, and loss of soil from development activities (transported by surface runoff) will largely be trapped and filtered by sediment traps and dense riparian vegetation.

4.7 Aboriginal and Non-Aboriginal Cultural Heritage

4.7.1 Potential Issues

No recorded Aboriginal or non-Aboriginal cultural heritage sites are known in the study area, as it has not previously been subject to formal survey and assessment.

Project construction may encounter previously unrecorded Aboriginal or non-Aboriginal cultural heritage sites or areas. Aboriginal cultural heritage sites that may be encountered include surface scatters and isolated artefacts, especially near watercourses, plains and marshy areas. Non-Aboriginal sites that may be encountered include infrastructure and damaged vehicles or machinery along the verges of the Trial Harbour Road originating from road construction, or evidence of shallow shafts, costeans or mining equipment from early mining lease activity (1880 to 1912).

4.7.2 Avoidance, Mitigation and Management

Experienced Aboriginal and historic archaeologists will undertake a systematic ground survey of the study area for Aboriginal and non-Aboriginal cultural heritage sites and areas prior to project construction. Any sites found during these surveys will be protected through the establishment of exclusion zones in consultation with TALC and THO. It is possible that artefacts may be discovered during the development of the Avebury Nickel Project. Therefore, a process will be implemented to identify and protect any future finds. Aboriginal and historical archaeologists will be on call during project construction in the event that archaeological material is detected.

The site-specific Archaeology and Heritage Management Plan detailed in Section 5.10 will ensure that impacts are managed in a culturally sensitive manner. Findings from the archaeology and heritage surveys will be incorporated into the detailed operating EMP prepared before construction.

4.7.3 Predicted Residual Impacts

There will be no damage to known Aboriginal or non-Aboriginal cultural heritage sites because none have been recorded in the study area. TASI-listed cultural heritage sites occurring outside the study area will not be impacted.

4.8 Visual Amenity

4.8.1 Potential Issues

An assessment of visual amenity incorporates three key factors:

- Views – areas that 'can be seen'. To interpret views, it is necessary to understand the context of a view.
- Landscape – the context of a view, taking into account physical appearance, population, naturalness and scenic beauty.
- Distance from views. As distance from a particular view increases, visual amenity decreases.

Potential impacts on landscape relate to how the change would affect the character of the landscape, as well as to sensitivity of views and the nature of the change. The physical components of landscape character are land cover (i.e., vegetation and land use) and topography. The Avebury Nickel Project study area and surrounding region is located in a landscape of undulating to steep forested land with grassy plateaux.

The assessment of visual amenity is essentially a subjective one, in that each person has a different perspective on what is or is not visually appealing. Not withstanding this, mining will unavoidably alter the existing visual attributes of the natural landscape, as vegetation will be cleared in association with the construction of roads and facilities.

Because of the landscape in which the project is located (i.e., undulating to steep forested land with grassy plateaux), and its distance from major populated centres, the visual sensitivity of the project is considered to be low. The valley of the study area, where the portal will be located, cannot be viewed from the nearest towns of Zeehan or Trial Harbour (several kilometres away), from Trial Harbour Road, or from vantage points in and around the towns.

The Avebury Nickel Project is located adjacent to an area of multiple-use state forest that has been assessed as having high quality wilderness values. Wilderness is the sum of three attributes; naturalness, remoteness and size. It must be large enough to enable long-term preservation of its natural systems and biodiversity, substantially undisturbed from human activity, and remote at its core from points of human activity (Robertson et al., 1992). Under Tasmanian legislation (*Regional Forest Agreement (Land Classification) Act 1998*), mineral exploration (including roads) and mine development are permitted activities in multiple-use state forest area with high-quality wilderness values.

Potential visual impacts associated with project development include:

- The visual presence of large construction equipment travelling along Trial Harbour Road via Zeehan.
- Road construction equipment temporarily stored overnight in some locations in view of Trial Harbour Road when not in use.
- The extension of the local electricity supply on support poles from where it currently terminates at the Comstock Mine to the proposed electricity substation site within the infrastructure area.
- The presence of an above-ground, narrow-diameter water pipeline from Kynance Creek to the water tanks within the infrastructure area. The pipeline will run under Trial Harbour Road but be visible as an above-ground feature on either side of the road.
- Signage used for access and safety purposes will be visible from a distance (due to their very nature and intent).
- The access road verge not blending in with the surrounding landscape until natural regeneration is advanced.

4.8.2 Avoidance, Mitigation and Management

The Avebury Nickel Project is not located in a wilderness area. Siting of project infrastructure will minimise land disturbance and vegetation clearing. Vegetation will be permitted to regenerate under the power distribution lines. The junction of the access road and Trial Harbour Road will be constructed in accordance with the Forest Practices Code (Forestry Tasmania, 2000) and Quarry Code of Practice (DPIWE and DIER, 1999), whereby a dog leg will be created so as to reduce any obtrusive views of the project (i.e., protect existing views) from Trial Harbour Road.

In the event that the Avebury Nickel Project does not progress beyond Stage 1, land rehabilitation and revegetation will take place to restore the landscape of the study area to a condition similar to that prior to disturbance (see Section 5.14).

The site-specific Visual Amenity and Landscape Management Plan detailed in Section 5.11 will ensure that impacts to visual amenity and aesthetics will be minimised.

4.8.3 Predicted Residual Impacts

The location of the Avebury Nickel Project is such that surrounding vegetation largely screens the visual impacts of construction activities and project components (such as most of the access road, surface infrastructure and portal) from surrounding areas.

Only its junction with Trial Harbour Road and the first 50 m of the access road will be visible from public viewing points along Trial Harbour Road. Dense vegetation screens most views of the project. Upon completion, the junction of the access road with Trial Harbour Road will appear no different than any other road in the region.

The Avebury Nickel Project will be less visually intrusive on the landscape than other mining activities already existing the area, such as the Comstock Mine east of the study area, which is an open cut mine located next to, and clearly visible from, Trial Harbour Road.

Most of these local impacts will be minor in extent and temporary in nature in terms of loss of visual amenity from publicly accessible vantage points (landscape level). There will be no interruption to views of significant features, such as Mt. Zeehan, Mt. Heemskirk or the Little Henty valley.

4.9 Socio-economic

4.9.1 Potential Issues

There are socio-economic advantages and disadvantages associated with development of Stage 1 of the Avebury Nickel Project. Impacts that may arise relating to the development include:

- Employment opportunities for the local community.
- Increased economic activity within the community.
- Potential attraction for the tourism industry (e.g., establishing tours of the project).
- The ability of currently established services and facilities to support the development.
- An increase in local traffic.

4.9.2 Avoidance, Mitigation and Management

Stage 1 of the Avebury Nickel Project will create approximately 20 to 25 full-time jobs. Recruitment for these jobs will be mainly from the local community in accordance with Allegiance's employment policy. Similarly, Allegiance will use goods and services provided by local companies.

Employment of locals will depend on availability and expertise. If construction of the Heemskirk Wind Farm commences in 2003 as planned, there may be a shortage of experienced individuals available locally. Alternatively, the opportunity may exist to train local people in skills that are required for the job.

Traffic and the transport of equipment associated with the project will be restricted to daylight hours and contractors will be instructed to adhere to speed limits through Zeehan and along the access road (Section 5.3).

The Social Management Plan detailed in Section 5.12 describes measures to enhance the socio-economic benefits of the project.

4.9.3 Predicted Residual Impacts

Additional employment opportunities will be a major benefit to the local community. The Avebury Nickel Project will inject $2.5 million in wages into the community during the nine months required for Stage 1. Mining will also provide an economic boost to the area in the form of increased support for existing local services and industries. The majority (90%) of the $7.5 million total cost estimate for the Stage 1 development will be spent in Tasmania, particularly in the local area. This cash injection will have a flow-on effect to other local businesses and industries, which in turn will strengthen their economic viability. Other business opportunities could also be associated with the project, such as the potential for mine site visits as a tourist activity. Expenditure and business opportunities within the community are expected to further increase if the project proceeds to stages 2 and 3.

Monetary benefits will also flow to the Tasmanian and federal governments in the form of taxes such as company, income and pay-roll tax. Should the project proceed to production in stages 2 and 3, royalties will also be paid to the Tasmanian Government.

Zeehan depends heavily on the Renison Mine, and to a lessor extent, on tourism. While the Renison Mine operates all year, tourism is seasonal. Proposed development at Avebury (and the Heemskirk Wind Farm) would broaden the commercial base supporting Zeehan and diminish the town's high vulnerability to global economic factors. Over the past 20 years, locals have experienced the closure of services and businesses due to a declining population. In the event that Stage 1 of the Avebury Nickel Project does not proceed, the economic future of Zeehan would be adversely effected.

Allegiance will preferentially employ people from the local area. If the required local capacity is not available, perhaps due to the timing of the construction of the Heemskirk Wind Farm, it may be necessary to source employees from outside of Zeehan. Considering the worst-case scenario, a possible influx of 20 to 25 people and their families may occur. Utilities services currently accommodate the seasonal change in Zeehan's population associated with the tourism industry. Existing accommodation and services and general community facilities (such as schools, health care, sewage and electricity) have the capacity to accommodate an increase in the population of Zeehan.

An increase in local traffic will be noticeable at the start and conclusion of Stage 1 development when earth moving equipment is transported to the site (mobilisation) and then from the site (demobilisation). Mitigation and management measures outlined in Section 4.9.2 will ensure that traffic hazards will be minimal. Ongoing traffic associated with Stage 1 of the project will be limited to light vehicles and supply trucks travelling to the project site during daylight hours. The increase in vehicle movements will be minimal compared with current traffic in and around Zeehan and will not be distinguishable from existing every-day traffic in the area, particularly given that greater increases in local traffic through Zeehan and along Trial Harbour Road are experienced during the tourist season. Traffic movements associated with the project will not result in the need for upgrading current road facilities.

4.10 Hazard Assessment

Hazards have been identified that may cause significant impact to people, property or the environment.

The following sections provide an initial assessment of scenarios specific to Stage 1 and their associated safeguards and control procedures. These sections will be re-evaluated as the environmental management plans are revised (Section 5.1.5).

4.10.1 Seismic Risk

No mine-induced seismicity will be associated with Stage 1 of the project (Davison, pers. com., 2003). No earthquake of magnitude greater than 6 has ever been recorded in Tasmania (Geoscience Australia, 2003). The project is located in an area that has an earthquake hazard risk of 0.05 to 0.1. This compares to >0.1 in areas of Australia that have experienced earthquakes with magnitudes greater than 6. This means that, in any 50-year period, there is a 90% chance that the peak ground acceleration[1] will not exceed 0.05 to 0.1. The higher the value, the higher risk of earthquake occurrence (Geoscience Australia, 2003). Therefore, seismic activity, and the associated risk, in the area is considered low. The design of structures to accommodate earthquake loads will be based on Australian Standard AS1170.4 (SAA, 1993). This standard provides design response spectra based on local ground conditions and an acceleration coefficient derived from a probabilistic seismic hazard analysis.

4.10.2 Flooding

The project facilities will be located within the small catchments of Contiguous and Hemp creeks (see Section 2.2.1), which flow through well-defined gullies that would help to contain flood waters. Facilities will be located to minimise the potential for flooding, e.g., the portal area is located approximately 50 m above Hemp Creek. The first section of the decline will be constructed with an uphill gradient to prevent the ingress of runoff into, and therefore flooding of, the decline. In addition, flood levels will be considered in the detailed design of the portal pad and plateau infrastructure sites. In the event of a flood, where necessary, measures, i.e., additional bunding, will be taken to minimise flooding of hydrocarbon storage areas.

4.10.3 Stability of Portal and Decline

The portal and decline are designed to ensure their overall geotechnical stability. The portal and decline locations were not selected until geotechnical drilling to

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[1] Peak ground acceleration is a dimensionless coefficient of acceleration that is used by civil engineers to estimate forces on structures.

determine stability had been completed. Once the portal and decline has been constructed, extra support will be provided by steel sets and, if necessary, cable bolts. A permanent concrete collar will also be formed around the portal if required.

Subsidence potential in a hard rock mine such as Avebury is considered to be very low because the intention is to develop and maintain stable voids in all openings and to use a mining method that requires self-filling of stoping voids (should the project proceed to Stage 2). The proposed mining system and operational measures directed at safety and stability will ensure long-term integrity of the mine and hence no subsidence effects.

4.10.4 Failure of Waste Rock Dumps

Temporary Waste Rock Dumps

Temporary waste rock dumps, at the portal and near the plateau infrastructure facilities, will only accommodate 1,000 and 2,000 t of waste rock respectively, at any one time, for a period of up to 14 days before the material is used in road construction. Therefore, due to the small quantities of waste rock temporarily stored at ground level, failure of the dumps will not result in significant adverse impacts.

Potentially Acid-forming Waste Rock Dump

The permanent potentially acid-forming waste rock dump will be constructed below the natural ground level, i.e., in a trench. Therefore, in addition to the fact that the area is non-active seismically, failure of the PAF waste rock dump can not occur.

4.10.5 Failure of Portal Water Treatment Facility and Plateau Infrastructure Site Settling Pond

Portal Water Treatment Facility

The portal water treatment facility is not a large structure. For the same reasons as stated above, failure due to seismic activity is considered low. The facility will also be designed to overflow when at capacity. Therefore, overtopping and instability-type failures in an extreme rainfall event is highly unlikely. If the facility did fail, it would discharge water to Hemp Creek. Given that the contents are treated to remove sediment, hydrocarbons and iron before entering the ponds (see Section 3.4.2), failure and release of the contents is not deemed to pose a significant environmental hazard. However, a failure could allow large quantities of soil to wash into Hemp Creek. If such a failure were to occur it would coincide with elevated stream discharge, and it is expected that the soil would eventually be transported through the stream system.

In the unlikely event that the cascading ponds cease to function effectively, water containing elevated iron concentrations could be discharged to Hemp Creek (or possibly Comstock Creek). Although iron is not a toxicant, the resulting precipitate would discolour Hemp Creek. Monitoring undertaken at the portal water treatment facility would detect a malfunction with the aeration system and appropriate remediation measures would be implemented.

Plateau Infrastructure Site Settling Pond

The risk of failure of the infrastructure site settling pond due to seismic activity is considered low. Like the portal water treatment facility, the pond is designed to overflow when at capacity, therefore overtopping and instability-type failure in an extreme rainfall event is highly unlikely. Should failure occur during such an event, water with elevated sediment loads would report to the natural drainage. However, intervening vegetation would filter some sediment. Elevated stream discharge expected to occur at the same time as the failure would eventually transport sediment downstream.

4.10.6 Hydrocarbon Leakage or Spillage

Fuel and lubricant usage is described in sections 3.2.5 and 3.4.5. Spillage of fuels or lubricants, either from routine usage of the fuels or accidental spillage or leakage from, and ruptures of, storage vessels, will have the potential to cause environmental damage.

Minor spillage of fuel and lubricant, such as during vehicle maintenance and refuelling, will be safeguarded against through bunding and a high level of operator training and diligence. Similarly, major spills that result from tank rupture will be contained by bunding. All bunding will be constructed in accordance with the relevant standards and codes (see Section 5.6). Measures to address spills will be incorporated into the Hazardous Materials Management Plan and Emergency Response Plan (see sections 5.5 and 5.6). Operators will be trained to cope in an emergency and other relevant parties (e.g., authorities) will be informed. Contractors working for Allegiance will be required to show they have measures in place which comply with Allegiance's operating standards.

Hydrocarbon spills will be reported through the incident reporting management system to Allegiance management, and government (DPIWE, Environment Division) and emergency services as required.

4.10.7 Fire and Explosion

Mining operations, including the storage and handling of flammable substances, can lead to the generation of potentially explosive and/or flammable gas emissions. Potential environmental impacts may include breakout of fire into surrounding vegetation, release of significant quantities of air emissions and contaminated runoff from firewater. Other impacts include damage to property and injury.

Preliminary mitigation measures include:

- Placement of explosives storage at least 300 m away from all infrastructure.
- Procurement of fire equipment adequate for the level of risk identified for the project and regularly maintained and tested to ensure good working order.
- Storage and handling of all substances, including waste, under conditions which minimise the risk of fire, explosion or toxic emissions.

- Implementation of a Fire Management Plan and Emergency Response and Contingency Plan (see sections 5.13 and 5.7).

4.10.8 Vehicle Accident

Fuel trucks will deliver diesel to the project site weekly and at the end of Stage 1, approximately 150 t of mineralisation (rock with elevated concentrations of nickel and sulfur) will be transported (8 trips) to an off-site facility for metallurgical testing (Section 3.3.2). Although minimal, there is the potential for these vehicles to be involved in an accident.

Contractors will be required to comply with Allegiance's procedures and the relevant codes and standards for transport, storage and handling of hazardous materials (including emergency response). Similarly, contractors will be required to adhere to Tasmanian road rules.

Fuel trucks will carry equipment necessary to respond to an accident that may result in a spill. In the event that mineralisation is spilt during transport, the material will be excavated and recovered as quickly as possible. The Project Manager will be notified immediately of spills that occur during transport and Allegiance will then notify the relevant authorities.

Should fuel or mineralisation come into contact with surface drainage, water quality will be monitored to ensure that the area is appropriately remediated, if necessary.

5. Environmental Management Plan

5.1 Environmental Management Systems

5.1.1 General

Allegiance is committed to reviewing, adopting and implementing the relevant provisions contained in the AS/NZS ISO 14000 family of standards. These standards will provide Allegiance with the elements of an effective environmental management system, i.e., a procedure for implementing, achieving, reviewing and maintaining the company's environmental policy.

5.1.2 Organisational Structure

The Project Manager is responsible for environment policy and implementation, and has authority from the Allegiance Board for ensuring that the environmental systems are implemented uniformly, revised as needed and maintained in accordance with company requirements. The Project Manager will also review the suitability and effectiveness of the environmental management system.

Particular functions that the Project Manager is required to fulfil via subordinate line management include:

- Ensuring that contractors fulfil their contractual obligations. Detailed environmental management requirements will be included in contracts as enforceable conditions.
- Implementing induction procedures and appropriate training.
- Ensuring compliance with land use permit conditions and company policy via the establishment and maintenance of appropriate reporting systems and databases.
- Participating with personnel to improve work practices on site.
- Undertaking internal site environmental audits.
- Providing advice as required to other project personnel.
- Liaising with local community-based environmental groups.
- Ensuring implementation and regular review of the EMP.

5.1.3 Environmental Induction Training and Education

Personnel recruitment will ensure that the appropriate knowledge and skills are available to achieve environmental policies, objectives and targets. Site inductions for new employees and contractors will address environmental issues and responsibilities, and will incorporate an Environmental Awareness Campaign. This will include:

- Obligations under Allegiance's environmental policy, relevant sections of the EMPCA and relevant permit conditions.

- Site environmental significance and layout.

- Community attitudes to the project and measures which could enhance the positive aspects of community attitudes.

- Site environmental guidelines.

- Specific procedures as detailed in the operating EMP concerning key environmental management aspects of the operation, including fire control, minimisation of impacts on flora/fauna, weed and pathogen management, protection of Aboriginal and non-Aboriginal heritage sites (if identified), segregation of rock types, water/wastewater control, hydrocarbon use and incident response.

Additional specific environmental training will be provided to personnel involved in:

- Maintaining and operating pollution control equipment/structures.
- Storing and handling hazardous materials.
- Responding to environmental incidents, e.g., fuel spills.

5.1.4 Reporting Systems and Databases

Routine Reporting Systems

Allegiance will employ the following environmental and social reporting systems:

- Results from environmental monitoring and investigation programs will be reported formally at a frequency specified by DPIWE.

- A report dealing specifically with environmental issues will be submitted to Allegiance's Board quarterly.

Databases

Allegiance will initially maintain a computerised database for monitoring data and other relevant information. Should the project proceed to Stage 2, Allegiance will review available computer-based environmental management information systems and similar programs with a view to installing such a system on site. The primary functions of the system would include:

- Recording water quality data, including details such as:

  – Location code, description (including elevation) and map reference.
  – Sampling interval.
  – Sampling date.
  – Variable.
  – Unit of measure.

- Method of analysis.
- Result.
- Last monitored date.

- Automated internal and external reporting of water quality data.
- Recording relevant regulatory documents, e.g., acts of parliament, state government policies, permits and dangerous goods or other licences.
- Recording additional information such as training records and the results of environmental audits and reviews.
- Providing other information, e.g., rock net acid-generation (NAG) and net acid-producing potential (NAPP) tests.
- Recording hydrocarbon usage.

Environmental Incidents

Environmental incidents which occur either as a result of an emergency, accident or malfunction, or which cause or threaten serious or material environmental harm[1], will be reported as specified in sections 32 and 33 in the EMPCA. Other incidents in breach of legislation or site permit conditions will be reported within the period specified by the legislation or accompanying site permit. In addition, Allegiance senior management will be made aware of any such incident within 24 hours of the occurrence of the incident.

Incident reporting forms will be filled out by involved personnel within 24 hours of an incident or near-miss occurring, and appropriate measures will be taken to ensure that similar incidents or accidents will not occur in the future.

5.1.5 Approach to the Environmental Management Plan

With respect to environmental management and monitoring, the management plans described in subsequent sections of this chapter are in-principle and strategic and set out the management issues identified during the preparation of this report and, for each, presents Allegiance's policy position and management intentions. The four components of these site-specific management plans are:

- Issue.
- Objective(s).
- Performance standard.
- Implementation measures.

These plans will subsequently be refined on the basis of stakeholder review of the DPEMP report. These refinements will include details for the remaining components of the management plans:

[1] 'Environmental harm' is defined in Section 5, EMPCA.

- Monitoring and mitigation.
- Responsibility.
- Schedule.
- Reporting.

The site-specific management plans will be refined after approval has been obtained, field surveys undertaken (see sections 4.6 and 4.7) and the detailed design phase of the project has been completed. These revised plans will form the basis of a detailed operating EMP that will be completed prior to construction. They will also form the basis of the stand alone DPEMPs that will be submitted for approval prior to the commencement of Stage 2 and Stage 3 of the Avebury Nickel Project (if the decision is made to proceed to these stages).

This approach has the following advantages:

- The DPEMP report contains sufficient information to allow an assessment to be made of the strategic approaches that will be reflected in the detailed plans.

- Subsequent versions of the EMP will incorporate detailed project-related information as it becomes available and at the appropriate stage of project development.

5.2 Water Management Plan

5.2.1 Issue

Project development may impact on the protected environmental values (PEVs) for surface waters in the project area. These PEVs can be impacted by changes in water flows, degraded water quality or sedimentation in the creeks in the project area and Little Henty River. This may result from:

- Runoff from the access road, plateau infrastructure site, portal site and waste rock dumps.

- Discharge of treated excess mine water from the treatment facility to Hemp Creek (or possibly Comstock Creek).

- Abstraction of water from Kynance Creek.

5.2.2 Objective

To maintain PEVs in receiving waters.

5.2.3 Performance Standards

This Water Management Plan will be assessed against the following legislation, policies, guidelines and codes.

- State Policy on Water Quality Management 1997 – aims to achieve sustainable development of Tasmania's surface water and groundwater by protecting or enhancing their qualities while allowing for sustainable development. The policy covers PEVs, derivation of water quality objectives, management of point sources of pollution (including discharge limits and mixing zones), management of diffuse sources, acid mine drainage and water quality monitoring.

- National Environment Protection Measure for National Pollutant Inventory (NEPC, 2000) – provides lists of contaminants that must be reported if they are emitted to water above a certain annual mass threshold. It is not expected that these thresholds will be exceeded and therefore it is unlikely that reporting under the inventory will be required.

- Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ, 2000) – provide a guide for setting ambient water quality objectives required to sustain current, or likely future, environmental values [uses] for natural and semi-natural water resources in Australia and New Zealand.

- Water quality objectives to be established by the Board of Environmental Management and Pollution Control.

5.2.4 Implementation Measures

Measures that will be implemented to ensure that the objective is achieved include:

Minimisation of Abstraction and Discharges

- Water from the treatment facility will be recycled for use during decline development. This will minimise abstraction requirements from Kynance Creek.

- The only point source discharges to surface water will be from the water treatment facility.

Protection of Water Quality

- The water management implementation strategy to minimise impacts on water quality is summarised in Table 5.1.

Erosion, Runoff and Sediment Control

Erosion will be minimised by:

- Minimising areas to be cleared (see Section 5.8.4).

- Avoiding clearance of areas with highly erodible soils and steep slopes.

- Revegetating areas as soon as is practical.

- Undertaking regular maintenance of access road.

- Ensuring vehicles keep to well-defined roads.

- Constructing and maintaining clean water diversion drains around disturbed areas.

- Constructing and maintaining drains directing sediment-laden water to sediment traps.
- Installing baffles in drainage lines to reduce water flow velocities.
- Minimising continuous slopes where scouring can occur.
- Lining drainage lines with crushed rock or geotextile where scouring may occur.
- Appropriate waste dump construction (see Section 5.4.4).

Monitoring

- Mine water, groundwater and surface water will be monitored as discussed in Section 5.15. The program includes background control and potentially-impacted site monitoring to fully capture any water quality changes that may impact on the modified aquatic ecosystems. Quantities of water abstracted from Kynance Creek and discharged to Hemp Creek (or Comstock Creek, see Section 4.1.2) from the water treatment facility will be recorded.
- If monitoring indicates water quality parameters in excess of the trigger values or water quality objectives, an environmental evaluation will be undertaken to determine any environmental impacts on modified aquatic ecosystems and define and implement management options.

Table 5.1 Water discharged to the environment

Source	Potential Contaminants/Stressors	Mitigation/Treatment	Receiving Environment	See Section
Runoff				
Runoff from plateau infrastructure site	Suspended solids	Directed to settling pond by drain. Silt fences will be used to filter discharge if required. Release of non-turbid water to standing vegetation.	Standing vegetation	3.4.3
Runoff from wash bay at the plateau infrastructure site	Oil and grease Suspended solids	Water directed to an oil trap with underflow reporting to the settling pond. Release of non-turbid water to standing vegetation.	Standing vegetation	3.4.3
Runoff from potentially acid-forming waste rock stockpile	Suspended solids Low pH water Metals	Acid-forming waste will be selectively placed in the middle of a below-surface dump and encapsulated with clay. Diversion drains will direct water away from the dump. The dump will be constructed so that rain falling on the dump will quickly drain away. Silt fences will be used if required. Release of non-turbid water to standing vegetation.	Standing vegetation	3.4.1
Runoff from temporary waste rock stockpile	Suspended solids	Directed to sediment traps by drains. Silt fences will be used to filter discharge if required. Release of non-turbid water to standing vegetation.	Standing vegetation	3.4.3
Runoff from access road	Suspended solids	Table drain diverting runoff to sediment traps and standing vegetation at least 50 m from streams. Silt fences will be used to filter discharge if required. Release of non-turbid water to standing vegetation.	Standing vegetation	3.2.4

Table 5.1 Water discharged to the environment (cont'd)

Source	Potential Contaminants/Stressors	Mitigation/Treatment	Receiving Environment	See Section
Runoff				
Runoff from southern section of access road.	Suspended solids	As above. On steeper sections of the road, water will be directed under the road via culverts and discharged to standing vegetation downhill of the road.	Standing vegetation	3.2.4
Runoff from portal site	Suspended solids Oil and grease	Directed to mine water treatment facility for removal of oil and grease and sediment.	Hemp Creek (or Comstock Creek)	3.4.3
Grey water and Sewage				
Grey water from ablutions buildings	Surfactants Nutrients Pathogens	Collected in tank. Remove from site and take to West Coast Council Sewage Facility	Off-site	3.2.2
Sewage from toilets	Nutrients Pathogens	Collected in trailer-mounted toilets. Remove from site and take to West Coast Council Sewage Facility.	Off-site	3.2.3
Groundwater				
Decline de-watering	Oil and grease Suspended solids Low pH water Metals Inorganic nitrogen	Directed to mine water treatment facility for removal of iron (by aeration and precipitation), oil and grease and sediment.	Hemp Creek (or Comstock Creek)	3.4.2

5.3 Air Quality Management Plan

5.3.1 Issue

Air quality management issues associated with Stage 1 development are dust generation from vehicle travel on unsealed roads and, to a lesser extent, dust generated from earthworks associated with vegetation clearing and construction of the access road. Trace amounts of asbestiform material (a potential carcinogen) contained within dust poses a health issue to construction personnel. Exhaust fumes from vehicles, plant, the portable electricity generators and the decline ventilation circuit also require assessment.

5.3.2 Objective

To minimise unacceptable air quality impacts, such as health risk or loss of amenity, from project development.

5.3.3 Performance Standard

The Air Quality Management Plan will be assessed against the following policies, guidelines and codes.

- National Environment Protection Measure for Diesel Vehicle Emissions (NEPC, 2001[1]) – establishes guidelines for determining the levels at which smoke emissions are unacceptable, diesel vehicle emission testing and repair programs and so forth. This NEPM provides guidelines for the states and territories to assess the need to manage emissions from in-service diesel vehicles and develop compliance programs specific to each jurisdiction. This only has relevance to the Avebury Nickel Project in terms of maintaining diesel-operated vehicles in good working order.
- National Greenhouse Strategy; Strategic Framework for Advancing Australia's Greenhouse Response (AGO, 1998) – provides a broad array of actions to guide the government, private sector and community to limit greenhouse gas emissions to meet international obligations. The strategy specifically mentions that the minerals and mineral processing industries should pursue best practice environmental management (BPEM) to reduce greenhouse gas emissions.
- Draft Environmental Protection Policy for Air Quality (DPIWE, 2001) – links to the NEPM for Ambient Air Quality, but relates mostly to controlling

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[1] National Environment Protection Measure for Ambient Air Quality (NEPC, 1998a) – establishes generic measures for determining concentrations of pollutants (cross-referencing to Australian Standards for pollutant modelling), with the aim of protecting human health and well-being. This measure may only be of relevance to the exhaust from the ventilation circuit at the decline, as it is not designed to address monitoring for the short-term nature of project developments such as the Avebury Nickel Project.

emissions from domestic solid fuel burning appliances, which is not relevant to the Avebury Nickel Project.

- Tasmanian Forest Practices Code (Forestry Tasmania, 2000) – contains general guidelines on minimising dust from traffic and the use of explosives, and reducing smoke from the burning of debris near residences.
- Quarry Code of Practice (DPIWE and DIER, 1999) – establishes an acceptable standard for dust generation and transport and suggested measures for control, which align with the measures outlined in this Air Quality Management Plan.
- Tasmanian Greenhouse Statement (1999) – establishes goals for reducing greenhouse gas emissions for the energy, transport, industrial process and waste management, agricultural and forestry sectors, but nothing specifically for mining. Many of the general principals are, nevertheless, easily adaptable to mining activities.
- Exposure Standards for Atmospheric Contaminants in the Occupational Environment (National Occupational Health and Safety Commission, 1995) – outlines exposure standards for various forms of asbestiform material.

5.3.4 Implementation Measures

Measures that will be implemented to ensure that the objective is achieved include:

- Restrict vehicle speed on the access road to 40 km/hr.
- If dust becomes a nuisance or a hazard, implement dust suppression measures, such as spraying the road surface (access road), topsoil stockpiles and waste rock dumps with water.
- Minimise the extent and period of exposed surfaces.
- Site topsoil stockpiles and waste rock dumps in areas sheltered from strong winds. Stockpiles and dumps will be constructed and maintained in accordance with the Quarry Code of Practice (DPIWE and DIER, 1999).
- Ensure vehicles and plant are mechanically sound and well-tuned, and fitted with appropriate emission control equipment.
- Promote conditions for prompt vegetation regeneration to stabilise soils along road verges and other exposed areas and revegetate progressively.
- Enforce a total fire ban on the lighting of all fires in the mining lease area for the life of the project.

Measures that will be implemented to specifically manage human health risks from trace amounts of asbestiform material in dust are:

- In the decline:
  - Wet drilling only.
  - Development face sprays.
  - Adequate ventilation.
  - Initial use of respirators until exposure conditions are established.
  - Initiate a high volume air sampling program to be developed by an occupational hygienist.
- Around the crusher:
  - Avoid crushing rock with high amphibole concentrations.
  - Use of sprays.
  - Initial use of respirators until exposure conditions are established.
  - Initiate a high volume air sampling program to be developed by an occupational hygienist.
- Along the access road:
  - Use high amphibole uncrushed rock for the road base.
  - Use rock with low amphibole concentrations for crushed top dressing of the road.

5.4 Mine Waste Management Plan

5.4.1 Issue

The management of mine waste, i.e., development waste rock, associated with the project is a fundamental requirement of ecologically sustainable development. Mine waste not managed effectively, particularly that which is potentially acid-forming, can cause significant environmental impacts.

5.4.2 Objectives

To ensure that mine waste, particularly PAF material, is managed safely and in an environmentally appropriate manner.

5.4.3 Performance Standards

This Mine Waste Management Plan will be assessed against the standard measures for the management of ARD (Environment Australia, 1997a):

- Reducing oxygen availability, e.g., storing PAF material under water.
- Minimising water percolation, e.g., clay (soil) cover and encapsulation of PAF material.
- Controlling the alkalinity and acidity balance by blending PAF material with acid-consuming material to buffer acid generation.

In addition, this management plan will be assessed against the following legislation, policies, guidelines and codes in relation to the protection of PEVs:

- State Water Policy on Water Quality Management 1997 – aims to achieve sustainable development of Tasmania's surface water and groundwater by protecting or enhancing their qualities while allowing for sustainable development. The policy covers PEVs, derivation of water quality objectives, management of point sources of pollution (including discharge limits and mixing zones), management of diffuse sources, acid mine drainage and water quality monitoring.

- National Environment Protection Measure for National Pollutant Inventory (NEPC, 2000) - provides lists of contaminants that must be reported if they are emitted to water above a certain annual mass threshold. It is not expected that these thresholds will be exceeded and therefore it is unlikely that reporting under the inventory will be required.

- Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ, 2000) – provide a guide for setting water quality objectives required to sustain current, or likely future, environmental values [uses] for natural and semi-natural water resources in Australia and New Zealand.

- Water quality objectives to be established by the Board of Environmental Management and Pollution Control.

5.4.4 Implementation Measures

Measures that will be implemented to ensure that the objective is achieved include:

- Routine examination and visual assessment of in situ material to identify PAF, non-acid–forming and acid-consuming materials which will require selective handling and emplacement.

- Using appropriate signage, i.e., acid-forming waste, clean waste, ore (i.e., mineralisation) to assist in the selective handling and storage of waste rock to minimise the potential for acid generation.

- Diversion of non-contaminated runoff away from the temporary waste rock stockpiles and permanent below-surface PAF waste rock dump.

- Minimisation of infiltration to sulfidic materials in the below-surface PAF waste rock dump through the selective placement of material within low-permeability clay barriers.

- Designing the below-surface PAF waste rock dump to shed water thereby reducing infiltration of water.

- Weekly monitoring of surface runoff downstream of the PAF waste rock dump (Section 5.15).

- Training of employees to ensure that they:

  - Are aware of ARD issues.
  - Can identify the visible signs of ARD.

- Can correctly identify and classify waste rock materials.
- Correctly implement the Mine Waste Management Plan.

5.5 Solid Waste Management Plan

5.5.1 Issue

The management of non-recyclable and recyclable non-hazardous solid wastes associated with the project is a fundamental requirement of ecologically sustainable development. If not managed effectively, solid wastes can pose significant health, environmental and aesthetic risks.

5.5.2 Objectives

To ensure that solid putrescibles, biodegradable and inert wastes are managed safely and in an environmentally appropriate manner.

To promote efficient use and conservation of resources, reduce the need for waste treatment facilities, and reduce the requirement of raw materials.

5.5.3 Performance Standards

This Solid Waste Management Plan will be assessed against the standard waste minimisation principles (Environment Australia, 1997b). These are listed below in order of preferred action:

- Avoid.
- Minimise.
- Reuse.
- Recycle/reclaim.
- Treat.
- Dispose.

This management plan will also be assessed against:

- National Environment Protection Measure for Movement of Controlled Wastes between States and Territories (NEPC, 1998b) – provides lists of controlled waste categories and aims to reduce adverse impacts on the environment and human health that might result from the movement of controlled wastes from one State or Territory to another by establishing a nationally consistent system for tracking the waste.

5.5.4 Implementation Measures

Measures that will be implemented to ensure that the objectives are achieved include:

- Ensure that all employees and contractors operate in accordance with Allegiance's procedures for solid waste management.

- Ensure a high level of staff employee and contractor awareness of solid waste management principles.
- Promote a high standard of housekeeping, thereby minimising litter and vermin infestation.
- Launch a recycling and waste minimisation program which will be regularly reviewed during the lifetime of the operation.
- Ensure waste storage areas are well signed and delineated.
- Ensure that licenced contractors, holding an approved WTB-EPN, dispose of waste off site when suppliers can not remove waste.
- Maintain records of solid wastes managed on site or sent to an off-site treatment, recycling, storage and disposal facility. For off-site recycling, treatment, storage and disposal, the following information is required:
  - Waste generator facility name and address.
  - Date of shipment for recycling, treatment or disposal.
  - Type of waste.
  - Quantities of waste.
  - Method of recycle, treatment or disposal.
  - Description of waste, including restricted characteristics.
  - Transporter name and address.
  - Name of recycling, treatment, storage or disposal facility accepting waste.
  - Where available, record receipt of waste from waste facility.
- Where possible utilise DPIWE's Tasmanian Waste Exchange Program.

In addition to the measures described above, Allegiance will comply with a range of management measures for the various solid wastes that will be generated on site (Table 5.2).

Table 5.2 Solid waste management procedures

Waste Type	Minimise	Reuse/ Recycle	Treatment/ Destruction	Disposal	Comments
Putrescible/ biodegradable litter	Minimise over ordering.		Collect in lidded 200-L drums located at designated points, transfer to central plateau infrastructure holding point, then remove off site by licenced contractor.	Emptied by contractor weekly and contents taken to Zeehan waste transfer station.	Lidded drums will prevent ingress of water and deny access to animals and birds. Drums will be colour-coded to differentiate contents.

Table 5.2 Solid waste management procedures (cont'd)

Waste Type	Minimise	Reuse/ Recycle	Treatment/ Destruction	Disposal	Comments
Packaging, paper, plastic, recyclable cans, containers, glass	Purchase in bulk.	Separate white paper and pet – HPDE, glass, plastic, cans.	Collect in lidded 200-L drums located at designated points, transfer to central plateau infrastructure holding point, then remove off site by licenced contractor.	Emptied by contractor weekly and contents taken to Zeehan waste transfer station.	Drums will be colour-coded to differentiate contents.
Scrap steel	Minimise over ordering.	Collect for recycling.	Separate store at plateau infrastructure site.	Removed by scrap merchant when truck load accumulates.	
Tyres	Maintain vehicles and equipment.	Collect for recycling.	Store at workshop at plateau infrastructure site.	Supplier will remove from site for recycling. Alternatively, re-use on site.	Small quantities expected.
Batteries	Maintain vehicles and equipment.	Collect for recycling.	Store at workshop at plateau infrastructure site. Batteries will be bunded.	Contractor will remove from site to licenced disposal site.	Small quantities expected.

5.6 Hazardous Materials Management Plan

5.6.1 Issue

Some consumables associated with the project are hazardous (mainly hydrocarbons and explosives), and will require management in terms of transport, storage, handling and disposal (see Section 4.5.1).

5.6.2 Objectives

To ensure that all hazardous materials are managed safely and in an environmentally appropriate manner, so as to:

- Prevent of contamination of soil and water.
- Minimise atmospheric emissions.

- Minimise waste generation.
- Avoid unacceptable safety risks.

5.6.3 Performance Standards

This Hazardous Materials Management Plan will be assessed against the following standards.

- AS 1216 Classification, Hazard Identification and Information System for Dangerous Goods.
- AS 2400 Part 21 – Packaging of Dangerous Goods.
- AS 2809 Road Tank Vehicles for Dangerous Goods.
- AS 1940 The Storage and Handling of Flammable and Combustible Liquids.
- AS 2187.1 Explosive Storage, Handling and Transport Storage.
- AS 2187.2 Explosive Storage, Handling and Transport Use of Explosives.
- AS 2508 Safe Storage and Handling Information Cards for Hazardous Materials.
- National Environment Protection Measure of Assessment of Site Contamination (NEPC, 1999).

5.6.4 Implementation Measures

Measures that will be implemented to ensure that the objectives are achieved include:

- Adopt the principles of reduce, reuse, recycle.
- Ensure a high level of staff employee and contractor awareness of the above principles.
- Incorporate hazardous materials management into site induction programs and training. Regular environmental/safety meetings will be held to inform site personnel of any developments in the management plan.
- Hydrocarbon materials will not be permitted onto the site unless their use is provided for in this management plan.
- Ensure that all contractors operate in accordance with Allegiance's procedures for:
  - Transportation.
  - Storage and handling.
  - Recycling and disposal.
- Incident reporting.

Transport

Procedures for transportation of hazardous materials to and from site will be a contractual responsibility of the suppliers and will include:

- Appropriate loading and unloading procedures.
- Proper vehicle and package labelling.
- Control of emissions and spills.
- Clean up and contingency procedures.
- Vehicle cleaning procedures.
- Refuelling procedures.
- Operator training and audit procedures.

Storage and Handling

Storage and handling measures for hazardous materials will include:

- Ensure the containers/tanks to be used for storage are compatible with the waste to be stored.

- Test new container/tanks and enclosures for fuel-intended purposes for leakages prior to and following delivery to mine site.

- Inspect containers/tanks periodically to prevent leakages.

- Label containers/tanks clearly with the following information:

  - Name or description of material.
  - Date that container was completely filled.
  - Name and address of facility.
  - Particular applicable characteristics (e.g., ignitable, toxic)

- Regularly inspect bunding to ensure that it is in good condition.

- Keep containers/tanks closed unless waste is being added.

- Ensure that containers/tanks are stored/stacked on one level only.

- Manage an inventory of containers/tanks to prevent unnecessary stockpiling.

- Store ANFO in a remote area that is bunded in accordance with the appropriate Australian standard.

- Carry out fuel transfers on the surface within bunded facilities.

- Carry out fuel transfers for use underground in the designated bunded areas.

- Provide a supply of absorbent material at designated areas to contain spillages which occur outside bunded areas.

- Place trays containing absorbent material under local work areas when an oil spill is unavoidable, i.e., removing hydraulic hoses, replacing filters.

- Keep a supply of oil-absorbent material stored in both operational and storage areas to clean up minor spills.

- Store all used absorbent material and waste oil in designated containers for off-site disposal.
- Launch a waste minimisation program which will be regularly reviewed and, where possible, adopt the following:
  - Hydrocarbon wastes, including waste oil, degreasers, engine coolants, grease and absorbent materials will be collected within separate receptacles and transferred to a central on-site bunded storage facility.
  - Hydrocarbon wastes, excluding waste oil, will be collected and removed from site by a licenced contractor and taken to an appropriate hazardous waste disposal facility, e.g., Port Latta.
  - Wherever possible, Allegiance will return all hazardous wastes and packaging to the supplier for recycling or disposal. Where this cannot occur, used containers and drums, and batteries will be disposed of off site by licenced contractor.
  - Tyres will be returned to the supplier for recycling. If this is not possible, tyres will be reused on site, e.g., for traffic control.
  - Waste oil will be taken directly to a central storage tank and taken off site by a registered contractor for disposal.
  - Hydrocarbon-contaminated soils will be placed in a centrally located lined or bunded (impervious to hydrocarbons) area for collection and disposal by a registered contractor.
- Implement a recording system to:
  - Reconcile hydrocarbon usage against stock and minimum/maximum storage requirements.
  - Maintain records of wastes managed on site or sent to an off-site treatment, recycling, storage and disposal facility. For off-site recycling, treatment, storage and disposal the following information will be recorded:
    - Waste generator facility name and address.
    - Date of shipment for recycling, treatment or disposal.
    - Type of waste.
    - Quantities of waste.
    - Method of recycle, treatment or disposal.
    - Description of waste, including restricted characteristics.
    - Transporter name and address.
    - Name of recycling, treatment, storage or disposal facility accepting waste.
  - Where available, record receipt of waste from waste facility.
  - Physical tests to ensure the integrity of all storage tanks and bunds on site is maintained.

- – Identify areas of risk for unintended discharge, loss or spills.
- – Identify the needs and storage requirements for emergency containment of materials.

5.7 Emergency Response Plan

5.7.1 Issue

Accidents and incidents can occur during construction and development of a project. The risk of certain events having significant consequences warrants the preparation of an Emergency Response Plan.

5.7.2 Objective

To ensure that a prompt and appropriate response is made to unplanned incidents where life, property or significant environmental or social values are threatened during development of the project.

5.7.3 Performance Standards

To ensure that this management plan complements the emergency response procedures of the West Coast Council, Forestry Tasmania and other relevant agencies, Allegiance will consult with local authorities during the development of the detailed operating plan on the following issues:

- On-site emergency procedures.
- Special risks and appropriate procedures to minimise those risks.
- Commercial ambulance and medical services.

This Emergency Response Plan will be assessed against the following standards:

- Hazardous Materials Emergency Manual – this manual is published by the State Emergency Service on behalf of the Tasmanian Hazardous Materials Management Committee and is designed to help develop information for use at an industrial site before and during emergencies.

5.7.4 Implementation Measures

Measures that will be implemented to ensure that the objective is achieved include:

- Demonstrate clear commitment and leadership by management through policy, participation, communication and allocation of resources, in improving readiness to respond to emergencies.

- Foster employee ownership in the processes of emergency management and response.

- Identify all hazards and risks of an unplanned incident. Credible emergencies that could potentially occur at the project site include:

  - Accidental spill of hydrocarbons while being transported, stored or used.
  - Accidental detonation of explosives while being transported, stored or used.
  - Gale-force wind or rainfall that causes extreme flooding or destruction of facilities.
  - Lightning or fire that damages facilities.
  - Injury to personnel.

- Provide a current, written, facility-specific plan, i.e., a detailed operating emergency response plan that addresses, among other matters, communication to employees, contractors and the public and, where appropriate, the recovery needs of the community after an emergency.
- Develop and maintain an induction and training program designed to improve the proficiency of the emergency response team as well as all employees and contractors covering operating procedures, emergency and safety procedures, regulatory compliance requirements and communication responsibilities.
- Develop an assessment process, periodically reviewed and updated, of potential risks from an accidental release or other emergencies to employees, contractors, local communities and adjacent neighbours, and initiate actions to reduce significant risks.
- Communicate relevant emergency response planning information to appropriate regulatory agencies and local emergency planning committees.
- Coordinate the detailed operating emergency response plan, community emergency response plan and other facility plans. If no community plan exists, initiate, where appropriate, community efforts to create one.
- Identify emergency responders and, where relevant, provide tours to promote emergency preparedness and to provide current knowledge of facility operations.
- Conduct emergency exercise sessions with emergency responders and others where appropriate, to test the workability of the detailed operating emergency response plan.
- Participate in the development and periodic testing of community emergency response plans.
- Share information and experience with other nearby facilities in the community relating to emergency response planning, exercises and incident handling.
- In the event of an emergency contact the appropriate SES offices, which are based at Zeehan, Rosebery and Queenstown.

5.8 Flora and Fauna Management Plan

5.8.1 Issue

Vegetation clearing associated with the development of the Avebury Nickel Project will impact on native flora and fauna values within the study area. This can result in minor losses in feeding, breeding and nesting habitat for some fauna species. There may also be a minor increase in habitat fragmentation.

5.8.2 Objective

To ensure that impacts to flora and fauna, and particularly threatened species, are minimised during project development.

5.8.3 Performance Standards

This Flora and Fauna Management Plan will be assessed against the following legislation, guidelines and codes.

- *Threatened Species Protection Act 1995* – provides for the listing and protection of threatened species in Tasmania. This is achieved through the preparation of Threatened Species Listing Statements that outline research requirements and management strategies for individual species. Species listed under the act must not be killed, injured or disturbed without a permit.

- Draft Threatened Species Strategy for Tasmania 1998 – develops actions to conserve threatened species in Tasmania, supported by the provisions of the *Threatened Species Protection Act 1995*, and outlines ways in which the government can work with industry to conserve threatened species.

- West Coast Planning Scheme (West Coast Council, 2001b) – places restrictions on land clearance with the aim of protecting Tasmania's vegetation assemblages and waterways. Vegetation clearing is only permitted if it is part of an approved use and can be conducted with minimal impact on unique values. Code 22 (Wetlands and Waterways Code) establishes objectives and performance criteria to which this Flora and Fauna Management Plan generally adheres.

- Forest Practices Code (Forestry Tasmania, 2000) – prescribes the manner in which forest practices shall be conducted in state forest so as to provide reasonable environmental protection. This includes management procedures for the building of roads in forest, timber harvesting, conservation of natural and cultural values and reforestation.

5.8.4 Implementation Measures

Measures that will be implemented to ensure that the objective is achieved include:

Vegetation and Habitat Loss

- The access road will be constructed along the route of the existing exploration tracks wherever possible (i.e., widened and upgraded), thereby minimising the extent of further vegetation clearing.
- The minimum area possible will be cleared for the access road and plateau and portal facilities infrastructure (but in accordance with road safety requirements). An area alongside part of the access road will need to be cleared to accommodate the overhead power distribution line and a water pipeline. The area of additional clearing will be minimised, especially through the buttongrass moorland.
- All retained vegetation outside the construction zone will be kept free of personnel and machinery.
- In recognition of the project area's land being managed by Forestry Tasmania, all clearing and road construction will be undertaken in accordance with the Forest Practices Code (Forestry Tasmania, 2000).
- No clearing of riparian vegetation will take place.
- A total fire ban on the lighting of all fires in the mining lease area will be in place for the life of the project.
- Stripped topsoil and vegetation will not be pushed into retained vegetation along creeks in accordance with the Forest Practices Code (Forestry Tasmania, 2000).
- Trees that have either milling or firewood value will be identified in consultation with, and stockpiled at points along the road for removal by, Forestry Tasmania.
- Plateau infrastructure facilities will be situated on, or as close as possible to, the rocky outcrops near the middle of the project area, to minimise the need for vegetation clearing.
- Where practicable, understorey vegetation will be maintained along road verges to assist with natural regeneration.
- Construction equipment, material stockpiles and other infrastructure will be placed on cleared land rather than in areas of native vegetation.

Habitat Fragmentation

- Where practical, the road verge understorey and mid-storey vegetation will not be cleared in order to provide a transitionary level of cover for fauna movement between dense intact vegetation and cleared open areas.
- Where practicable, logs and other habitat features will be retained along the road verge.
- Where practicable, habitat trees, such as those with well-developed hollows, will be retained with the access road designed around them.

Fauna Management

In addition to the mitigation and management measures outlined for minimising vegetation clearance and habitat fragmentation, the following provides extra measures to be implemented for the protection of fauna:

- Wildlife in the project area should not be disturbed. There will be no trapping or killing of native wildlife within the mining lease area.
- No firearms will be brought into the project area.
- Native wildlife will not be intentionally fed.
- No domestic pets, such as cats and dogs, will be brought to site.
- If feral animals are identified within the mining lease area, consultation with DPIWE and Forestry Tasmania will determine if a feral cat trapping program is necessary.

Effects on Significant Species

To minimise the effects of the development on species of conservation significance, the following measures will be implemented:

- Prior to construction commencing, a flora and fauna survey (including aquatic survey) will be undertaken, with a targeted search for species of conservation significance (as listed under the *Threatened Species Protection Act 1995*), such as the wedge-tailed eagle and the Australian grayling.
- Should species of conservation significance be identified during the survey and can not be avoided by the direct path of the access road or other infrastructure, a permit to disturb will be sought and obtained. Where necessary, species will be salvaged in consultation with the Nature Conservation and Parks and Wildlife branches of DPIWE.
- Any species of conservation significance found during this survey will be flagged for avoidance (where they are not in the direct path of, but near to, the access road or other infrastructure), or their habitat flagged for avoidance (e.g., wedge-tailed eagle nests).
- Where the access road crosses Hemp and Contiguous creeks, and other significant drainage, fish-friendly (bio-baffle) culverts will be installed, where practicable, so as not to impede the upstream and downstream movement of Australian grayling.

Traffic Collisions

Methods to minimise opportunities for fauna collision with construction traffic, include the following mitigation measures:

- Establish a 40-km/hr speed limit along the access road to enable vehicles to respond to unexpected hazards such as fauna crossing the access road or suddenly emerging from the road verges.

- Consider installing posts with light reflectors angled towards retained vegetation, at regular intervals along the road verge, to frighten animals from crossing the access road when traffic moves along the road at night[1].

Other Potential Impacts

Methods to mitigate potential impacts such as entrapment of fauna in the decline, collision with, and electrocution by, the overhead distribution power line and sedimentation of waterways include:

- The appropriate capture and relocation to forest surrounding the portal of fauna found trapped or disoriented in the decline.
- Consultation with Hydro Tasmania and DPIWE to determine the need for the installation of bird flight diverters (i.e., plastic orange balls) on the overhead power distribution line to enable avian fauna to see the power line and avoid it during flight.
- The installation of culverts where the access road crosses significant drainage.
- The construction of sediment control structures at appropriate locations.

5.9 Weed and Pathogen Management Plan

5.9.1 Issue

Earthworks and vehicle movements provide opportunity for the introduction and spread of weed and pathogen species.

5.9.2 Objective

To prevent project activities from introducing or spreading declared weeds or pathogens into, or out of, the study area.

5.9.3 Performance Standards

This Weed and Pathogen Management Plan will be assessed against the following legislation, guidelines and codes.

- Threat Abatement Plan for Dieback Caused by the Root-rot Fungus *Phytophthora cinnamomi* (Environment Australia, 2002) – one of the main objectives of this plan is to limit the spread of dieback into areas where it may threaten already threatened species and ecological communities or into areas where it may lead to further species or ecological communities

[1] The light from traffic headlights reflects off the reflectors into the forest, startling the animal and discouraging it from advancing on to the road.

becoming threatened. It lists actions that assist in achieving this objective, which the development of this management plan has taken into account.

- *Weed Management Act 1999* – provides for the control and eradication of weeds to protect primary productivity and natural ecosystems. The act provides for the listing of noxious weeds and the development of plans to control these weeds. Any declared noxious weeds present in the project area must be controlled.

- Mineral Exploration Code of Practice (Mineral Resources Tasmania, 1999) – outlines the environmental threats posed by weeds and pathogens and describes practical measures to prevent and control their spread, particularly that of pathogens. This management plan accords with the recommendations in the Code of Practice.

- Quarry Code of Practice (DPIWE and DIER, 1999) – suggests measures for reducing the spread of dieback. This management plan will be consistent with this code.

- West Coast Weed and Fire Management Strategy (West Coast Council et al., undated) – assesses the threat of weeds within catchments of the municipality of West Coast, and provides broad management measures (including options for integrated weed control) to reduce the introduction and spread of weeds in the area.

- Threatened Species Strategy for Tasmania (DPIWE, 1998) – identifies actions to limit the spread, and control, of weeds and pathogens in relation to the risks they pose to threatened flora and fauna species. The development of this management plan satisfies the objectives of the strategy.

5.9.4 Implementation Measures

Measures that will be implemented to ensure that the objective is achieved include:

Weeds

- Wash down heavy vehicles and equipment and portable infrastructure before initial deployment to the project area to avoid foreign soil and organic matter entering the area. Wash-down certification procedures will be applied.

- Establish a 'clean vehicles' policy, whereby heavy vehicles and equipment will be cleaned in Zeehan for travel along the Trial Harbour Road and into the project area, and again before leaving the project area.

- Restrict access to the site (through the use of a locked gate) to minimise entry of non-project vehicles to the area.

- Identify weeds existing in the study area in the flora survey to be conducted prior to construction. Weeds found during this survey will be shown on posters in the site office so that project personnel can assist in weed identification and help locate new infestations.

- Where practicable, control (and preferably eradicate) existing weeds in areas proposed to be disturbed through the manual removal or the application of appropriate herbicides prior to project development.
- Minimise soil disturbance and therefore the opportunity for weed invasion and spread, outside the nominated construction zones.
- Monitor for weed outbreaks during project development and eradicate such outbreaks at the appropriate time using the most efficient means.

Pathogens (Dieback and Myrtle Wilt)

- Conduct a *P. cinnamomi* and myrtle wilt survey in conjunction with the flora and fauna survey (see Section 5.8.4). Should infected vegetation be identified, DPIWE and Forestry Tasmania will be notified and soil testing will be undertaken to determine the exact presence and distribution of the pathogen.
- Should positive records of the pathogens emerge from testing, vehicle and personnel access will be limited to such areas through appropriate signage, flagging or barriers.
- Measures to control the introduction and spread of pathogens will be included in construction contracts and outlined during inductions.
- In vegetation communities susceptible to *P. cinnamomi* and myrtle wilt (regardless of the pathogens' status in the area), wash down of vehicles, equipment and portable infrastructure upon initial deployment to the project area will take place to avoid foreign soil and organic matter entering the area. Wash-down certification procedures will be applied.
- Where practicable, avoid driving through boggy soil or areas where water has ponded.
- Wash down of heavy vehicles and equipment will also take place prior to their exit from the project area to avoid the movement of possible pathogens from within the study area to elsewhere. Containment of wash-down water (and treatment with a sterilising agent) will prevent contaminated runoff infecting downstream areas. Wash down will be conducted downstream from the buttongrass plains.
- Undertake regular maintenance of access road to minimise ponding.
- Backfill all holes and trenches created by bogged vehicles and machinery.

5.10 Archaeology and Heritage Management Plan

5.10.1 Issue

Although no recorded Aboriginal or non-Aboriginal cultural heritage sites are known in the study area, project construction may encounter cultural heritage sites or areas.

5.10.2 Objectives

To prevent damage to known Aboriginal or non-Aboriginal cultural heritage sites and provide for the conservation of cultural heritage sites or artefacts that may be uncovered during project development.

5.10.3 Performance Standards

This Archaeology and Heritage Management Plan will be assessed against the following legislation, guidelines and codes.

- *Aboriginal and Torres Strait Island Heritage Protection Act 1984* – the purpose of this act is to preserve and protect areas and objects that are of particular significance to Aboriginals in accordance with Aboriginal tradition, from injury or desecration. The measures outlined in this management plan accord with the main provisions of the act.

- *Aboriginal Relics Act 1975* – primary legislation governing the treatment of Aboriginal cultural heritage in Tasmania (any place, site or object made or created by, or bearing the signs of activity of, the original inhabitants of Australia or descendants of such inhabitants in or before 1876). All relics are protected under the act. The measures outlined in this management plan accord with the main provisions of the act.

- *Historical Cultural Heritage Act 1995* – establishes procedures for the establishment of the Tasmanian Heritage Register and the criteria for entries into the register. A person must not carry out any works in relation to a registered place or a place within a heritage area that may affect the historic cultural heritage significance of the place unless the works are approved by the Heritage Council. This management plan accords with the main provisions of the act through the commitment to undertake a heritage survey prior to project development and through the development of management measures in the event of discovery of new heritage artefacts.

- Forest Practices Code (Forestry Tasmania, 2000) – the code establishes general principles for the protection and management of cultural heritage of all ethnic groups (Aboriginal and other Australians). This is primarily achieved through consultation with relevant groups and organisations and through identification (by survey), recording and assessment of cultural heritage artefacts using cultural heritage expertise.

- West Coast Planning Scheme (West Coast Council, 2001b) – contains procedures for the appointment of a Heritage Advisory Committee to assist council with heritage-related issues and refers to the *Aboriginal Relics Act 1975* and *Historical Cultural Heritage Act 1995* for the granting of permits involving works to a registered place or area.

5.10.4 Implementation Measures

Measures that will be implemented to ensure that the objectives are achieved include:

- Undertake a systematic ground survey of the project area for Aboriginal and non-Aboriginal cultural heritage sites and areas prior to project commencement by an experienced Aboriginal archaeologist and historical archaeologist.

- Perform an assessment of any Aboriginal and non-Aboriginal cultural heritage sites or areas that may arise from the ground survey, and register with Department of Tourism, Parks, Heritage and the Arts (Aboriginal) or the Tasmanian Heritage Office.

- Avoid newly registered sites through careful selection of alignment of access road and facilities (i.e., maintain flexibility in project design until Aboriginal and non-Aboriginal values have been identified).

- Protect registered sites through the establishment of exclusion zones.

- Restrict and monitor activities in areas known to contain Aboriginal and non-Aboriginal cultural heritage sites, where sites have the potential to be exposed during project development.

- In the event that impacts to registered sites are unavoidable, obtain consent to destroy from the relevant Minister in line with processes outlined in the *Aboriginal Relics Act 1975* and *Historic Cultural Heritage Act 1995*.

- Follow Tasmanian Aboriginal Land Council and Tasmanian Heritage Office established protocols to manage cultural heritage material identified during project development (in consultation with these agencies).

- Aboriginal and historical archaeologists will be on call during project construction in the event that ground surface visibility is poor or archaeological material is detected. If archaeological material is uncovered, the archaeologists will consult with agencies to determine an appropriate course of action. The Aboriginal archaeologist will assist the Aboriginal representatives to record any heritage material, in accordance with Tasmanian Aboriginal Land Council and Aboriginal community requirements. The historical archaeologist will record any historic heritage material in accordance with Tasmanian Heritage Office requirements.

- Through induction, instruct construction personnel in site recognition of cultural heritage features and locations for avoidance, and reporting processes in the event that new cultural heritage features are uncovered during construction.

5.11 Visual Amenity and Landscape Management Plan

5.11.1 Issue

The Avebury Nickel Project will result in unavoidable but minor impacts to visual amenity and landscape aesthetics, i.e., interruption to existing views and changes to the landscape of the study area.

5.11.2 Objective

To minimise the impact of project development on the visual amenity of the landscape.

5.11.3 Performance Standard

This Visual Amenity and Landscape Management Plan will be assessed against the following policies and codes.

- Forest Practices Code (Forestry Tasmania, 2000) – establishes guidelines for the construction of roads and quarries in the context of the visual amenity of landscape. Access road design will accord with these guidelines.
- West Coast Planning Scheme (West Coast Council, 2001b) – classes the study area as a Natural Resources Zone. One of the objectives of this zone is the maintenance of its scenic values, and more specifically (Objective 8.1), to protect views and vistas from major tourist roads. This management plan aims to meet this objective.

5.11.4 Implementation Measures

Measures that will be implemented to ensure that the objective is achieved include:

- Retain as much vegetation as practicable under the powerline extension into the project area, but within safety requirements required under the relevant electricity codes.
- Minimise clearing north of Trial Harbour Road associated with installation of the water pipeline from Kynance Creek.
- Allow herbaceous and shrubby vegetation to naturally regenerate on the access road verge around the water pipeline and under the powerline.
- Keep construction areas free of litter by providing bins where food is consumed.
- Move and stockpile cleared vegetation along Trial Harbour Road away from the road (i.e., along the access road south of, and out of view of, the Trial Harbour Road).
- Remove and dispose of all unnecessary project safety flagging and signage at the completion of construction.
- Site project facilities to minimise land disturbance and therefore vegetation clearing.
- Where practicable, rehabilitate disturbed areas progressively, using locally indigenous species.

5.12 Social Management Plan

5.12.1 Issue

Project development will be consistent with the requirements of the local communities.

5.12.2 Objectives

To establish good communication with local communities.

To maximise the positive impacts and minimise the negative impacts.

To establish a socio-economic management framework for stages 2 and 3 of the Avebury Nickel Project should the project proceed.

5.12.3 Performance Standards

This social management plan will be measured against the following:

- West Coast Planning Scheme (West Coast Council, 2001b) – the relevant objectives for development affecting the urban zone of Zeehan relate to the retention of existing services within the town to provide for the needs of residents and visitors and establishing Zeehan as a significant tourist destination.

5.12.4 Implementation Measures

Measures that will be implemented to ensure that the objectives are achieved include:

- Where possible, source employees from the local community.
- Where possible, use local goods and services.
- Manage project-associated traffic to minimise hazards and disruptions to the local community.
- Establish a process for community consultation that will include:
  - Community meetings and information sessions as required to keep the local community informed as developments proceed. This will allow the community to raise issues relevant to the Stage 1 development in a timely manner.
  - An open day at site to further inform and educate the local community about the project, allow familiarisation and facilitate a better understanding of the project.
  - Establish and disseminate a complaint mechanism.
- Establish a monitoring program to assess key socio-economic indicators.

5.13 Fire Management Plan

5.13.1 Issues

Project development activities may lead to fire ignition in surrounding vegetation. Sources of fire ignition include:

- Sparks from chainsaws.
- 'Hot work' (e.g., metal grinding or welding).
- Vehicles.
- Inappropriate handling or storage of combustible substances.
- Discarding lit tobacco products, matches or any other burning material.
- Mechanical malfunction in surface infrastructure facilities, vehicles, machinery, the substation or explosion of the magazine.
- Vegetation coming into contact with the overhead powerlines.

5.13.2 Objectives

To minimise bushfire risk within the project area and to prevent the spread of bushfire once a fire has started (either within the project area or off site).

To protect life and property.

5.13.3 Performance Standards

This Fire Management Plan will be assessed against the following legislation, guidelines and codes.

- *Fire Service Act 1979* – provides for the establishment of fire brigades, fire crews and resources to fight fires and enables the Tasmanian Fire Service to declare days of Total Fire Ban and establish fire breaks, as necessary. The Avebury Nickel Project must abide by Total Fire Ban declarations and allow firefighters to take control of wildfire in the project area, should it occur.
- Forest Practices Code (Forestry Tasmania, 2000) – stipulates that a fire management plan take into consideration land assets, proposed land use, fire history in the area and fire control resourcing and methods.
- West Coast Weed and Fire Management Strategy (Lyall, 2001) – broadly prescribes management measures for creating and maintaining fire breaks, planning and undertaking fuel reduction burns, fire mapping and conducting fire suppression.

5.13.4 Implementation Measures

Measures that will be implemented to ensure that the objectives are achieved include:

- A total fire ban will apply at all times within the mining lease area.
- Monitor fire danger ratings issued by state authorities and comply with all relevant statutory requirements and permits.
- Collect meteorological data and fire warnings from the Bureau of Meteorology during the fire season through fax, telephone or radio communications.
- Train personnel in fire prevention and response through induction.
- Maintain a trailer-mounted fire fighting tanker on site.
- Provide and maintain appropriate firefighting equipment, including fire extinguishers, water knapsacks and rake hoes. Fire extinguishers will be provided on all vehicles.
- Park vehicles in a cleared car park and not over tall groundcover vegetation.
- Keep vehicles clean, e.g., clear grasses from the belly-plates.
- Fit chainsaws used for vegetation clearance with spark arresters.
- Ensure that existing Forestry Tasmania tracks are not taken out of service during project development.
- Provide maps showing the location and height of powerline components to the relevant authorities including Tasmanian Fire Service, Forestry Tasmania and the Civil Aviation Safety Authority.
- Liaise with the Tasmanian Fire Service, Forestry Tasmania and the West Coast Council regarding fire risk, danger ratings and preparedness.
- Ensure that the detailed operating Fire Management Plan complements existing Forestry Tasmania, West Coast Council and Tasmanian Parks and Wildlife Service fire management plans. Liaise with these organisations during preparation of the detailed operating EMP.
- Provide relevant information on project development and operating practices to fire authorities.
- 'Hot work' will not be permitted on days of declared Total Fire Ban without a permit being issued by the relevant authorities.
- Whenever undertaking 'hot work', ensure that spark guards are used, the immediate area is clear of flammable materials and fire extinguishers are on hand.
- Vegetation under overhead power lines will be cleared and maintained to a height considered safe (for the continued operation of the powerline in the event of a fire).
- Construct fire breaks around sensitive areas, such as the explosives magazines.

- Establish fire evacuation procedures and an emergency assembly area.
- Provide emergency contact numbers in the site office in an easily accessible area (i.e., noticeboard). Contacts should include the Zeehan Fire Brigade, Zeehan Medical Centre, Forestry Tasmania (Strahan) and DPIWE.
- Report all incidents on Crown land to the Tasmanian Fire Service and to Forestry Tasmania if it has spread to surrounding vegetation. Report fire incidents to the Zeehan Fire Brigade and medical centre if there are injuries to personnel, and transport to Zeehan for medical treatment.

5.14 Mine Closure and Rehabilitation Plan

In the event that Allegiance reaches a decision not to continue the Avebury Nickel Project beyond Stage 1 development, this Mine Closure and Rehabilitation Plan will be developed into a detailed EMP for implementation during Stage 1. Otherwise, subsequent versions of this plan will address stages 2 and 3 of the project.

5.14.1 Issues

Due to its very nature, mining results in changes to a local landscape. But it is a temporary landuse that can be followed by other forms of landuse if mine closure and rehabilitation are successfully planned and executed.

Future land use will guide the way in which an area is rehabilitated. The Avebury Nickel Project is located on land managed by Forestry Tasmania as state forest (with minimal quantities of merchantable timber). A suitable initial objective is to return the land back to a similar condition to which it was pre-mining, that is, intact (but not undisturbed) forest, capable of being a self-sustaining ecosystem withstanding normal disturbances such as fire, flood or drought. This objective will be subject to revision after consultation with relevant stakeholders.

Unlike open cut mines with large areas of disturbance, the main area of concern for the Avebury Nickel Project, from a landscape restoration perspective, is the restoration of the access road and two small infrastructure areas.

Issues that will be considered for mine closure and rehabilitation include:

- Agreed land use after mine closure.
- Treatment of stockpiled waste rock.
- Removal of mine services and infrastructure.
- Closure of the decline portal.
- Reinstatement of landscape features.
- Rehabilitation of vegetation.
- Public safety and human health.

5.14.2 Objectives

To restore the project area to a condition that is suitable for an agreed, post-closure land use.

To protect human health and safety.

To minimise adverse post-closure environmental impacts.

5.14.3 Performance Standard

This management plan will be assessed against the following policies and codes.

- Mineral Exploration Code of Practice (Mineral Resources Tasmania, 1999) – presents broad guidelines on methods for revegetation.
- Forest Practices Code (Forestry Tasmania, 2000) – establishes broad guidelines for reforestation of forested land, with a focus on site preparation and species selection for revegetation.
- Quarry Code of Practice (DPIWE and DIER, 1999) – contains guidelines for land rehabilitation and revegetation, particularly in relation to open-pit style mining, the concepts of which are still relevant to the Avebury Nickel Project.
- Rehabilitation and Revegetation. Series of Booklets on Best Practice Environmental Management in Mining (Environment Protection Agency, 1995/1996) – contains detailed guidelines for land rehabilitation and revegetation, and includes case studies.
- National Environment Protection Measure of Assessment of Site Contamination (NEPC, 1999) – is aimed at establishing a nationally consistent approach to site contamination assessment to ensure sound environmental practices by the community and industry, rather than specific guidelines or measures for the assessment of site contamination, and provides a recommended general process for assessment of site contamination.
- Contaminated Sites. One booklet in a series on Best Practice Environmental Management (Environment Australia, 1999) – is aimed at minimising the risk of land contamination, management systems to limit contamination threats and assessing and remediating contaminated land.
- Classification and Management of Contaminated Soil for Disposal (DPIWE, 2002c) – defines criteria used by the Environment Division (DPIWE) for the classification of contaminated soil that requires off-site disposal and/or treatment and outlines the management of each classification.
- Strategic Framework for Mine Closure (Australian and New Zealand Minerals and Energy Council & Minerals Council of Australia, 2000) – provides a broadly consistent framework for mine closure in Australia without prescriptive measures. It outlines strategies for stakeholder involvement, planning, and closure implementation.

5.14.4 Implementation Measures

Measures that will be implemented to ensure that the objectives are achieved include:

Mine Closure

Consultation

- Identify and engage key stakeholders in a consultation program whereby their concerns and interests can be addressed during the mine closure planning. Key stakeholders are likely to include:
  - Allegiance: employees, contractors, management and shareholders.
  - Community: nearby landholders and Municipality of West Coast.
  - State government: Forestry Tasmania, Tasmania Parks and Wildlife Service, DPIWE, Mineral Resources Tasmania.
  - Other interest groups.
- Allocate adequate resources to the consultation process to enable effective and open communication (the local community will require the necessary information and resources to participate in the consultation process).
- Initiate the consultation process during the planning phase for Stage 1 development, even though the project may continue to Stages 2 and 3.
- Prior to implementation, submit the detailed Mine Closure and Rehabilitation Plan to the Director of Environment Management (DPIWE) for approval.

Planning

- Identify and assess risks associated with closure, to determine the feasibility of removing surface infrastructure and of returning underground structures to a stable condition.
- Allocate sufficient personnel resources, physical and monetary resources for closure planning, implementation and monitoring. A dedicated team may be required with clearly delineated roles and responsibilities.
- Determine legal and other obligations relating to mine closure.
- Determine closure criteria in consultation with the stakeholders.

Decommissioning

- All above-surface stockpiled waste rock will be returned underground.
- All underground mine services and equipment, such as air lines, ventilation ducting, power cabling, underground pumps and transformers will be removed from the decline, and then removed from the project area.

- The decline and box-cut will be secured and made safe. The portal will be appropriately sealed to prevent unauthorised access. In the event that permanent closure of the decline is required, the portal will be filled in (unless animals such as bats have colonised the decline as new habitat) and the box-cut reprofiled.

- If feasible, all infrastructure, both at the portal site and the plateau site north of the portal, will be removed. Concrete structures will be broken up and removed from site, and pits and excavations backfilled and reprofiled.

Contamination Assessment and Treatment

- Contaminants such as hydrocarbons (oil and grease, etc.) from bunds in the surface infrastructure area and residual soil contamination from spills will be removed. A plan (as part of the detailed mine closure and rehabilitation plan for implementation) for the assessment, treatment and removal of hydrocarbon and other contamination will be prepared in accordance with the NEPC (1999) and the Classification and Management of Contaminated Soil for Disposal (DPIWE, 2002c).

Rehabilitation

Planning

- Planning will take into account the nature of the surrounding forest (such as dominant overstorey and understorey species) and site factors, including:

  – Altitude and exposure.
  – Slope.
  – Soil moisture and rainfall.
  – Soil type, erodibility and depth.
  – Drainage features.

Site Preparation

- Where possible, the access road and surface infrastructure areas will be deep-ripped (along the contours) to alleviate compaction, encourage water infiltration and promote vegetation regeneration. Waste rock used as the road base will become part of the soil profile (in the A Horizon).

- In erodible areas, i.e., short, steep sections of the access road to the portal, surfaces will be deep-ripped and reprofiled. Shallow diversion berms may be required at regular intervals to direct runoff into stable vegetated areas. Jute matting (decomposable) may supplement these measures in highly erodible areas or areas requiring quick regeneration.

- Materials sourced from borrow pits will be backfilled into those original pits (where practicable) and the pits rehabilitated.

- Culverts on the access road will be removed and creek crossings reconstructed to approximate the original profiles.

- Topsoil stockpiles located along the access road will be respread over the access road, along the contours. This will constitute the fertile O Horizon.

Revegetation

- Where possible, revegetation will be completed progressively during project development.
- Vegetation debris from clearing will be evenly distributed over the bare earth to provide erosion control and a potential seed source for regeneration. This is most important in the eucalypt and buttongrass plains vegetation communities, where bradysporous seed (i.e., seed retained on the plant in persistent woody capsules) can be shed from the debris as it dries.
- The species seed mix and planting densities for revegetation (along with fertiliser requirements) in disturbed areas will be determined in consultation with Forestry Tasmania and DPIWE. Ideally, species will be of local provenance (i.e., locally indigenous plants). The following planting methods will be considered:
  - Seed broadcasting.
  - Direct seeding.
  - Hydro-mulch application.
  - Spreading of seed-bearing slash (especially for eucalypt, buttongrass and tea-tree species).
  - Nursery grown tube stock.
  - Transplantation (for species such as ferns).
- The need for the use of a fast-growing, sterile cover crop to stabilise the soil will be determined in consultation with Forestry Tasmania and DPIWE. This will be important in the high-rainfall environment of the project area.
- Consideration will be given to planting tube stock where rapid establishment of native vegetation is required, such as along watercourses.

Timing

- If practicable, rehabilitation will be undertaken in early autumn (March and April), when soil temperatures are still warm from the summer months and autumn rains stimulate the growth of seed shed during summer. Rehabilitation undertaken in autumn also ensures that winter rains in the following months provide adequate moisture for maximum seedling survival and growth.

Monitoring

- Establish 360° photo monitoring points throughout the project area (nominally five; the portal site, the surface infrastructure area, the Trial Harbour Road junction and two at regular intervals along the access road).

- Conduct follow-up visits to the project area on a regular and frequent basis (frequency decreasing with time) to monitor the success rate of seedling emergence and survival, weed invasion, browsing levels (i.e., insect and animal attack of regenerating vegetation) and erosion, using the photo monitoring points to track progress.

- Establish water quality monitoring locations to monitor the success of rehabilitation works (Section 5.15).

- Ensure that the monitoring program reflects the agreed closure criteria established through consultation with stakeholders.

Maintenance

- Where monitoring has identified erosion, weed invasion, failure of revegetation (to any degree) or excessive browser damage to regenerating vegetation, maintenance activities will be implemented to ensure regeneration progresses successfully and rapidly. These may include:

  – Repairing eroded areas.
  – Weed control (chemical, mechanical and manual methods).
  – Pest control (baiting, shooting, fencing, etc.).
  – Enrichment planting.
  – Spot sowing.
  – Reseeding.
  – Watering.
  – Fertilising.

5.15 Monitoring Program

5.15.1 Approach

The primary objectives of an environmental and social monitoring program are to:

- Provide information that will determine the adequacy of environmental and, where relevant, social management practices and allow improved practices and procedures to be developed.

- Detect and measure trends or environmental/social changes, and enable analysis of their causes.

- Confirm environmental and social impacts of particular activities (as described in Chapter 4 of this DPEMP) and identify unforeseen effects and the need for additional remedial measures.

The proposed environmental monitoring program is based on a conventional three-phase surveillance system, incorporating operations, discharge (or emission) and ambient monitoring. These are discussed below.

The proposed social monitoring program is based on data that, more often than not, would be collected in any case, but would not otherwise be assessed from a social impact perspective.

In situ measurements will be collected using an appropriate field meter while all laboratory analyses will be undertaken by an NATA-registered laboratory or a laboratory approved by the Director of the Board.

Reporting procedures are described in Section 5.1.4.

5.15.2 Operations Monitoring

A modern mine maintains comprehensive routine records for cost control, technical efficiency and safety reasons, as well as for environmental purposes. General monitoring of the operation, which will take place on a routine (and frequent) basis, will include the following:

- Waste rock production.
- pH of mine water and runoff from the permanent waste rock dump.
- Water balance.
- Diesel and other consumables usage rates.
- Potable water quality.
- Rehabilitation progress.
- Inspection of drainage and sediment controls.
- Waste production and recycling rates.

5.15.3 Discharge (Emission) Monitoring

Discharge or emission monitoring records the passage of contaminants at points outside the perimeter of activity. Discharge monitoring provides direct information concerning the concentrations and loads of contaminants being discharged from the operation, and also serves as a link between ambient monitoring results and the operation itself.

Sedimentation Control Structure

A sedimentation control structure will be constructed as part of the water management system at the surface infrastructure site. Although discharges are not expected to report directly to the river system, monitoring will be undertaken to characterise the nature of the water being discharged from this structure. Variables to be determined will include:

- pH, conductivity, turbidity.
- Oil and grease (on selected samples).

Runoff from Acid-Forming Waste Rock Dump

Monitoring is a critical component of managing acid rock drainage. Identifying acid rock drainage or the likelihood of acid rock drainage at an early stage may provide advance warning of more significant problems. This will enable proactive control and possibly treatment strategies to be adopted. Monitoring of the waste rock dump will involve:

- pH, conductivity, acidity, sulfate, Al, Fe and Mn if there is runoff from the waste dump.
- These same indicators in surface waters upstream and downstream of the waste dump (Section 5.15.4).

Routine testing of geological materials during mining will also be undertaken to validate predicted acid-generating and neutralising capacity.

Mine Water and Mine Water Treatment Pond

A geotechnical and geochemical drill hole established along the proposed decline route in February 2003 has indicated that mine water will be generated. Water excess to development requirements (i.e., that can't be recycled (see Section 3.4.2)) will be discharged off site. Monitoring of mine water pre- and post-treatment will be undertaken to ensure that the water is suitable for discharge, and will involve:

- Discharge rate.
- pH, conductivity, turbidity, dissolved oxygen.
- Al, As, Cd, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag, Zn (unfiltered and filtered (<0.45 μm)).
- TSS.
- NO_3, NO_2 and NH_3.
- Oil and grease.
- Faecal coliforms.

The proposed discharge monitoring program is summarised in Table 5.3 in Section 5.15.4.

5.15.4 Ambient Monitoring

While operational and discharge monitoring should determine if environmentally significant releases have occurred, effects on the ultimate receptors within the receiving environment can be determined only by ambient monitoring, as summarised in Table 5.3[1].

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[1] This program will be reviewed should discharge of excess mine water to Comstock Creek become necessary as described in Section 4.1.2.

Receiving Water Quality

Key factors to be considered in the design of the ambient water quality monitoring program include:

- Physico-chemical and biological indicators.
- Statistical design.
- Spatial design and sampling frequency.
- Mixing zone(s) downstream of project inputs.
- Procedural details, e.g., detection limits for trace metal determinations and sampling methods, and the availability of appropriately experienced laboratories to undertake the analyses.

Table 5.3 Summary of environmental monitoring program

Site	Sampling Frequency	Parameters
Discharge Monitoring		
Settling pond	Daily (when discharging)	• pH, conductivity and turbidity • Oil and grease on selected samples
Runoff from acid-forming waste rock dump	Weekly (if there is runoff)	• pH, conductivity and turbidity
	As required if weekly monitoring indicates that ARD may be a concern	• Al, As, Cd, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag, Zn (filtered and unfiltered) Ongoing program to be determined pending results
Mine water	Daily	• pH, conductivity and turbidity, discharge rate
Mine water treatment pond	Daily	• pH, conductivity, turbidity, dissolved oxygen and discharge rate
	Weekly (for one month)	• TSS • NO_3, NO_2 and NH_3 • Al, As, Cd, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag, Zn (filtered and unfiltered) • Oil and grease • Faecal colifroms
	Monthly (if weekly water quality indicates that water quality is acceptable)	• TSS • NO_3, NO_2 and NH_3 • Al, As, Cd, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag, Zn (filtered and unfiltered) • Oil and grease • Faecal colifroms
Ambient Monitoring		
Receiving water quality	Daily (Hemp Creek only)	• pH, conductivity, turbidity, dissolved oxygen and flow • Visual inspection for iron precipitate/floculants

Table 5.3 Summary of environmental monitoring program (cont'd)

Site	Sampling Frequency	Parameters
Ambient Monitoring (cont'd)		
	Weekly (for one month) at Contiguous Creek, Comstock Creek downstream, Hemp Creek downstream and Little Henty River	• TSS • NO_3, NO_2 and NH_3 • Al, As, Cd, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag, Zn (filtered and unfiltered) • Oil and grease • Chlorophyll-a
	Monthly (if weekly water quality indicates that water quality is acceptable) at Contiguous Creek, Comstock Creek downstream, Hemp Creek downstream and Little Henty River	• TSS • Al, As, Cd, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag, Zn (filtered and unfiltered) • Oil and grease • Chlorophyll-a • TOC, DOC (for first three months only)
	Flood-event sampling	• pH, conductivity, turbidity, dissolved oxygen and TSS • Al, As, Cd, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag, Zn (filtered and unfiltered)
Benthic macroinvertebrates	Bi-annual at Contiguous Creek, Hemp Creek downstream and Little Henty River	• Benthic macroinvertebrate survey
Meteorology	As required	• Temperature, rainfall, evaporation, wind speed and direction
Hydrology	Weekly/monthly to coincide with surface water sampling	• Estimate of flow
Rehabilitation	Monthly	• 360° photographic record from up to five sites

The ambient monitoring program will also take into account information available from the studies undertaken as part of the DPEMP investigations.

The goals of the ambient water quality monitoring program are, in conjunction with the operations and emission monitoring and the data obtained as part of the DPEMP investigations, to determine the status of the aquatic ecosystems in the catchments that potentially can be affected by the project, and to detect any improvements over time.

A range of factors has been examined to allow selection of monitoring indicators that would both:

- Be changed by the mine, and
- Are significant in terms of the quality of the receiving aquatic ecosystems.

Both physico-chemical and biological indicators will be considered.

Physico-chemical Indicators

From a water quality perspective, the primary mine-derived stressors are metals (naturally occurring given that there will be no processing associated with Stage 1 of the development) and TSS. The active and passive management features of the project mean that, in effect, the impacts from metals are expected to be negligible, while that from TSS will be more noticeable close to the portal and along the access road during construction, but minor thereafter. These considerations have been reflected in the program's subsequent emphasis on the following variables:

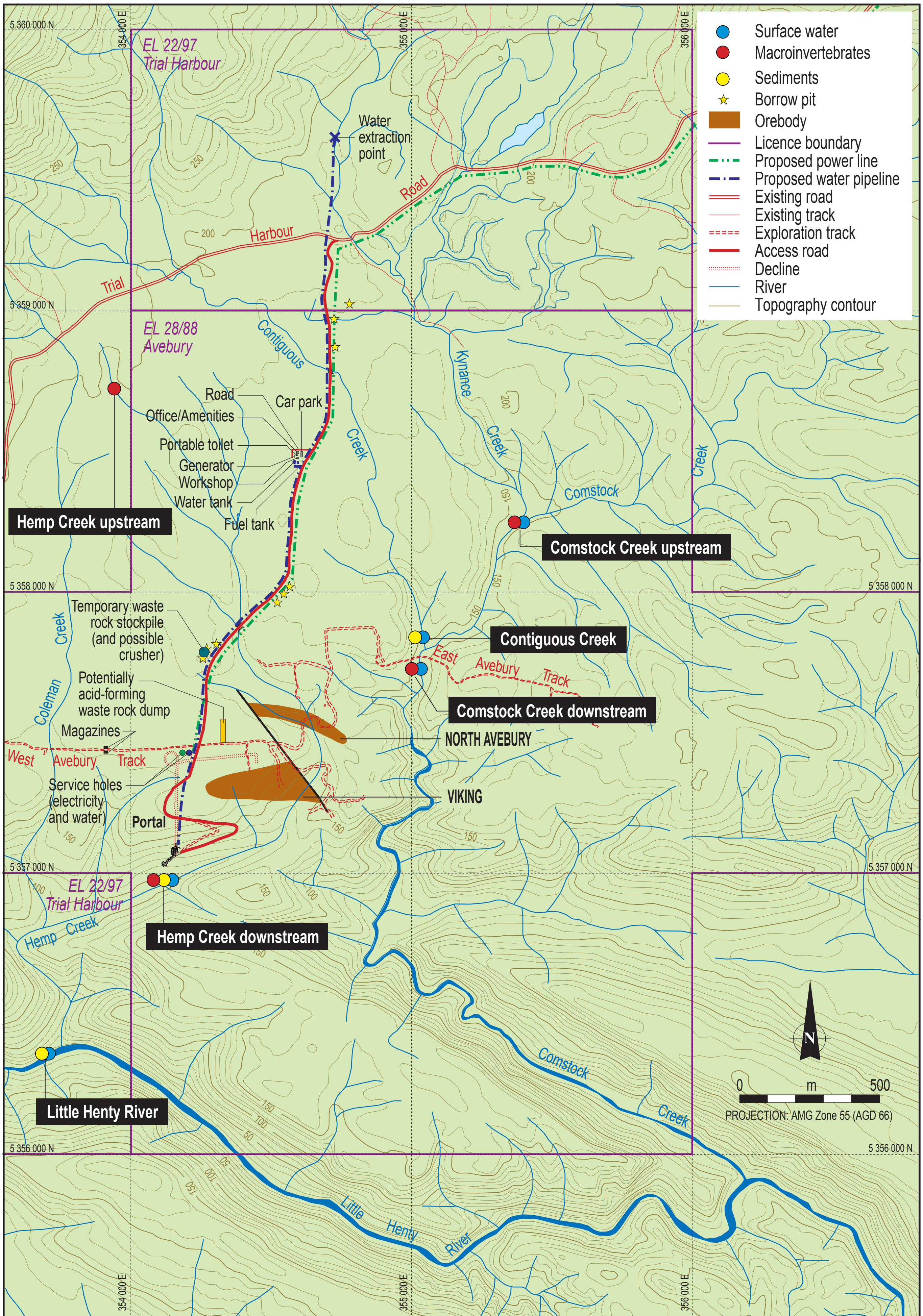
- Physical characteristics (e.g., turbidity, conductivity).
- Water chemistry (e.g., trace metals, total organic carbon (TOC), dissolved organic carbon (DOC), pH, inorganic nitrogen, dissolved oxygen, chlorophyll-a).
- Estimated flows.

Chlorophyll-a will be measured to determine if any increase in primary productivity of Hemp Creek occurs due to inorganic nitrogen in the excess mine water. Changes in dissolved oxygen concentrations that could be caused by iron precipitation will be measured directly. Sampling sites will include sites on Contiguous Creek (upstream of Comstock Creek) and Comstock Creek downstream of mine-related disturbance in addition to those established as part of the DPEMP investigations (Figure 5.1):

- Hemp Creek, downstream of the proposed decline portal.
- Comstock Creek upstream of the confluence of Kynance Creek.
- The Little Henty River approximately 50 m downstream of the confluence of Hemp Creek.

Sampling will include both routine and opportunistic event sampling where the latter is focused on obtaining samples from the river during a flood event, thereby taking into account flow-related variations in water quality. Specifically:

- Up to 10 samples (or more, depending on the size of the flood event) will be taken over a single flood event, with the majority of samples being taken on the rising limb of the flood hydrograph. The balance of the samples will be taken on the falling limb of the hydrograph and at low flow both before and after the flood event. If feasible (depending on logistical constraints and the stream flow variability observed during the sampling period), more than one flood event will be sampled.
- Stream discharge data will be obtained for the sampling event and the total load of material transported by that flood event calculated.



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Job No: 938	Allegiance Mining NL	Ambient monitoring locations	Figure No: 5.1
File No: 938_2_F5.01_HB	Avebury Nickel Project		

- Ongoing sampling will be undertaken at the same site to increase the level of confidence associated with the results from the initial sampling. The required sampling frequency will be determined once the results of the initial sampling program have become available. In determining the required sampling frequency, the following will be taken into account:
  - The size of the flood event sampled relative to the total annual river discharge.
  - Works being undertaken on site which may have affected downstream water quality during the sampling event.
  - Logistical constraints in terms of site accessibility and the need for appropriate sample handling procedures.

Biological Indicators

Biological indicators have been included in the current program and are discussed in Section 5.15.6.

Noise, Blasting and Air Quality

No formal nuisance noise, blasting or air quality monitoring is proposed, given the absence of receptors that may be affected during operations. Monitoring will be by complaint.

A high volume air sampling monitoring program for respirable asbestiform fibre and crystalline silica will be implemented. This program will be designed and controlled by an occupational hygienist with specific experience in the nickel mining industry where surveys of this nature are routine elsewhere in Australia and overseas.

Meteorology and Hydrology

The following data either will be collected directly by Allegiance or will be obtained from other parties:

- Zeehan rainfall and evaporation, wind speed and direction (existing Hydro Tasmania weather station).
- Flow estimates at water quality monitoring locations.

Rehabilitation

The progress of rehabilitation will be monitored by ground level photographic monitoring points.

Post-decommissioning Monitoring

Should the project not proceed to Stage 2 of the development, decommissioning will be undertaken. Discharge and ambient monitoring will continue until a 'steady state' has been achieved. The monitoring program will continue measuring rehabilitation success until it becomes apparent that:

- Active decommissioning and rehabilitation measures have achieved their aims and are no longer required.
- Normal vegetation growth over time is occurring and the rehabilitation objective, which will be defined in consultation with the West Coast Council, Forestry Tasmania, DIPWE and other relevant stakeholders, has been achieved.

Active monitoring by Allegiance may be required for a period of two to three years after these final rehabilitation works are completed.

5.15.5 Social Monitoring

The following indicators (that will be monitored on an ongoing basis) are particularly appropriate to the relevant aspects of Zeehan and Trial Harbour:

- Workforce statistics. These will include details such as:
  - Gender and age.
  - The number of project-related people moving to Zeehan/Trial Harbour.
  - Specific training undertaken by Allegiance (if conducted for Stage 1).
- Service and goods supply statistics. These will include details regarding:
  - Type and quantity of goods/service.
  - Value.
  - Location of supplier.
- Local and state business opportunities provided by the project.
- Local attitudes towards the project.
- The number of complaints documented in the complaints register.
- Allegiance sponsorship of events in Zeehan or other contributions made by Allegiance to the local communities.

5.15.6 Investigations

Sediment

Chemical analysis of sediments complements water quality data, in that the latter provides instantaneous information about the water column while the former, in its capacity as a sink for many contaminants, provides an integrated picture of water quality over time.

Bed sediment samples from Contiguous and Hemp creeks and the Little Henty River, taken from the water quality sampling sites, will be analysed for trace metals, particle size distribution and total organic carbon on the <2000 µm fraction. Sediment samples will be collected prior to construction.

In addition to sampling, monitoring of sediment aggradation sites will be undertaken to determine any changes to the fate and movement of sediment within Comstock Creek and Little Henty River.

Benthic Macroinvertebrates

A benthic macroinvertebrate survey will be undertaken prior to construction to identify macroinvertebrates, i.e., number of individuals and number of families. This information will be used to create an index of river health for Comstock and Hemp creeks and the Little Henty River that can be compared to other rivers in Tasmania and Australia. Through monitoring, the index will also be used to identify temporal changes in the river system that are associated with the project. Macroinvertebrates will be sampled using standard methods outlined by AusRivAS (Australian River Assessment Scheme), a protocol devised for a nation-wide river bioassessment program. The AusRivAS protocol also outlines data management and analysis procedures that form the basis of establishing an index of river health.

Acid Rock Drainage

If the geology and geochemistry in the decline is different to that which has been indicated by drilling and testwork to date, additional samples will be collected for geochemical characterisation. The proposed monitoring program has been designed to monitor the potential for acid generation in the mine water and from the permanent waste rock dump, and to monitor the impact of mine-derived pollutants on surface water quality (see sections 5.15.3 and 5.15.4).

6. Summary of Commitments

Allegiance will ensure that the commitments provided in Chapters 3, 4 and 5, and summarised in Table 6.1, are conducted in a satisfactory manner. Several of these commitments relate to surveys to be undertaken after approval of the DPEMP but before project development commences.

Table 6.1 Summary of commitments

No.	Section	Commitments
1	3.2.4	Where practicable, topsoil dumps will be formed on flat ground to minimise erosion.
2	3.2.4	Only material classified as competent and non–acid-forming, or marginal material blended with non–acid-forming material, will be used in the construction of the access road.
3	3.2.4	To minimise erosion at Hemp and Contiguous creeks, culverts will be installed and the access road will be designed, in accordance with the Forest Practices Code, to approach the creeks at right angles.
4	3.4.1	Potentially acid-forming waste rock identified during the development of the decline will be transported to a below-ground waste rock dump and encapsulated with clay to inhibit the generation of ARD.
5	3.4.1	A survey will be undertaken to confirm that adequate quantities of clay are available for management of PAF material.
6	3.4.1, 5.4	The surface drainage of the waste rock dump will be designed to shed surface water and minimise interaction between sulfidic material and water.
7	3.4.2	Suspended solids, oil and grease and dissolved iron will be removed from the mine water prior to discharge to Hemp or Comstock Creeks.
8	3.4.3	Surface water runoff will be managed through the implementation of clean and dirty water drainage systems.
9	4.1.2	Optimisation of water treatment facility during the detailed design phase including empirical precipitation tests to determine iron kinetics and behaviour of the precipitate.
10	5.1	An environmental management system (EMS) will be established to guide the planning, implementation and operation framework for the detailed operating EMP.
11	5.2	Abstraction of water from, and discharge to, natural waterways will be minimised. Abstraction rates and volumes from Kynance Creek and discharge rates and volumes to Hemp Creek from the water treatment facility will be recorded.
12	5.3	Dust generation will be minimised by restricting traffic speeds along the access road and by the appropriate stockpiling and treatment of soil and waste rock.
13	5.4	Non-contaminated runoff will be diverted away from the temporary waste rock stockpiles and permanent below-surface waste rock dump.

Table 6.1 Summary of commitments (cont'd)

No.	Section	Commitments
14	5.5, 5.6	A recycling and waste minimisation program for solid and hazardous waste will be implemented.
15	5.6	Hazardous substances will be transported, stored and handled in accordance with the applicable Australian standards.
16	5.7	All employees and contractors will be trained to respond appropriately to unplanned incidents.
17	5.8	Infrastructure facilities will be sited on rocky outcrops or previously cleared areas, where practicable, to minimise loss of vegetation.
18	5.8	Trees with commercial value will be identified in consultation with Forestry Tasmania and stockpiled for removal.
19	5.8	There will be no clearing of riparian vegetation.
20	5.8	No domestic animals will be permitted on site and, if necessary, a feral animal eradication program will be introduced.
21	5.8	To minimise impacts to native flora and fauna, the access road will be constructed along existing tracks, where practicable, and in accordance with the Forest Practices Code 2000.
22	5.8	All vegetation clearing will be undertaken in accordance with the Forest Practices Code 2000.
23	5.8	Prior to construction commencing, a flora and fauna survey (including aquatic survey) will be undertaken to identify any species of conservation significance.
24	5.9	Weeds will be monitored, controlled and, if possible, eradicated.
25	5.9	Before commencement of construction, a survey to determine the presence or not of the pathogens dieback and myrtle wilt will be undertaken. Any recorded infestations will be reported to the appropriate authority.
26	5.9	All heavy construction vehicles and equipment entering or exiting the project area will undergo wash downs to minimise pathogen transport.
27	5.9	Wash-down water will be contained to prevent contamination of downstream areas.
28	5.10	Before commencement of construction, a survey will be undertaken to determine the presence of Aboriginal and non-Aboriginal cultural heritage sites.
29	5.10	Construction personnel will be instructed in the recognition and reporting of sites of cultural heritage.
30	5.10	Exclusion zones will be established to protect Aboriginal and non-Aboriginal cultural heritage sites.
31	5.10	Where impacts to registered Aboriginal and non-Aboriginal cultural heritage sites are unavoidable, consent to destroy will be obtained from the appropriate authorities.
32	5.11	Clearing of vegetation associated with installation of the water pipeline and the electricity distribution line near Trial Harbour Road will be minimised to limit the loss of visual amenity.
33	5.11	Project facilities will be sited to minimise land disturbance and therefore vegetation clearing to limit the loss of visual amenity.

Table 6.1 Summary of commitments (cont'd)

No.	Section	Commitment
34	5.12	Employees and goods and services will be sourced from the local community wherever possible.
35	5.12	A process for community consultation will be formulated and implemented.
36	5.13	Personnel will be trained in fire prevention and control.
37	5.13	Fire extinguishers will be provided in all vehicles.
38	5.13	Maps showing the location and height of powerline components will be provided to the relevant authorities.
39	5.13	A total fire ban will apply to the mining lease area at all times.
40	5.14	Key stakeholders will be identified and engaged in a consultation program whereby their concerns and interests can be addressed during mine closure planning.
41	5.14	Upon decommissioning, if the project does not proceed beyond Stage 1, all infrastructure and equipment will be removed and the landscape restored to a similar condition to that prior to development.
42	5.14	Upon decommissioning, if the project does not proceed beyond Stage 1, the above-surface waste rock stockpiles will be returned underground.
43	5.14	Revegetation of disturbed areas will be undertaken in consultation with the appropriate authorities.
44	5.15	An operations, discharge and ambient monitoring program, along with social monitoring will be implemented.
45	5.15	An investigation will be undertaken into creek sediment quality and benthic macroinvertebrates prior to project commencement.
46	General	A detailed operations EMP based on the management and mitigation measures described in this DPEMP, and the results of the detailed surveys, will be developed prior to project development.
47	General	All personnel will undergo an environmental induction program outlining all aspects of environmental management prior to commencing work on the project.

7. Study Team

Allegiance appointed NSR Environmental Consultants Pty Ltd (NSR) to prepare this Development Proposal and Environmental Management Plan. NSR engaged a number of specialist subconsultants and the report draws on their work. These contributions are gratefully acknowledged.

The following individuals contributed to the preparation of the Allegiance Avebury Nickel Project DPEMP.

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Appendix 1

DPEMP Guidelines

GUIDELINES FOR THE PREPARATION OF AN
DEVELOPMENT PROPOSAL AND ENVIRONMENTAL MANAGEMENT PLAN

FOR ALLEGIANCE MINING NL –
AVEBURY NICKEL PROJECT STAGE 1

Environment Division
Department of Primary Industries, Water and Environment
GPO Box 44 Hobart Tasmania 7001

GENERAL INFORMATION FOR THE PROPONENT

These guidelines are based on the requirements of Sections 73 and 74 of the *Environmental Management and Pollution Control Act 1994 (EMPCA),* and the objectives given in Schedule 1 of that Act.

The purpose of the Development Proposal And Environmental Management Plan (DPEMP) is to provide the Board of Environmental Management and Pollution Control (the Board) with sufficient information to assess an application for a Land Use Permit by Allegiance Mining NL to develop Stage 1 of the Avebury Nickel project in accordance with the requirements of the EMPCA, associated State Policies and Regulations.

The document will also fulfil the role of providing information on the proposed activities to other decision-making authorities (ie. Local Government) and the public, including general interest groups, which has the opportunity to make submissions on the proposal and ultimately appeal against the issuing of a permit or the conditions of the permit. As such, the document must be written in a manner, which is clear and concise, yet easily read and understood by the general public. Where it is necessary to include material of a highly technical nature, this should be contained in an appendix and summarised in the main body of the text.

It is intended that compliance with the Best Practice Environmental Management (BPEM), as defined by the EMPCA prescriptions set down in the DPEMP should form the basis of the conditions under which any land use permit is granted under the *Land Use Planning and Approvals Act 1993 (LUPAA).* The management prescriptions to achieve satisfactory environmental performance should therefore be described in sufficient detail to serve this purpose.

The DPEMP is normally required to initially be reviewed after twelve months from commencement of commercial operations and at three yearly intervals thereafter, to ensure the document remains accurate and up to date with respect to changing site conditions over the operational life of the mine and agreed developments in BPEM which is recognised as a dynamic concept. In addition, a review of the DPEMP is normally required in the event of a:

- significant change in an Activities operation not anticipated in the DPEMP.
- significant change in knowledge of the environmental situation.

However, in view of the three staged approach to the Avebury Nickel project by Allegiance Mining NL, it is recommended that a stand alone DPEMP be submitted for approval prior to commencement of each of Stages 2 and 3 of the mine development.

Every attempt has been made to ensure that these guidelines address all the major issues associated with a proposal, however, other issues that may emerge as important during the preparation of the DPEMP should also be considered.

However, it should be noted that not all matters as indicated in the guidelines might be relevant to all aspects of the proposal. Only those matters that are relevant to the proposal should be addressed.

The guidelines set out below are intended to define the minimum scope of the DPEMP document. It is desirable that the format of the document follows as closely as possible the format of the guidelines so that it may be readily ascertained that all aspects of the guidelines have been addressed. It is recognised that an alternative arrangement of subject material may sometimes improve the readability of the document. Any significant deviation to the layout of the document from that set out in the guidelines should be discussed with the Environment Division of the Department of Primary Industries, Water and Environment (DPIWE).

Close consultation with the Environment Division of the DPIWE and the planning authority during the preparation of this document is recommended, as more than one draft may be necessary before it is suitable for public display. When the document is ready for public display, a minimum of 6 copies of the document should be provided to the Division for distribution to relevant assessing officers and files, other relevant government agencies, also libraries, Council and office reception areas.

Following the public consultation process, the DPEMP may then require amendment as a result of consideration of public and government agency submissions. This often takes the form of an addendum or supplement, unless substantial changes have been made which necessitates revision of the entire document.

CONTENTS OF THE DEVELOPMENT PROPOSAL AND ENVIRONMENTAL MANAGEMENT PLAN

I FRONTISPIECE

This should explain the function of the DPEMP and its role in the statutory process of obtaining a permit. The statutory rights of any person to lodge a submission on the application should be described together with instructions as to how a submission may be lodged and an appeal may be made, and the relevant time constraints.

II LIST OF CONTENTS

A list of the contents of the DPEMP (including illustrations), referring readers to the appropriate page numbers should be provided.

III EXECUTIVE SUMMARY

An executive summary of the contents of the DPEMP should be provided to give a short overview of the proposal and the potential environmental impacts, along with the measures that will be taken to avoid or minimise the potential impacts.

1.0 INTRODUCTION

1.1 IDENTIFY THE PROPONENT AND THE PROJECT

The introduction should identify the proponent, Allegiance Mining NL, the corporate body and any associates involved in developing and managing the project.

1.2 SCOPE

Provide relevant background of Stage 1 of the Avebury Nickel project, while also briefly describing Stages 2 and 3, including the projected commencement timeframes for each of the mine development stages, as currently planned.

1.3 HISTORICAL BACKGROUND

Provide brief description of the history of the project, including exploration work undertaken to date to identify the Avebury resource and any other resources in the region (ie. Avebury East and Melba Flats).

1.4 ENVIRONMENTAL LEGISLATION

The proposal must be considered in the light of relevant local, State or National Legislation, State Policies plus identification of approvals required [ie. by DPIWE, West Coast Council, Mineral Resources Tasmania (MRT)] for the development to proceed, and the status of each approval required.

Other statutory legislation relevant to the operations on site including, *Dangerous Goods Act 1998*, *Workplace Health and Safety Act 1995*.

National Environment Protection Council (NEPC) in relation to National Protection Measures (NEPM) for air, water, soil pollution and the Movement of Controlled Wastes between States and Territories, National Pollutant Inventory (NPI)

Greenhouse Challenge (if signatory) with respect to life cycle analysis and research into the generation and reduction of greenhouse emissions due to operations.

Any legislated agreements with the State (*To be Determined and formalised)*, are required to be detailed if relevant.

Implications of Best Practice Environmental Management as it applies to the project.

1.5 ENVIRONMENTAL POLICY

Allegiance s Environmental Policy (if developed) should be provided.

1.6 MINERAL RESOURCE

Provide a description of the identified ore reserve, proposed Stage 1 mining activity and exploration including both historical drilling and ongoing drilling/or prospect identification program.

1.7 ECONOMIC IMPLICATIONS

The broad economic implications of the project for the local community and for Tasmania generally should be detailed, including:

- projected employment levels;
- level of capital investment required to enable development of Stage 1;
- flow on effects; and
- potential value and earnings.

2.0 SITE DESCRIPTION AND EXISTING ENVIRONMENT

This section must include, as a minimum including maps and photographs, where this assists with the description of the proposal.

<u>Locality maps (1:25,000) detailing the following information:</u>

- land tenure (public/private) of all land within or adjacent to the mine lease area;
- topography, natural watercourses (ie. Comstock, Keynance and Hemp Creeks and the little Henty River) and other major physical features, the hydrology of the lease and projected significant modifications to the landform resulting from the proposed mining activity on the lease, primarily associated with Stage 1 of the development but as well foreshadowed changes associated with Stages 2 and 3;
- existing access and proposed access/cartage routes for raw materials/products, and wastes, within the lease;
- location of waste rock areas, (if required) dependant on the potential for the reuse of waste rock generated by the decline shaft for road construction and sheeting hardstand areas on site;
- boundaries of mining lease(s) and any other land over which Allegiance Mining NL has control, and relevant land zoning (West Coast Planning Scheme) of all adjacent land within 1000m of the lease boundary;
- compatibility of Stage 1 of the project with any planning provisions or land use constraints; and
- location of any adits or excavations (drill holes) from existing and historic mining activities on the lease area.

2.1 TERRESTRIAL ENVIRONMENT

- provide a description of the physical setting of the Avebury mine site including any historical and current land uses;
- a description of the local climatology (ie. temperature, rainfall, windspeed and direction) and topography (ie. as relevant to flooding, dispersion of site discharges/emissions and disturbance of particulates);
- a detailed description of geological characteristics of the lease site and surrounding area including the nickel sulphide ore body (including ore grade and estimated size of the reserve) and constituent minerals, geomorphology, and soils;
- consultation with all relevant literature resources (a desk top study) is considered adequate to provide a description of the biological characteristics of the site and surrounding areas such as the vegetation (species and community structure) and the fauna (habitats and species) - noting especially any rare or endangered species. However, vegetation and fauna surveys may be required to identify the local species and communities, if a species or priority community is listed by either the *Threatened Species Act 1995* or the *Regional Forest Agreement 1997*, and a permit under that Act, including a conservation management strategy is required. A commitment to undertake this work, following approval of the project but prior to operations commencing will be required;
- a description of local air quality and local sources of air emissions (if relevant); and
- traffic considerations in respect of impact on local traffic due to ore transport from Avebury site to an approved facility.

2.2 AQUATIC ENVIRONMENT

- surface drainage and groundwater hydrology (hydrogeology) relationships to local and regional drainage systems;
- description of current water quality and environmental objectives to protect water quality from impacts associated with development of Stage 1.

2.3 SOCIO ECONOMIC

Provide a brief description generally of the importance of the mining industry in Tasmania, and in particular the impact of the proposed Avebury Mine Development (especially Stage 1) both locally and regionally, including economic and tourism considerations.

Detail the relevant demographic, occupation, income and expenditures, plus projected workforce requirements/availability for Stage 1.

2.4 ARCHAEOLOGY AND HERITAGE

Provide information on sites or areas of scientific, historical or cultural heritage values, which may be affected by the proposed activity.

While consultation with relevant literature resources (desk top study) is adequate to satisfy this requirement, if the need for a Cultural Heritage (including Aboriginal Heritage) survey is identified to satisfy the requirements of the *Aboriginal Relics Act 1975* and the *Historic Cultural Heritage Act 1995*, a commitment to undertake this work, following approval of the project but prior to operations commencing will be required.

3.0 DEVELOPMENT DESCRIPTION

3.1 PROJECT SITING

This section should provide a complete and detailed description of the development of Stage 1 and, brief overview of the proposed plans for Stages 2 and 3.

<u>Detailed plan(s) (at least 1:5,000) of the mine area showing:</u>

- portal entrance and decline shaft, any borrow pits, adits, waste rock dumps (if required);
- an outline of any site preparation works required including removal of vegetation.

3.2 PROJECT COMPONENTS

- the operational life and respective timeframes required for each stage of the development should be detailed, based on known economic reserves and mining rates. Concentrate products and product uses (markets) should be identified and future predicted production levels detailed;
- include a step by step description of operations ie. method of extraction to produce the bulk sample (quantity to be extracted), projected geochemical characterisation and in-situ mineralisation investigations, transport requirements off site to enable metallurgical test work; and
- the hours of operation (hours per day/days of the week) for development of Stage 1.

3.3 INFRASTRUCTURE

- the location of all structures and items of equipment, and site infrastructure. This includes all roads, drainage works, discharge controls (ie. runoff collection sumps), energy and water supply infrastructure associated with Stage 1; and
- identification of any office, crib rooms, ablutions (sewage), workshop locations.

3.4 DECLINE DEVELOPMENT

- timetable and requirements for construction of the new access road to the site including requirements for site facilities, portal entrance and decline shaft development;
- drilling and blasting requirements, including compliance with relevant safety procedures (including any requirement for blast monitoring: ie. air blast overpressure and ground vibration) with respect to portal and decline shaft development;
- the number of vehicle movements per day required to deliver excavated raw materials, products and wastes, (the projected number of vehicle movements should be given as a daily average over the development of Stage 1 and maximum during transport of the bulk sample to an approved treatment facility);
- outline of the condition and use of the proposed transport route (ie.Trial Harbour road) impacted by the operations and any upgrading and associated drainage and erosion protection works likely to be required by Stage 1, plus recognition that if development of Stage 2 or 3 is to proceed, improvements to the road may be required;
- description of the type and numbers of mining equipment to be used for development of Stage 1;
- description of ventilation requirements and infrastructure to be installed in respect of development of the decline shaft;

- details on the location of mine magazine (explosives), source, quantity and nature of hazardous materials storage (ie. fuel, chemicals) and required safety procedures; and
- description of mine closure and rehabilitation requirements in the event of either a premature closure of the activity and/or if the project fails to proceed beyond completion of Stage 1.

3.5 WASTES

- description of the source, nature, quantity and location of all permanent and temporary stockpiles of raw materials, overburden, topsoil, waste rock, concentrates, or any other material. Any materials with special storage or handling requirements (including hazardous or putrescible materials) should be clearly identified. The nature, quantities and geochemical characteristics of waste rock, and its potential for acid generation;
- as it is proposed to utilise waste rock for construction of the new access road, generated as a result of development of the decline shaft, geochemical characterisation of the PAF properties of the rock will need to be undertaken and reported for, including static and kinetic testing (NAPP and NAG, column or humidity cell tests).

  If it is determined as a result of these tests the waste rock is unsuitable for reuse, estimated quantities and disposal method for waste rock in waste rock dumps, including evidence to demonstrate environmental harm from acid generation due to oxidation processes will not occur in both the short and long term will need to be provided.

  As part of any dump cover design, the identification of a suitable non-acid cover (ie. clay) resource of adequate volume and competency will need to be identified. The cover material needing as a minimum standard to satisfy a permeability coefficient of 10^{-8} metres per second or equivalent, dependant on the cover design;
- identify all points from where liquid wastes (ie. mine water, vehicle wash down water, general site runoff) are expected to be generated and discharged from the site, including the nature (pollutants, ie. TSS, oil and grease, metals, nitrates, sulphates etc) and volume of wastewater generated. Also provide estimates of the probable rate of water consumption, source of supply and any storage/treatment requirements. In estimating the volume of waste water produced as a result of operations, also review the disposal options including potential for reuse for dust suppression and/or recycling;
- identify the types, and provide estimates of volumes plus handling procedures (ie. on-site storage) for all solid waste generated by development of Stage 1; and
- identify the types, and provide estimates of volumes plus handling procedures (ie on-site storage) for all hydrocarbon waste generated by development of Stage 1.

3.6 LANDFORM MODIFICATIONS

- detail all land form modifications associated with Stage 1 including current site characteristics and a broad description of how future mining operations will be integrated into the existing land form;
- a description of all cross-loading, unloading, loading or storage areas at Avebury with particular reference to surfacing and controls on stormwater collection, treatment and dispersal. A description of stormwater and other drainage structures and their layout, how they alter drainage patterns.

3.7 WORKFORCE

- identify, as possible, the source of workforce to undertake development of Stage 1, projected workforce numbers and any requirements for contactors; and
- general environmental induction training, information, or education provisions for employees and site contractors.

3.8 DEVELOPMENT SCHEDULE

Provide an estimated complete timeframe for development of Stage 1, including project planning, approvals, site development, operations and potential closure timeframe requirements (in the event the project fails to proceed beyond Stage 1). Use of a Gnant chart would be acceptable to identify these timeframes.

4.0 POTENTIAL ENVIRONMENTAL IMPACTS

The DPEMP should clearly indicate in the following sub-sections, by the use of clearly defined objectives and corresponding prescriptions, how the management of operations and progressive rehabilitation of impacted areas will serve to minimise and ameliorate environmental impacts.

Unsupported assertions that BPEM will be achieved will not be considered adequate.

Sections 4.0 and 5.0 of these guidelines should form the bulk of the document. It should also describe how the facilities will be managed and operated so as to meet BPEM standards while identifying measures to avoid or mitigate (to an acceptable level) the potential negative environmental impacts due to the proposed mine development.

Details should be provided on relevant codes of practice recognised by the company (such as the Mineral Exploration Code of Practice), and Environmental Management Systems endorsed by the Company.

Each significant environmental issue should be identified, and the method of achieving BPEM clearly defined. It should define the relevant or proposed environmental performance standard for each environmental impact identified. These may take the form of emission/discharge standards or requirements defined by legislation, the planning scheme, codes of practice (including any National codes), and BPEM. It should also include contingencies for the premature closure of the operation during the period of the DPEMP. BPEM may be achieved by the use of specific pollution control equipment, or management prescriptions.

Identify the methods to be adopted for routine discharges/emissions and also emergency procedures for accidental releases. Outline any proposed methods to reduce, re-use and/or recycle, and any plans for an internal environmental management system or an accredited ISO14001 based system.

Where there are clear, feasible options to deal with a particular environmental problem, review the alternatives and justify the preferred option.

The descriptions of BPEM should be in a form that will provide a ready basis upon which the Board may develop prescriptive permit conditions to be applied to the operations.

The matters to be detailed in this section should include that which is relevant to the activity, as outlined in the following sections:

Examples of potential environmental impacts include water and air pollution, site contamination, threat to the sustainability of a resource, modification of a land form, loss of habitat, loss of an endangered species, disruption of a food web, increase in noise levels, erosion, production of dust, litter, increased risk of fire or explosion, increase or loss of land value, overloading existing infrastructure (ie. Trial Harbour Road), improvement in employment prospects .

In evaluating the potential environmental impact, take into consideration the:

- identification of the worst case consequences of the effects of an incident on the affected area and the emission pathways, and the likelihood that those consequences will occur;
- the vulnerability (susceptibility, resilience, ability to recover) of the environment to the likely (or probable) impacts; and
- significance (ie. predicted residual impact) of the area affected in terms of its local, regional or state importance.

4.1 AQUEOUS DISCHARGES

Recognising the relatively undisturbed nature of the Avebury Nickel project site (except for previous forestry activities), the DPEMP should establish water quality and site quality objectives achievable within the life of the DPEMP, based on BPEM of Allegiance s proposed operations.

The proposal must satisfy the *State Policy on Water Quality Management 1997* and the *Water Management Act 1999.*

A principal environmental issue for management at the Avebury Mine site is surface runoff due to surplus precipitation, and the impact of aqueous discharges to any relevant water catchments identified (ie. Comstock Creek etc).

This section should provide the following details:

- sources of contaminated water ie. mine water drainage, stormwater drainage, drainage from overburden and any ore stockpiles;
- sources of any process water associated with Stage 1, quantities used and any potential environmental effects of storage;
- description of sanitary facilities and sewage treatment;
- risk assessment of pollution of surface waters including the consequence of the breakdown or mass failure of any pollution control facility ie. surface drainage and sediment settlement dams;
- potential for recycling of stormwater runoff/effluent water generated;
- the methods of water treatment utilised including specific details of the estimated volume and retention times of wastewater treatment dams or any alternative treatment facilities proposed;
- a summary of all available water monitoring data (including any baseline monitoring to date) undertaken by Allegiance of watercourses which transgress the mine lease, including up and downstream of the proposed mine site, and if possible any relevant water monitoring data identifying impacts of other mining activities or disturbance in the region which may impact on water courses passing through the lease;
- water quality (TSS, metals nitrate, sulphate [concentration and mass loadings], pH etc.) and expected quantity of effluent from each discharge point likely to be released from these sources over the life of the Stage 1 mine development phase should be specifically reviewed compared with ambient concentrations for the same parameters;
- review the potential for acidic/alkaline generation, including mobilisation off site, principal exit points from the site and existing inputs to identified watercourses;
- the nature and estimated quantity of discharge water or leachate resulting from AMD (if relevant) due to flooding of the decline, should the mine not proceed beyond Stage 1;
- slope stability and erosion of all landform modifications due to general site runoff;
- sediment, transport and deposition and impact on stream ecology;
- identification of measures to avoid pollution of water courses over the Avebury lease, and measures to restrict the release of polluted water discharged off-site to water courses; and
- identification of both short and long-term impacts in relation to the above points from water discharged to watercourses leaving the mine site.

4.2 ATMOSPHERIC EMISSIONS

The potential for atmospheric emissions (dust) from development of the portal and decline, mine site, access road and bulk sample mining/transport operations and any ozone depleting gases on site should be detailed and containment strategies outlined and the expected adequacy of these procedures.

The *Report on Findings and Modified Draft Policy November 2002 of the Assessment of the Draft Environment Protection Policy (Air Quality) September 2001,* presents the current position with respect to air quality management that may be included in the forthcoming State Policy on Air Quality Management. The assessment report is available on line at www.rpdc.tas.gov.au .

4.2.1 Greenhouse Gases

Estimate the annual emissions of greenhouse gases generated on site due to emissions from vehicles/machinery (particularly carbon dioxide, methane, nitrous oxide, hydrochlorofluorocarbons, perfluorocarbons and sulphur hexaflouride, as relevant), in terms of carbon dioxide mass equivalents, and demonstrate how such emissions will be minimised or offset (ie. by sinks) by the use of BPEM. Refer to the *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks* workbooks, produced by the National Greenhouse Gas Inventory Committee, which include workbooks for transport, waste, fugitive fuel emissions and fuel combustion, and are available from the DPIWE Environment Library.

4.3 NOISE EMISSIONS AND VIBRATION

The impact of noise on the closest communities (ie. Trial Harbour and Zeehan) must be critically evaluated in terms of the combined noise generation capacity of all traffic, plant and equipment associated with development of Stage 1. Use of typical noise emission data for such sources will be considered acceptable.

Consideration should be given to the increase in the noise levels over the background level that could be expected for such a remote location, as a result of the proposed hours of operation (hours/day, days/week), and associated activities including, vehicles/machinery, blasting regime/frequency (including ground vibration/air blast overpressure impact), exploration drilling and any other potential sources of noise.

Specification of the possible maximum increment in the ambient noise levels likely to be experienced at the boundary, including any variation during day time, night time (if relevant) weekends or Public Holidays;

Use of modern machinery with appropriate emissions control, hours of operation, and a comparison of expected surface with underground activities in respect of potential noise levels emitted.

4.4 SOLID WASTE DISPOSAL

Provide a description (ie. a table outlining waste management procedures, identifying kinds of solid wastes generated, options for minimisation (bulk purchases, reuse/recycling, treatment/destruction, disposal and handling requirements) of on and off-site waste disposal practices proposed for Stage 1, including the disposal of the following items:

Waste rock dumps (if unable to be used for road/hardstand construction), plus worn parts, surplus machinery, tyres, general refuse (including putrescible or bio-degradable), containers and packaging (plastic, paper), pallets, scrap steel, wood, drums and batteries.

Development of a waste management strategy in accordance with the well accepted principles of waste management: Waste avoidance >> recycling >> re-use >> treatment >> disposal is considered advisable.

4.5 HAZARDOUS MATERIALS

4.5.1 Hydrocarbons

This section should include information on transport and storage options, (bulk containers are preferable to individual drums) recovery of waste product (oil and grease) and recycling. In addition it should address the following:

- storage of hydrocarbons, distribution and handling areas including workshops and fuelling bays which ideally should be covered, bunded across exterior openings and/or graded towards a collection sump and oil water separator;
- provision of oil absorbent materials to be utilised in the event of spillage and a disposal strategy for used materials;
- details on the arrangements for recovery and collection by the holder of an appropriate Waste Transport Environment Protection Notice for used hydrocarbons and strategies for recycling and/or disposal by an approved end user; and
- detail contingencies proposals (including recognition of reporting requirements to appropriate authorities), for when control measures/equipment breakdowns or accidental releases to the environment occur, including proposed emergency and clean-up measures.

4.5.2 Chemical Storage and Utilisation

The management of hazardous materials is required to be in compliance with *Dangerous Goods Act 1998* and associated Regulations (1994), to the satisfaction of Workplace Standards Tasmania.

The nature and quantities of all potentially hazardous materials held on the premises must be identified. The storage locations, quantities stored and containers used must be given, and safeguards (including bunding requirements, availability of absorbent materials on site) to be incorporated to contain these materials and ensure clean up of accidental spillage described. A contingency plan must be formulated to deal with spills. Risk assessment of the various materials stored should be presented.

Details required should also address the following criteria:

- a disposal strategy for used chemical drums (if relevant), including potential for return to manufacturer for recycling, or washing, crushing and appropriate disposal;
- safe storage and handling including bunding and covering of storage areas and details of products subject to relevant standards;
- risk assessment of mass emission;
- the provision of Material Safety Data Sheets for all chemicals (if relevant) used including examples provided as appendix; and
- a strategy to remove and appropriately dispose of all hazardous wastes generated by the operation.

4.6 FLORA AND FAUNA

Impact as a result of development of Stage 1 on any identified flora and fauna of conservation and ecological significance should be discussed, including any measures to avoid or minimise such impacts.

As detailed in Section 1.1 of these guidelines, surveys and consultation of the species listed under the *Threatened Species Act 1995* and/or reference to the priority communities listed by the RFA 1997, permit requirements and a conservation management strategy may also be required. This discussion should also include consideration of the potential of weed infestation, or spread of *Phytophthora cinnamomi* root rot fungus due to development of Stage 1.

Reference should also be drawn to the potential for weed infestation and control measures to be implemented to prevent, and manage this issue. Reference to the recommendations in the West Coast Weed Management Strategy would be advantageous.

Consideration must also be given as to the potential short term and long term residual impacts on flora and fauna on the mine lease due to development of Stage 1, mine closure and any site rehabilitation requirements.

4.7 ARCHAEOLOGY AND HERITAGE

As a result of a review of available information related to the lease site (desk top review) any impacts as a result of development of Stage 1 on any identified features/structures of previous mining heritage importance should be discussed, including any measures detailed, following consultation with the Mining Heritage Committee to avoid or minimise such impacts.

It is recommended that consultation with the Department of Tourism, Parks, Heritage and the Arts be undertaken to determine whether a survey of the site's historical value is required, if the information review identifies the potential for features of significance.

Arrangements to ensure compliance with the *Aboriginal Relics Act 1975* and *Cultural Heritage Act 1995,* should also be made and described. If relevant, any features of archaeological significance within the lease should be identified and future management of these features detailed in accordance with the requirements of the Acts.

4.8 VISUAL IMPACT AND LANDSCAPE MANAGEMENT

The existing and progressive visual impact of the mine site from any significant vantage points (ie. lookouts, residential areas [Trial Harbour/Zeehan], public roads, recreation reserves etc.) should be reviewed, and any measures designed to progressively minimise the visual impact of the development should be described.

4.9 SOCIO-ECONOMIC

Provide a review of the socio-economic implications of the project proceeding/failing, on the local communities, including potential employment and economic benefits/losses for the region, including for employees, contractors and the spinoff effects to other businesses/communities in the region.

4.10 HAZARD ASSESSMENT

An assessment must be made of potential risks by way of a hazard analysis for development of Stage 1, including possible long term environmental risks associated with the site in the event of the premature closure of the mine.

This should include a review of major structures (ie. portal entrance and decline plus landform modifications including any open cut areas (ie. borrow pits), waste rock dumps (if required), and fuel/chemical storage vessels/sites, explosives magazine and any sediment/water storages, and the risk (both environmental and human health) associated with failure of any of these structures/facilities.

5.0 ENVIRONMENTAL MANAGEMENT PLAN

The level of detail provided in the Environmental Management Plan (EMP) is to be commensurate with the level of development (Stage 1) and recognise the importance of managing potential impacts plus provide management objectives and strategies. Sufficient information needs to be provided in the EMP to demonstrate the importance of issues/impacts associated with the Stage 1 development and the appropriate management requirements to enable granting of the land use permit.

Identify the responsibilities (by position) of staff to ensure that the different aspects of the Environmental Management Plan are implemented. This should include auditing of operational practices, maintenance of competence and knowledge of the Environmental Management Plan by personnel and contractors, emergency preparedness and incident investigation.

5.1 WATER MANAGEMENT PLAN

Identify the issues associated with mine water generation and site runoff, water requirements, collection, treatment, reuse and/or disposal. Discussion of the application of the State Water Policy on Water Quality Management 1997 and how it affects the mine site and proposed performance standards to be achieved, including measures to ensure compliance.

5.2 AIR QUALITY MANAGEMENT PLAN

Identify the issues associated with respect to emissions to air, including dust control requirements, including roads, site development, vehicle load damping and vehicle/machinery emissions in respect of ventilation underground/human health issues, and contribution to Greenhouse emissions. Reference to the *Report on Findings and Modified Draft Policy November 2002 of the Assessment of the Draft Environment Protection Policy (Air Quality) September 2001* in respect of the forthcoming State Policy on Air Quality Management and Quarry Code of Practice 1999 in respect of standards applicable to air pollution control for Stage 1.

5.3 MINE WASTE MANAGEMENT PLAN

In conjunction with Sections 3.5 and 4.4 of these guidelines, as Acid Mine Drainage(AMD) is a major issue for the majority of West Coast Mining activities the DPEMP should include a geochemical characterisation of the orebody and block modelling based on geological plans of acid producing rock in proposed mine areas. Static and kinetic testing (NAG and NAPP, and column or humidity cell tests respectively) of all geological units and waste (excavated) rock should be detailed, given it is proposed to use waste rock excavated from the decline for road construction and site sheeting purposes.

If in the event waste rock is unsuitable for these purposes, it is expected that disposal in waste rock dumps will be required. Accordingly an assessment of the environmental issues as part of a mine waste management plan, plus associated design, construction and closure details for waste rock dumps should be provided including advice on possible dump construction methods and ARD prevention controls, ie. capping. In terms of performance standards to be achieved, application of BPEM engineering standards in respect of ARD prevention and control including appropriate clay/rock cover modelling to predict potential rates of infiltration should be provided.

Alternatively, if geochemical testwork establishes that the excavated waste rock is suitable for construction and sheeting uses, in conjunction with the details given in Section 5.1, as part of a mine waste management plan, identify the TSS controls (drainage work, sediment traps/settlement ponds and maintenance requirements) to be developed to ensure no off-site transport of elevated sediment laden water. Compliance as a minimum standard with the Quarry Code of Practice 1999 in respect of sediment laden runoff and the State Policy on Water Quality Management 1997 in terms of protection of water courses is applicable.

5.4 SOLID WASTE MANAGEMENT PLAN

In accordance with the issues identified above in Section 4.4 development of both waste management procedures and a waste management strategy, to identify and target waste minimisation, reuse and recycling initiatives is considered appropriate. Compliance with the requirements of the *Environmental Management and Pollution Control (Waste Management) Regulations 2000* and other relevant State and National Codes of Practice (NEPMs) as applicable.

5.5 HAZARDOUS MATERIALS MANAGEMENT PLAN

Development of a hazardous materials management plan in accordance with the issues identified in Section 4.10 to identify and quantify the level of risk associated with the development of Stage 1 should be provided. Application of relevant Australian Standards, State Policies and the requirements of the *Dangerous Goods Act 1998* and Regulations (1994) are appropriate.

5.6 EMERGENCY RESPONSE PLAN

The development of an emergency response plan in respect of environmental incidents should identify the employee training requirements and control procedures to be followed in respect of notification to relevant authorities, environmental mitigation requirements, sampling, follow-up reporting and cleanup procedures to be adopted.

5.7 FLORA AND FAUNA MANAGEMENT PLAN

In conjunction with the issues identified in Section 4.6 of the guidelines, develop a management plan to incorporate the conservation requirements with respect to flora, fauna (as required) under the *Threatened Species Act 1995*.

5.8 WEED AND PATHOGEN PLAN

As noted in Section 4.6 of the guidelines, management procedures to control the risk of both weed infestation and spread of *Phytophthora cinnamomi* root rot fungus needs to be identified. A plan to both control the introduction and/or spread of weeds, including spraying if required plus vehicle washing and the control of washdown water discharged from the site should be outlined. It is recommended that adequate controls in accordance with the principles detailed in the *Mineral Exploration Code of Practice 1999* and *Quarry Code of Practice 1999* and recommendations in the West Coast Weed Management Strategy be outlined and committed to.

5.9 ARCHAEOLOGY AND HERITAGE MANAGEMENT PLAN

In accordance with Section 4.7 of the guidelines, identify management procedures with respect to any archaeological (Aboriginal) and previous mining heritage at the Avebury site and provide commitments and timeframes to comply with the requirements of the relevant legislation.

5.10 VISUAL AMENITY PLAN

As identified in section 4.8 of the guidelines, provide a management plan to address any issues relating to development of Stage 1 in respect of any existing or potential visual impact of the mine site from any significant vantage points. The plan should identify (if required) any measures (ie. vegetation screening) to progressively minimise the visual impact of the development.

5.11 SOCIAL MANAGEMENT PLAN

In accordance with the benefits and implications of the project proceeding and/or failing to proceed beyond Stage 1, as identified in Sections 1.7, 2.3 and 4.9 of the guidelines, provide any management plans which will maximise the potential of the project to the regions economy and community, while minimising any potential negative impacts from the project ceasing operations prematurely.

5.12 FIRE MANAGEMENT PLAN

Development of the Avebury mine has implications with regards to the potential for fire both for conservation and commercial forestry interests outside of the immediate operational areas.

The potential for the risk of fire and methods proposed to prevent the ignition of fires (ie. from sparks, self-combustion from vegetation [forest/peat/buttongrass] cleared and stockpiled) and to prevent escape from the premises (in areas of high bushfire hazard) is of particular importance.

For the ongoing operation, a fire prevention and control plan will be required to be developed in consultation with the appropriate Authorities within a six month time frame of the DPEMP.

Management of flammable and combustible materials on site should also be detailed.

5.13 MINE CLOSURE AND REHABILITATION PLAN

The works should be appropriate for the intended subsequent use of the site. The intended type of use where possible should be identified. This plan should include details regarding the topography, drainage and landscaping, methods proposed to ensure that remaining features do not become a long-term risk to the environment or community, and make provision for the removal of equipment and structures as required.

There should be a description of provisions made for remedial action if monitoring indicates that the project is causing unexpected environmental degradation.

A rehabilitation plan for above ground disturbed areas must be presented. The plan should include consideration of :

- the changes in topography and landform associated with the sites at the completion of mining activities, the long-term stability, visibility and revegetation potential;
- any ongoing drainage and runoff collection management and treatment facilities;
- the proposed method of rehabilitation of disturbed areas, including the depth of topsoil to be spread as required and revegetation techniques to be applied;
- outline site rehabilitation of abandoned tracks, borrow pits etc associated with development of Stage 1 and closure requirements in the event of the project not proceeding beyond the initial development should also be provided;
- the timing of all rehabilitation works relative to the level of development of Stage 1 up to mine closure and abandonment;
- details on the rehabilitation bond provided to the State;
- provide a comprehensive description of the plans for any necessary decontamination or rehabilitation of the site;
- commitment to a rehabilitation maintenance program including re fertilising, seeding and/or planting, criteria for completion, and contingencies in the event of instability; and
- contingencies to achieve satisfactory rehabilitation, should the operation cease during the life of the initial DPEMP.

5.14 MONITORING PROGRAM

A description of the proposed sampling and monitoring program for discharges/emissions to the ambient environment to ensure compliance with the objectives and predictions of the DPEMP must be presented. The performance indicators selected for monitoring should relate to the performance standards identified earlier in the DPEMP.

The monitoring program should include the sites to be sampled, sampling procedures, parameters to be analysed, the frequency of sampling and format and frequency of reporting. A map and summary tables are useful in this section.

The program should include:

- monitoring of ambient, point source, and receiving environment water for determination of the effect of relevant BPEM prescriptions undertaken by Allegiance;
- an investigation of water quality in the Comstock Creek and any other water courses which may be impacted by the proposed mine development both upstream and downstream of operations including flow proportional monitoring of pollutants;
- an investigation which will both quantify any sources of AMD (if relevant) at the Avebury mine site and allow the future extent of AMD generation (if relevant) to be predicted (notwithstanding any remediation works which may be undertaken as a result of previous operations);

- any requirements for noise, and dust emissions monitoring should be evaluated;
- monitoring of the progress of any rehabilitation works undertaken in developing Stage 1;
- the rationale and frequency of sampling for sampling specific points should be clearly detailed; and
- commitment to use a NATA registered laboratory or other appropriate standard of testing laboratories (ie. laboratory approved by the Director) must be provided.

6.0 SUMMARY OF COMMITMENTS

This section should briefly summarise the management commitments that have been made to ensure the activity performs as stated in the Potential Environmental Impacts and Environmental Management Plan sections of the DPEMP. It may be expedient to document all commitments by inclusion of a table, which links the section of the DPEMP to commitments and timeframes for completion or duration of the project.

In this way, where relevant, such commitments can also be integrated into the permit conditions.

Appendix 2

Summary of Relevant Legislative and Regulatory Requirements

Appendix 2 Summary of relevant legislative and regulatory requirements

Primary Acts and Regulations

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
- *Aboriginal Relics Act 1975*
- *Australian Heritage Commission Act 1975*
- *Chloro Fluorocarbons and Other Ozone Depleting Substances Control Act 1988*
- *Crown Estates Act 1961*
- *Crown Lands Act 1976*
- *Dangerous Goods Act 1998 and Regulations*
- *Environment Protection Act (Water Pollution) Regulation 1974*
- *Environment Protection Act (Water Pollution by Oil and Noxious Substances) Regulations 1989*
- *Environment Protection (Waste Disposal) Regulation 1974*
- *Environment Protection (Noise) Regulation 1977*
- *Environment Protection (General) Regulations 1974*
- *Environment Protection (Atmospheric Pollution) Regulations 1974*
- *Fire Services Act 1979*
- *Forestry Legislation (Transitional Provisions) Act 1994*
- *Forest Practices Act 1985*
- *Forestry Rights Registration Act 1990*
- *Historic Cultural Heritage Act 1995*
- *Inland Fisheries Act 1995*
- *Local Government (Building and Miscellaneous Provisions) Act 1993*
- *Mineral Resources Act 1951*
- *Mineral Resources Development Act 1995*
- *Mines Inspection Act 1968*
- *Mining Act 1958*
- *National Environment Protection Council (Tasmania) Act 1995*
- *National Parks and Wildlife Act 1970• Native Forestry Agreement Act 1980*
- *Native Title (Tasmania) Act 1994*
- *Pollution of Waters by Oil and Noxious Substances Act 1987*
- *Mines Inspection Regulations 1991*
- *Mines Inspection (Medical Examinations) Regulations 1991*
- *National Parks and Reserves (General) Regulations 1971*
- *Native Title Act 1993*
- *Regional Forest Agreement (Land Classification) Act 1998*
- *Threatened Species Protection Act 1995*
- *Water Management Act 1999*
- *Weed Management Act 1999*
- *Workplace Health and Safety Act 1995*
- *State Policies and Projects Act1993*
- *Mines Inspection Act 1972*
- *Groundwater Act 1985*

Australian Standards

- AS1216 Classification Hazard Identification and Information Systems for Dangerous Goods
- AS1940-1992 Storage and Handling of Flammable and Combustible Liquids
- AS2243-10 Chemical Storage
- AS2508 Safe Storage and Handling Information Cards for Hazardous Materials
- AS/NZS ISO 14001 (Int):1995 Environmental Management Systems - Specification with Guidance for Use
- ASNZS ISO 14004 (Int): 1995 Environmental Management Systems - General Guidelines on Principles, Systems and Supporting Techniques

Commonwealth Agreements, Policies and Strategies

- Intergovernmental Agreement on the Environment
- National Competition Policy (1995)
- National Environment Protection Measures
- National Forest Policy Statement (1992) and Regional Forest Agreements
- National Strategy for the Conservation of Australia's Biological Diversity (1996)
- National Strategy for Ecologically Sustainable Development (1992)
- National Greenhouse Strategy (1998)
- Sustainable Energy Policy (1997)

Appendix 3

Flora and Fauna Assessment Stage 1

Allegiance Mining NL

Avebury Nickel Project

Flora and Fauna
Desktop Assessment - Stage 1

April 2003
CR 938_4_v6

Allegiance Mining NL

Avebury Nickel Project

Flora and Fauna
Desktop Assessment - Stage 1

April 2003
CR 938_4_v6

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1. Introduction

1.1 Project Background

Allegiance Mining NL (Allegiance) intends to develop the Avebury Nickel deposit, near Zeehan, western Tasmania.

Stage 1 of the Avebury Nickel Project involves the development of a decline into the upper section of the deposit where high grades of nickel are indicated. The decline will be about 1,000 m in length, 5 m wide and 5 m high. Approximately 75,000 t of waste rock will be excavated during development of the decline.

Accompanying the first leg of the portal and decline development will be the establishment of on-site facilities and ancillary facilities that will occupy an area of about 2.5 ha.

A 1.5-km access road will be constructed that runs south from Trial Harbour Road to the on-site facilities and then further south to join the access track to the portal. Disturbance associated with access road construction will total approximately 9.6 ha. Waste rock from the decline construction will be used in road construction (development waste will be geochemically characterised to confirm that this material is suitable for use as road base).

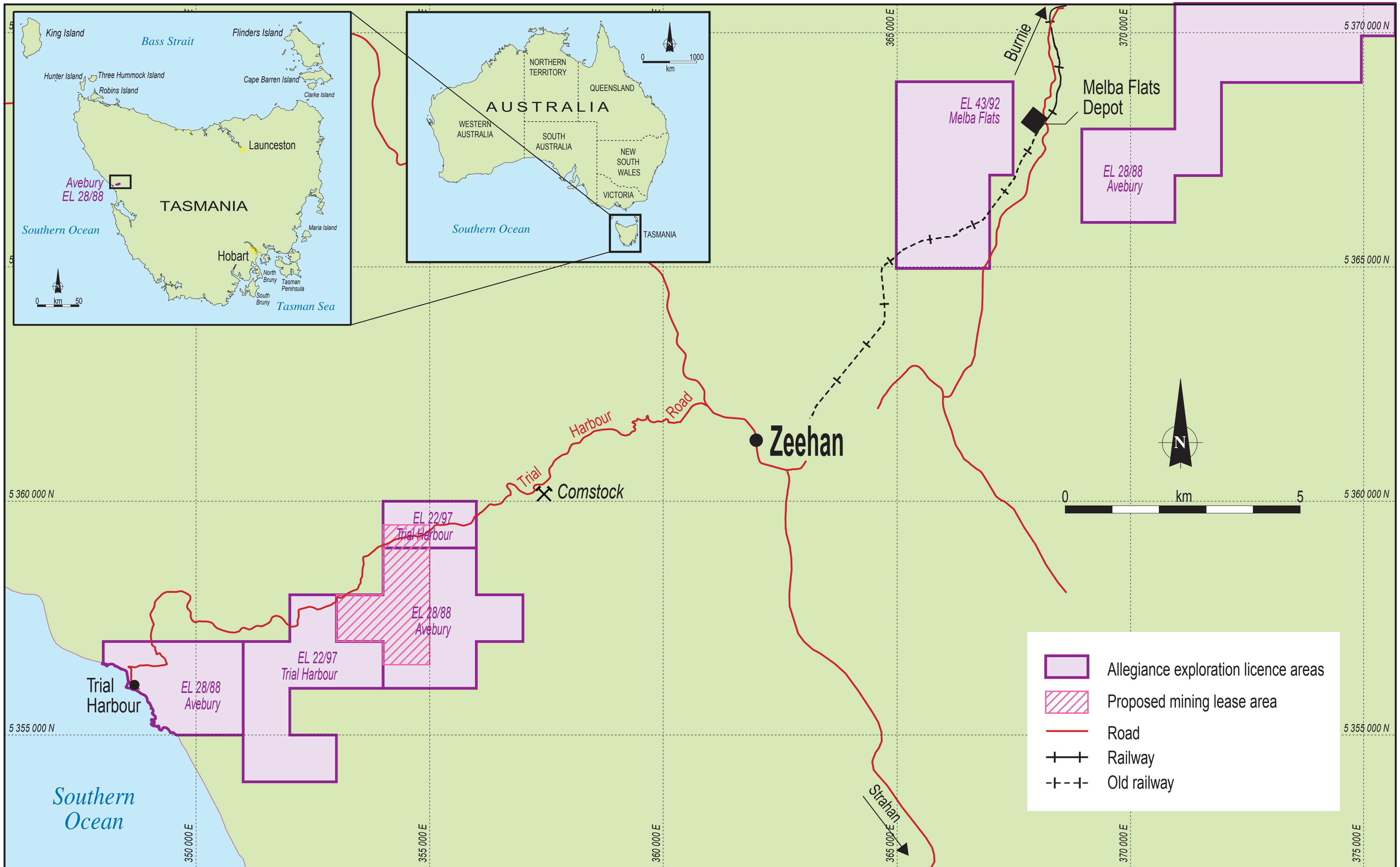
1.2 Aims

The aims of this desktop vegetation, flora and fauna assessment for Stage 1 of the Avebury Nickel Project are to:

- Characterise the existing vegetation communities of the study area.
- List threatened flora and fauna species in the study area.
- Provide a summary of potential impacts to flora and fauna resulting from Stage 1 development.
- Flora and fauna mitigation and management measures to be implemented during Stage 1 development and operation will be provided in the Development Proposal and Environmental Management Plan (DPEMP).

1.3 Study Area

The Avebury Nickel Project is located 6 km west of the town of Zeehan, on Tasmania's west coast. Trial Harbour Road runs north of the proposed mining site, while the site is bounded by Kynance and Comstock creeks to the east, Hemp Creek to the west and the Little Henty River to the south (Figure 1.1).



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Allegiance Mining NL

Avebury Nickel Project

Study area

Figure No: **1.1**

The study area occupies Crown land that is managed by Forestry Tasmania as State Forest. It is densely vegetated, with buttongrass plains occupying the exposed and higher elevated areas along Trial Harbour Road, grading to rainforest dominated by myrtle beech (*Nothofagus cunninhamii*) in the lower half of the study area.

1.4 Bioregion

The Avebury study area is located within the Tasmanian West bioregion as classified under the Interim Bioregionalisation for Australia (IBRA), one of nine such regions for the state. As the name suggests, this bioregion covers much of Tasmania's west coast.

IBRA regions represent a landscape-based approach to classifying the land surface. Specialist ecological knowledge, combined with regional and continental scale data on climate, geomorphology, landform, lithology and characteristic flora and fauna were interpreted to describe patterns that eventually formed the 80 IBRA regions (Environment Australia, 2000).

The baseline data set for Tasmania was the 1:500,000 scale Nature Conservation Regions. Map regions were aggregated by grouping regions with similar climate, landform, geology/lithology, vegetation and floristics (Environment Australia, 2000).

2. Methods

2.1 Database Review

A primary source of information for this desktop review was the GTSpot database (Geo Temporal Species Point Observations Tasmania), developed and maintained by the Tasmania Parks and Wildlife Service. Inputs into the database come from all branches of the Department of Primary Industries, Water and Environment (DPIWE), of which the Tasmania Parks and Wildlife Service is a part, and specialist ecological consultants.

2.1.1 Flora and Fauna

Flora and fauna records, including threatened state flora and fauna (i.e., rare or endangered), are recorded as spot localities in GTSpot, as is detail about whether each species is covered by state or Commonwealth legislation. The Commonwealth Environment Protection and Biodiversity Conservation Act (EPBC) Online Database was accessed to determine whether nationally listed threatened species occur in the study area.

The GTSpot and EPBC databases are separate but related databases - GTSpot lists species listed as threatened at the state level (with corresponding EPBC listings, where relevant), whereas the EPBC database lists species considered threatened at Commonwealth level only.

2.1.2 Vegetation Communities

TASVEG 2000, part of the GTSpot database, was accessed to determine the vegetation communities present within the study area. TASVEG 2000 uses the Comprehensive Regional Assessment (CRA) developed for the Tasmanian Regional Forestry Agreement (RFA) as a mapping base. More broadly based vegetation community and habitat descriptions was accessed from Bushcare Management Information linked to each vegetation community in TASVEG 2000.

2.2 Literature Review

The database review was supported by a literature review. This involved a review of the information presented in the Avebury Scoping Study (NSR, 2000), as well as the West Coast Planning Scheme (2001), Forest Practices Code (Forestry Tasmania, 2000), the Heemskirk Wind Farm DPEMP (Hydro Tasmania, 2003), Tasmania's Threatened Fauna Handbook (Threatened Species Unit, 1999), Tasmanian Regional Forestry Agreement (Commonwealth of Australia, 1996), and other relevant literature and threatened species lists available from the World Wide Web.

2.3 Reconnaissance Trip

During January 2003, a reconnaissance trip to the study area was undertaken by NSR personnel to assist with identification of issues and project planning. During this trip, a visual assessment of vegetation was undertaken.

3. Legislative Framework

This section briefly outlines the legislative framework relevant to flora and fauna management in Tasmania.

3.1 Commonwealth

Environment Protection and Biodiversity Conservation (EPBC) Act 1999.

The EPBC Act repeals the following Commonwealth legislation:

- *Environmental Protection (Impact of Proposals) Act 1974.*
- *National Parks and Wildlife Conservation Act 1975.*
- *Endangered Species Protection Act 1992.*
- *Whale Protection Act 1980.*
- *World Heritage Properties Conservation Act 1983.*

The EPBC Act establishes a process for assessing actions that are likely to have impacts of national environmental significance, including impacts to Ramsar-listed wetlands, World Heritage Areas, migratory species listed under international agreements, Commonwealth marine waters and nationally threatened species and communities.

3.2 State

Threatened Species Protection Act 1995

The *Threatened Species Protection Act 1995* determines if a species or community is considered to be of state conservation significance and provides mechanisms for protecting these species and communities from threatening processes. A permit from the Tasmanian National Parks and Wildlife Services is required to conduct activities that may adversely impact species listed under the act.

Forest Practices Act 1985

This act ensures that forest operations are conducted in an environmentally acceptable manner on public and private forest lands, and establishes the Forest Practices Board and Forest Practices Code.

Weed Management Act 1999

This act provides for the management of weeds in Tasmania and the development of management plans for specific weeds prior to proclamation as noxious weeds, and for their control and eradication.

3.3 Policies

Policies and guidelines relevant to flora and fauna management on Tasmania's west coast include:

- Draft Threatened Species Strategy (1998).
- Draft Framework of Tasmania's Nature Conservation Strategy (2000).
- Forest Practices Code (2000).
- West Coast Planning Scheme (2001).
- Tasmania's Weed Management Strategy (WeedPlan).
- West Coast Weed and Fire Management Strategy (2001).
- Mineral Exploration Code of Practice (Edition 4, 1999).

4. Results

4.1 Flora

This section provides a description of the flora species and vegetation communities present in the Avebury study area.

4.1.1 Species

A complete flora list cannot be compiled for the study area from a desktop assessment; this would be achieved with a field survey. From the point localities identified in the study area (Figure 4.1), the GTSpot database lists 17 native species, many of which are orchids and ferns (Appendix 1). The description of vegetation communities in Section 4.1.4 provides a broad listing of species found within each vegetation type.

4.1.2 Threatened Species

A search of the GTSpot database indicates no flora species of state conservation significance (i.e., threatened[1]) within the study area. No flora species of national conservation significance (i.e., threatened[2]) are listed for the study area. The definitions of the categories listed under the threatened status differ between the states and the Commonwealth[3].

4.1.3 Weeds and Pathogens

A search of the GTSpot database indicates no weedy flora species. During the reconnaissance trip however, it was noted that there are isolated patches of cutting grass (*Gahnia filum*) along the drilling tracks, which is thought to have been introduced when the area was selectively logged for Huon, King Billy and celery-top pine, using horses in the 1960s. There are little or no known priority weed infestations along the Trial Harbour Road (West Coast Council, Forestry Tasmania & DPIWE, no date).

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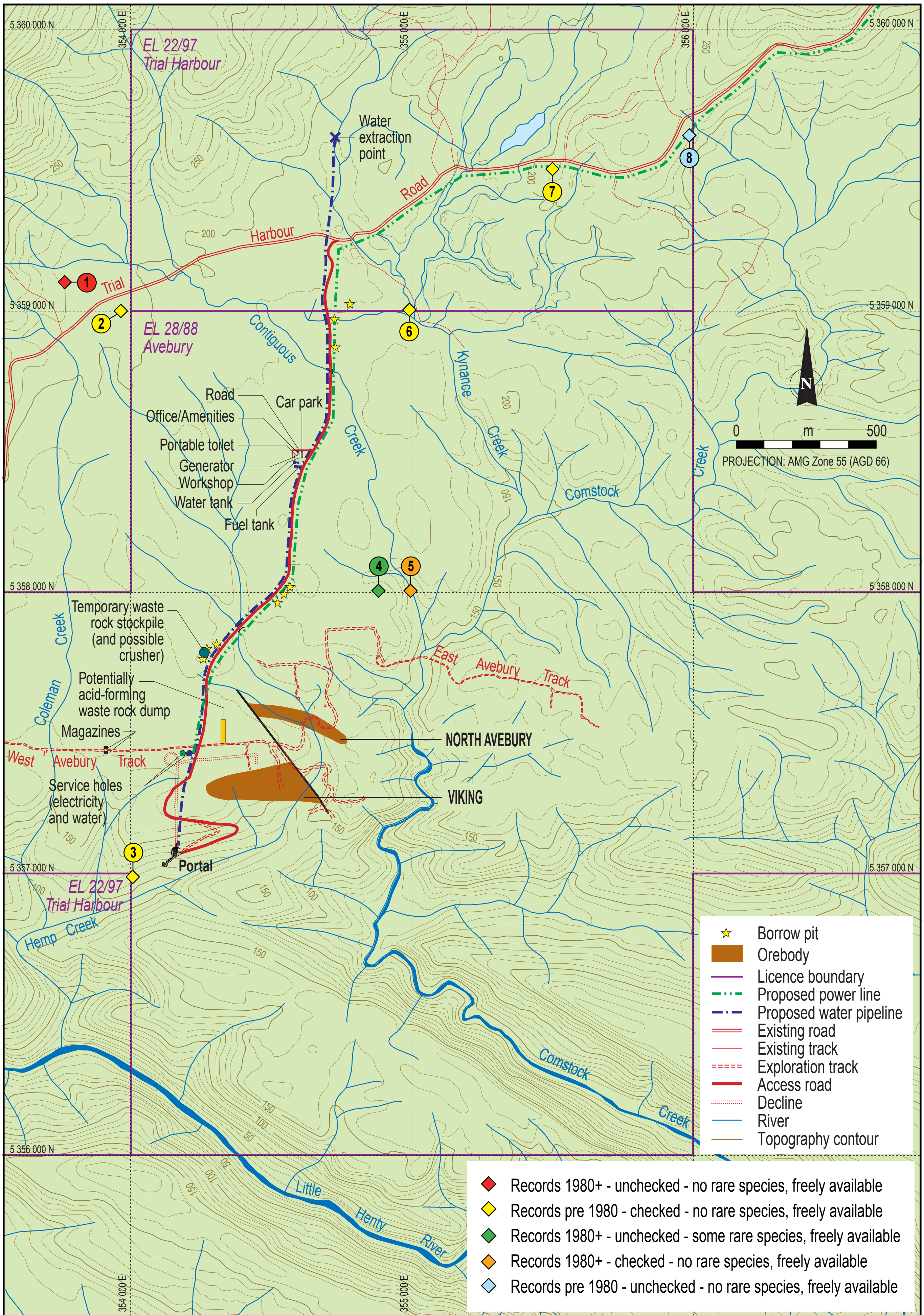
[1] The 'Threatened' status in Tasmania includes species listed as extinct, endangered, vulnerable or rare under Schedules 3, 4 or 5 of the *Threatened Species protection Act 1995*.

[2] The 'Threatened' status for the Commonwealth includes species listed as extinct in the wild, critically endangered, endangered or vulnerable under Part 13, Division 1, Subdivision A of the *Environment Protection and Biodiversity Conservation Act 1999*.

[3] Definitions of the term 'Threatened' at the Tasmanian and Commonwealth levels are provided in Appendix 2.



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Allegiance Mining NL

Avebury Nickel Project

Flora and fauna point locality records
(source: GTSpot, February 2003)

Figure No: **4.1**

Signs of *Phytophthora cinnamomi,* (dieback or root-rot), while not noted during the site visit, have been recorded elsewhere on the west coast. Consultation with DPIWE indicates that no formal records of *P. cinnamomi* are known in or around the project area (Woolley, pers. com. 2003; Rudman, pers.com., 2003). Mapping provided in 'The Draft Threat Abatement Plan for Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)' (1999) and the 'Mineral Exploration Code of Practice' (1999) also indicate that the fungus has not been positively identified in the project area.

Myrtle wilt, caused by the pathogen *Charlara australis*, is endemic to areas vegetated by myrtles (*Nothofagus cunninghamii*). However, myrtle wilt incidence has increased due to human activities, such as logging, vegetation thinning and road construction in myrtle-dominated rainforest (Australian Paper, 1999; Packham, 1994). The disease develops through the infection of stem or root wounds via air (wind dispersal) or water-borne inoculum. The most prominent disease symptom is wilting of the tree crown, with eventual death (Australian Paper, 1999). In undisturbed forest, myrtle wilt acts primarily to facilitate stand rejuvenation (Packham, 1994).

4.1.4 Vegetation Communities

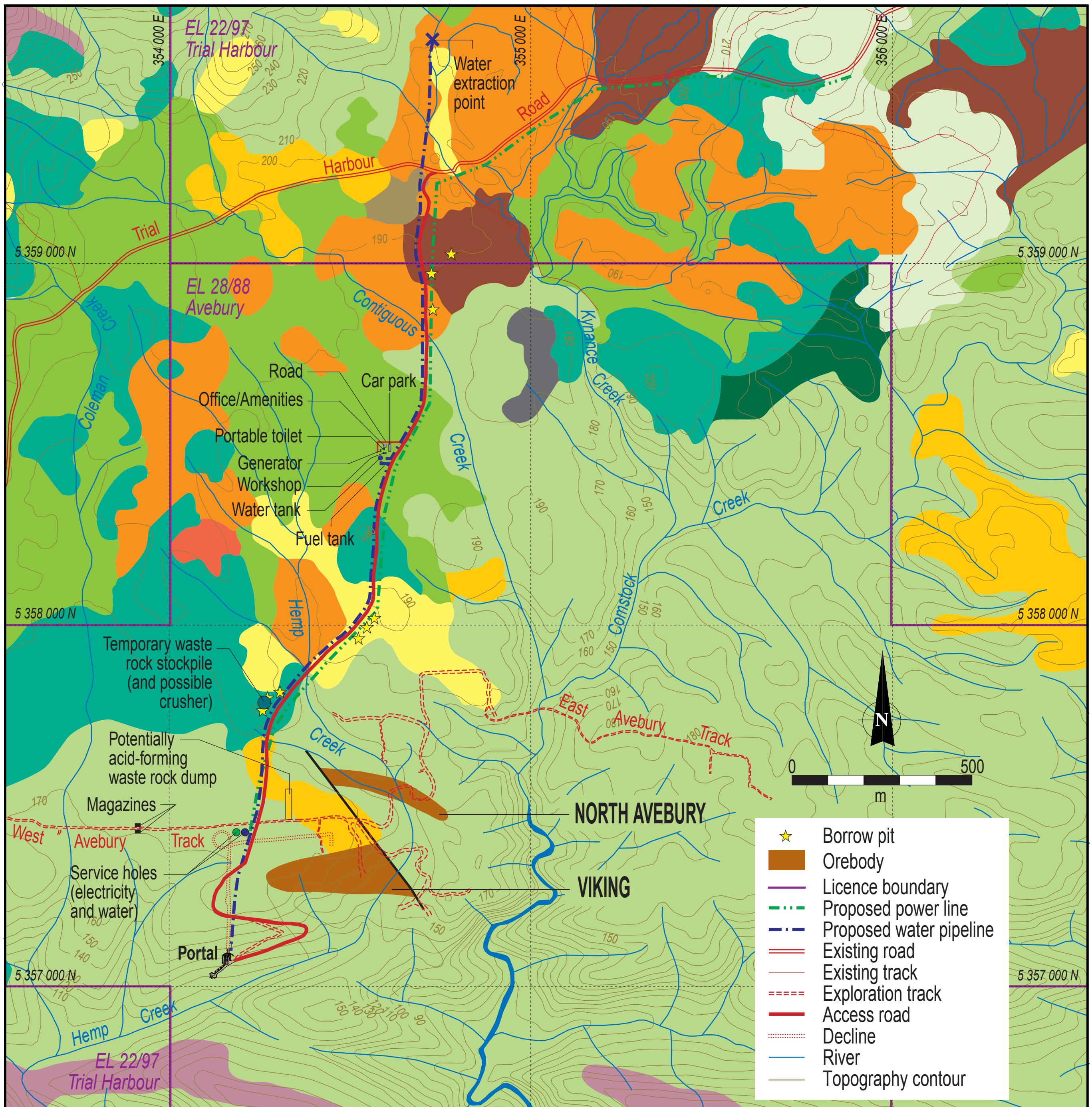
Vegetation of the project area can generally be described as comprising predominantly rainforest communities and mixed forest (as the rainforest degrades to wet sclerophyll communities) or a combination of both. The rainforest is a poorer quality, small-crowned, short, thamnic (shrubby) rainforest dominated by myrtle with leatherwood. The understorey comprises younger leatherwood and myrtle with sassafras, and wet fern species.

Specifically, the vegetation of the study area is divided into the following categories, based on TASVEG 2000 classification, mapped at 1:25,000 (GTSpot). Forest and non-forest vegetation mapped by TASVEG provides a greater level of detail and infill from the RFA mapping conducted in the mid-1990s. Ten vegetation communities have been identified as occurring in the project area, out of a possible 50 for the state. Figure 4.2 illustrates these vegetation communities.

Buttongrass Moorland (Bb)

In western Tasmania, blanket moor forms large tracts of vegetation across flats, and gentle and steep slopes on infertile rocks such as Precambrian Quartzite and Ordovician conglomerate. Within the study area, Buttongrass moorland occupies an extensive part of the study area south of the Trial Harbour Road.

Buttongrass typically occurs as broad areas of moorland without tree cover in western Tasmania (Plate 4.1). Buttongrass (*Gymnoschoenus sphaerocephalus*) is the signature species, but the community ranges from pure buttongrass to moorlands with a mixture of buttongrass and low shrub species as well as numerous sedge species. It can be open to very dense but most plants occur within a single stratum.



Vegetation

- Broadleaf shrubbery
- Buttongrass moorland
- *Eucalyptus nitida* dry forest
- *Eucalyptus nitida* wet forest
- *Eucalyptus obliqua* dry forest
- *Leptospermum lanigerum* scrub
- *Leptospermum lanigerum* scrub/sparse *Eucalyptus nitida*
- *Melaleuca squamea*
- Recently cleared *Eucalyptus obliqua* dry forest
- Restionaceae flatland
- Short rainforest
- Tea-tree forest
- Western wet scrub

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Plate 4.1 Buttongrass moorland near Trial Harbour Road (foreground), grading to eucalypt forest, with Mt Zeehan in the background.

In southwest and western Tasmania, blanket moorland typically has 20 to 25% buttongrass (*Gymnoschoenus sphaerocephalus*) as well as shiny tea-tree *(Leptospermum nitidum),* white waratah *(Agastachys odorata),* slender baeckea *(Baeckea leptocaulis),* hairy boronia *(Boronia pilosa),* straggling heath *(Epacris corymbiflora),* western Tasmanian heath *(E. heteronema),* pink swamp heath *(Sprengelia incarnata),* silver banksia *(Banksia marginata)* and scented paperbark *(Melaleuca squarrosa)*.

Melaleuca Squamea *with/without Buttongrass on Slopes (Bm)*

This community occurs on slopes, ridge tops and better-drained flats at all altitudes on predominantly siliceous substrates including quartzite, conglomerate and sandstone. There is small area of this vegetation community south of the Trial Harbour Road.

The vegetation included in this mapping unit is dominated by shrubs (e.g., swamp melaleuca *(Melaleuca squamea*) to 1.5 m) which occur in a distinct layer above any sedges present in the vegetation. This community may be very dense and is transitional between buttongrass moorland and wet scrub. Buttongrass *(Gymnoschoenus sphaerocephalus*) may persist as swathes within *Melaleuca* moorland or as scattered tussocks, often overgrown. Mountain heath baeckea *(Baeckea gunniana*) and shiny tea-tree *(Leptospermum nitidum*) may be the only other tall shrubs, or narrow-leaf orites *(Orites revoluta*) may be present. On drier ridge tops, openings contain prostrate heath species such as carpet heath *(Pentachondra pumila),* prostrate cheeseberry *(Cyathodes dealbata*) and sometimes strawberry pine *(Microcachrys tetragona*), as well as a diversity of small heath, shrubs and herbs as well as tussock grass *(Poa gunnii*).

Short Rainforest (M)

Short rainforest occupies low to moderately fertile sites. It occurs predominantly in the western part of the state and is common on quartzite substrates and is the dominant vegetation community of the study area (Plate 4.2). Forestry Tasmania classifies this community as old growth forest (Woolley, pers. com. 2003) (Figure 4.3).

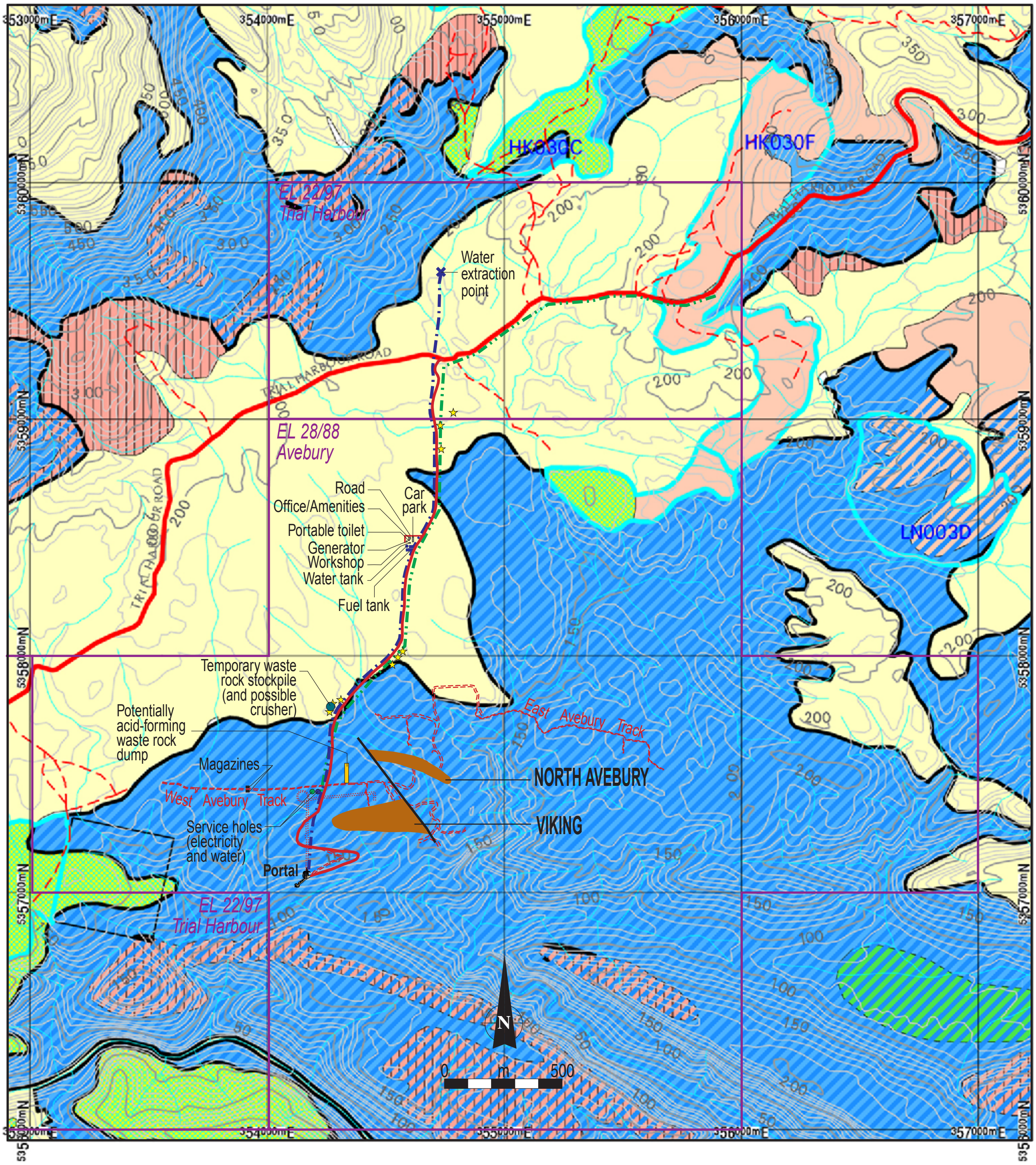
In infertile rainforest, mixtures of several co-dominants are often present. The most common species that may occur as co-dominants include myrtle (*Nothofagus cunninghamii*), celery top pine *(Phyllocladus aspleniifolius*) and leatherwood (*Eucryphia lucida*). Across the altitude range of infertile rainforest the tree species may include sassafras (*Atherosperma moschatum*), dwarf leatherwood (*Eucryphia milliganii*), woolly tea-tree (*Leptospermum lanigerum*), shiny tea-tree (*L. nitidum*), semi-glaucous tea-tree (*L. glaucescens*), manuka (*L. scoparium),* scented paperbark (*Melaleuca squarrosa*) and variable sallow wattle (*Acacia mucronata*). In general, the trees are short, from 8 m to usually less than 25 m tall, often with a broken and uneven canopy.

Plate 4.2a

Short rainforest in the project area, with sparse understorey upslope of Hemp Creek.

Plate 4.2b

Short rainforest in the project area, with dense understorey.



Thamnic rainforest on less fertile sites	King Billy pine	Private land boundary	Heavy vehicle single lane access road
Eucalyptus nitida dry forest	Old growth	Plan coupe (boundary)	Vehicular track fire trails (un)formed 2.4
Eucalyptus nitida tall forest	10 m topography contour	Not coded	
Not forest	50 m topography contour	Primary aii weather 2 lane access	
Eucalyptus obliqua dry forest	River/stream/creek	Significant all weather 2 lane feeder	

Note: Any topographic data on this map has been supplied by DPIWE.

Source: Forestry Tasmania

NSR Environmental Consultants Pty Ltd	Job No: 938 / File No: 938_4_F4.03_HB	Allegiance Mining NL / Avebury Nickel Project	Forestry Tasmania RFA communities	Figure No: 4.3

The understorey is dense and often continuous with the canopy layer. Shrubs are usually common and often form a dense tangle. The most common species include horizontal (*Anodopetalum biglandulosum*), native laurel (*Anopterus glandulosus*), native plum (*Cenarrhenes nitida*) and pandani (*Richea pandanifolia*). The lower shrubs include *Trochocarpa* spp., round-leaf monotoca (*Monotoca submutica*) and pink or crimson berry (*Cyathodes juniperina*). Ground ferns and epiphytic ferns are common.

Much of the rainforest in the southwest of the study area was selectively logged and burned in the 1960s (Newnham, pers. com. 2003).

Eucalyptus obliqua *dry forest (O) (and recently cleared* E. obliqua *[crO])*

Eucalyptus obliqua dry forest is associated with three substrate types: dolerite, argillaceous substrates (mudstones and metamorphosed mudstones) and siliceous substrates including granites and sandstones. It occurs in a small area east of Kynance Creek.

Browntop stringybark *(E. obliqua*) is the dominant species. Silver wattle (*Acacia dealbata*) is frequently present in the tall shrub layer. Similarly, when blackwood (*Acacia melanoxylon*) is present it is usually as a tall shrub rather than as a tree. Typically, the understorey is shrubby. Common species include silver wattle (*Acacia dealbata*), native cherry (*Exocarpos cupressiformis*), bull-oak (*Allocasuarina littoralis*), guitar plant (*Lomatia tinctoria*) and common heath (*Epacris impressa*).

Broad-leaf Shrubbery (Sb)

This community commonly occurs in gullies or on talus (fragmented rock) slopes on mountainsides or boulder fields, usually in very fire-protected situations. Only a small patch of this vegetation occurs in the study area, between two minor tributaries of Hemp Creek.

Dogwood *(Pomaderris apetala*), native olive (*Notelaea ligustrina*) and musk (*Olearia argophylla*) are common in this community, occurring as a dense canopy 4 to 8 m in height; occasionally with scattered emergent eucalypts or other trees.

The understorey is often open with mossy boulders and herbs such as starwort (*Stellaria* spp.), Brassicaceae and *Geranium* spp. sometimes present. In areas which have been subject to disturbance, this community forms an open to dense layer of recolonising vegetation which may include shrubs or small trees (1 to 8 m) of tallow-wood (*Pittosporum bicolor*), native pepper (*Tasmannia lanceolata*), dogwood (*Pomaderris apetala*), blackwood (*Acacia melanoxylon)*, manuka (*Leptospermum scoparium*), and lancewood *(Nematolepis squamea*).

Western Wet scrub with **Eucalyptus nitida (Sn)**

Western wet scrub is abundant in western Tasmania on peat soils derived from quartzitic rocks. It occurs as scattered large patches of vegetation in the study area, as thickets within the buttongrass moorland.

Scattered Smithton peppermint (*Eucalyptus nitida*) are ubiquitous as small trees to 5 m (or at most 8 m) in the centres of thickets.

A number of species commonly occur in this unit, including up to five species of tea-tree (shiny tea-tree [*Leptospermum nitidum*], manuka [*L. scoparium*] and semi-glaucous tea-tree [*L. glaucescens*]); swamp melaleuca (*Melaleuca squamea*) and, sometimes, scented paperbark (*M. squarrosa*). Variable sallow wattle (*Acacia mucronata*) is nearly always present, while silver banksia (*Banksia marginata*) is usually present and may dominate.

Other common species include round-leaf monotoca (*Monotoca submutica*), wiry bauera (*Bauera rubioides*), pouched coral-fern (*Gleichenia dicarpa*), spreading rope-rush (*Empodisma minus*), cutting grass (*Gahnia grandis*) and sometimes Christmas bells (*Blandfordia punicea*). Wetter areas and steep slopes usually also have native plum (*Cenarrhenes nitida*), lancewood (*Nematolepis squamea*), white waratah (*Agastachys odorata*) and sometimes celery top pine (*Phyllocladus aspleniifolius*).

Leptospermum *spp. Scrub (St)*

This community consists of almost pure stands of *Leptospermum* spp. (up to 8 m, but usually 3 to 5 m tall). Dominant *Leptospermum* species may occur in a mix with any other *Leptospermum* species including woolly tea-tree (*L. lanigerum*), shiny tea-tree (*L. nitidum*), semi-glaucous tea-tree (*L. glaucescens*) and occasionally manuka (*L. scoparium*). *Leptospermum* scrub is found as a large patch of vegetation between Hemp and Kynance creeks, adjoining the short rainforest.

The community has a closed upper canopy dominated by even-aged *L. lanigerum*, with *Melaleuca ericifolia* an occasional sub-dominant. The shrub layer is absent, while the ground stratum is represented by sparse clumps of *Carex appressa* and/or cutting grass (*Gahnia grandis*) (plus a few small herbaceous species).

Leptospermum lanigerum *Scrub/ Sparse* **E. nitida** *(St)*

While the name of this community indicates sparse *Eucalyptus nitida* among the tea-tree scrub, the description for this community is the same as that for *Leptospermum lanigerum* scrub.

Retionaceae Flatland (Br)

Information on this vegetation community is not yet available from the Tasmania Parks and Wildlife Service

E. nitida *Wet Forest (NT)*

A description for this vegetation community is yet to be finalised by the Tasmania Parks and Wildlife Service.

4.1.5 Significant Vegetation Communities

The criteria used to review the conservation status of forest communities are provided in Table 4.1 as defined in the Tasmanian RFA (Commonwealth of Australia, 1996). There are no Commonwealth-listed threatened ecological communities in the study area as listed under the *EPBC Act 1999*.

Table 4.1 Vegetation community conservation classification criteria

Conservation	Criteria
Rare	R1-total range generally less than 10,000 hectares.
	R2-total area generally less than 1,000 hectares.
	R3-patch sizes generally less than 100 hectares.
Vulnerable	V1-approaching greater than 70% loss (depletion).
	V2-includes forest communities where threatening processes have caused loss or significant decline in species that play a major role within the ecosystem or significant alteration to ecosystem processes.
Endangered	E1-distribution has contracted to less than 10% of original range.
	E2-less than 10% of original area remaining.
	E3-90% of area is in small patches and is subject to threatening processes.

Table 4.2 provides the conservation status of the ten vegetation communities found in the study area. *Melaleuca squamea* (Bm) emerges as the only vegetation community in the study area regarded as high priority for conservation (bioregionally rare in the Tasmanian West bioregion). This vegetation community is mapped as occurring immediately south of the Trial Harbour Road, about 100 m west of the proposed junction with the development access road, however, field verification by Forestry Tasmania indicated that the community mapped is not *Melaleuca squamea*.

Table 4.2 Vegetation community conservation classification for study area

Vegetation Community	Vegetation Code	Conservation Status[1]
Buttongrass moorland	Bb	Not a priority
Melaleuca squamea	Bm	High priority - bioregionally rare
Restionaceae flatland	Br	No information available
Short rainforest	M-	Not a priority
Eucalyptus nitida wet forest	NT	Not a priority
E. obliqua dry forest (including Recently cleared *E. obliqua* dry forest [crO])	O	Not a priority

Table 4.2 Vegetation community conservation classification for study area (cont'd)

Vegetation Community	Vegetation Code	Conservation Status[1]
Broadleaf shrubbery	Sb	Not a priority
Western wet scrub	Sn	Not a priority
Leptospermum lanigerum scrub, sparse *E. nitida*	St En-	Not a priority
Leptospermum lanigerum scrub	St	Not a priority

[1] As listed for the Tasmanian West bioregion by the Nature Conservation Branch of DPIWE (Harris, pers.com, 2003).

4.2 Fauna

This section provides a description of the terrestrial fauna species (including avifauna) and significant habitat present in the study area.

4.2.1 Species

A complete fauna list cannot be compiled for the study area from a desktop assessment; this would be achieved with a field survey. From the point localities identified in the study area (see Figure 4.1), the GTSpot database lists 79 species, all of which are birds. No mammals are recorded from the study area, though an unconfirmed sighting of what is believed to be a Tasmanian pademelon (*Thylogale billardierii*) was made during the reconnaissance trip to the project area.

4.2.2 Threatened Species

State Threatened Species

The GTSpot database reveals that three species of state significance are listed within the study area on a tributary of Comstock Creek (at location 354877 E, 5357979 N) (see Figure 4.1). These species are listed in Table 4.3 and discussed below.

Table 4.3 Threatened species potentially occurring within the study area

Species Name	Common Name	State Significance[1]	Year Recorded
Aquila audux fleayi	Wedge-tailed eagle	Vulnerable	1981
Pachyptila turtur subantarctica	Fairy prion southern sub-species	Vulnerable	1977
Halobaena caerula	Blue petrel	Vulnerable	1978

[1] As listed under Schedule 4 of the Tasmanian *Threatened Species Protection Act 1995.*

Wedge-tailed Eagle

The wedge-tailed eagle (*Aquila audux fleayi*) is found throughout Tasmania (and is an endemic subspecies of Tasmania), building nests in tall eucalypts in areas of mainly old-growth forest, with large home ranges. As a result of statewide disturbance to nests and breeding adults, breeding success for the species is on the decline. This, combined with shooting, trapping, poisoning, electrocution and collisions with vehicles, has led to a reduction in population size and its listing as vulnerable in Tasmania. Forest clearing for agriculture, forestry and housing is also contributing to the decline in abundance of the eagle (Bell & Mooney, 1999). Management of the eagle and its habitat at the state level is covered by the provision of the *National Parks and Wildlife Act 1970*, *Forest Practices Act 1985* and the *Threatened Species Protection Act 1995*. There is also a Wedge-tailed Eagle Recovery Plan 1998-2003 prepared under the latter Act.

Fairy Prion Southern Sub-species

The fairy prion is a sea-bird of southeastern Australia and Tasmania, with the only breeding colonies found on two rock stacks off Macquarie Island. The species digs nesting burrows under cushion plants, with young predated upon by subantarctic skuas, rats and feral cats, with rabbits causing degradation of burrows (Garnett, 1992). Due to the restricted distribution of the species and its oceanic habitat, it is likely to be an error in identification in GTSpot and not likely to occur in the study area.

Blue Petrel

Distributed throughout the world's southern oceans, it is an irregular visitor to the seas of southern Australia. The only Australian population is on Macquarie Island. The species is confined to rocky stacks offshore where it digs nesting burrows in rocks or tussock grasses, with young predated upon by subantarctic skuas, rats and feral cats, with rabbits causing degradation of burrows. Rabbit and cat control programs have been undertaken on Macquarie Island (Garnett, 1992). Due to the restricted distribution of the species and the lack of suitable habitat in the study area, it is likely to be an error in identification in GTSpot and not likely to occur in the study area.

Other Possible State Threatened Species

Other threatened fauna species listed as occurring in the Trial mapping grid of Tasmania include the orange-bellied parrot (historic record from 1981), short-tailed shearwater, hooded plover and migratory waders. These species are all listed as occurring at the coast at Trial Harbour or at the mouth of the Little Henty River (Bryant & Jackson, 1999), both of which are some distance west of the study area. Should suitable habitat be available within the Trial mapping grid, other threatened species that may occur include the Australian grayling, grey goshawk, and the eastern spotted-tail quoll (Bryant & Jackson, 1999).

Nationally Threatened Species

A search of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC 1999) online database for nationally threatened species lists several fauna species; the results are presented in Table 4.4.

Table 4.4 Nationally threatened fauna species within the study area

Species Name	Common Name	Status	Habitat
Threatened Species			
Aquila audux fleayi	Wedge-tailed eagle	Vulnerable	Found throughout Tasmania (and is an endemic subspecies of Tasmania), building nests in tall eucalypts in areas of mainly old-growth forest (eucalypt and rainforest), with large home ranges. Emergent trees are the preferred nest sites.
Lathamus discolor	Swift parrot	Endangered	Grassy blue gum (*E. globulus*) forest in eastern Tasmania, with grassy/shrubby swamp gum (*E. ovata*) forest used when flowering of blue gum is poor. Post-breeding habitat is wetter forests in west and northwest Tasmania, where summer flowering eucalypts are available (stringybark, alpine ash, white gum, mountain gum).
Dasyurus maculatus maculatus	Spot-tailed quoll	Vulnerable	Rainforest, open forest, woodland, coastal heathland and riparian forest, from coast to snowline. Dens in caves, rock crevices and hollow logs (Strahan, 1998).
Prototroctes maraena	Australian grayling	Vulnerable	Coastal rivers and streams (Fulton, 1990) draining to the sea (McDowell, 1996), cool and clear waters with gravel substrate (Cadwallader & Backhouse, 1983; McDowell, 1996).
Terrestrial species covered by migratory provisions of the EPBC Act 1999			
Haliaeetus leucaogaster	White-bellied sea-eagle	Listed - species or species habitat likely to occur in area	Coastal, estuarine and lake environments, from India to Australia.
Hirundapus caudacutus	White-throated needletail	Listed - species or species habitat likely to occur in area	Aerial birds, now known to roost in trees.
Wetland species covered by migratory provisions of the EPBC Act 1999			
Gallinago hardwickii	Latham's snipe, Japanese snipe	Listed - species or species habitat likely to occur in area	Networks of artificial and ephemeral freshwater wetlands in coastal areas along the Australian east coast and Tasmania (Lane, 1987).
Species covered by marine provisions of the EPBC Act 1999			
Gallinago hardwickii	Latham's snipe, Japanese snipe	Overfly marine area	As above.
Haliaeetus leucaogaster	White-bellied sea-eagle	Listed	As above.

Table 4.4 Nationally threatened fauna species within the study area (cont'd)

Species Name	Common Name	Status	Habitat
Species covered by marine provisions of the EPBC Act 1999			
Hirundapus caudacutus	White-throated needletail	Overfly marine area	As above.
Lathamus discolor	Swift parrot	Overfly marine area	As above.

4.2.3 Habitats

Four broad fauna habitat types are present in the study area:

- Temperate rainforest.
- Buttongrass plains.
- Shrubby eucalypt forest.
- Tea-tree and paperbark wet scrub.

Detailed descriptions of these habitat types are covered in Section 4.1.4 'Vegetation Communities.' A broad outline of the value of these habitats to fauna within the study area is presented in Table 4.5.

Table 4.5 Habitat values of the study area

Habitat[1]	Corresponding Vegetation Community (refer Section 4.1.4)	Location (within study area only)	Structure	Characteristic Fauna Species
Temperate rainforest	Short rainforest (M)	Southern 75%.	Dominated by tall (>20 m) and dense canopy, with patchy dense understorey.	High diversity of birds, high order avian predators (such as eagles and goshawks), mammals such as wallaby.
Buttongrass plains	Buttongrass moorland (Bb) Retionanceae flatland (Br)	Northern part around Trial Harbour Road.	Less than 2 m tall, dominated by buttongrass hummocks and a mix of shrubs, sedges and rushes.	Birds (ground parrots and wrens) and ground-dwelling mammals such as native rats.
Shrubby eucalypt forest	*Eucalyptus obliqua* dry forest (O) *E. nitida* wet forest (NT)	Adjacent to rainforest in northern part of study area.	Tall canopy (< 20 m) and dense understorey shrubs.	Birds, ground-dwelling mammals, marsupials.

Table 4.5 Habitat values of the study area (cont'd)

Habitat[1]	Corresponding Vegetation Community (refer Section 4.1.4)	Location (within study area only)	Structure	Characteristic Fauna Species
Tea-tree and paperbark wet scrub	*Melaleuca squamea* (Bm) Broad leaf shrubbery (Sb) *Leptospermum* scrub (St) *Leptospermum* scrub/sparse *E. nitida* (St) Western wet scrub with *E. nitida* (Sn)	Patchy through rainforest, scattered throughout buttongrass moorland north and south of Trial Harbour Road.	Closed canopy, usually forming dense thickets several metres high. Some emergent eucalypt species.	Birds (especially those requiring dense vegetation for nesting/predator protection), ground-dwelling mammals such as native rats.

[1] Habitat classification based on groupings of TASVEG 2000 vegetation communities and Bushcare Management Information associated with TASVEG 2000.

4.2.4 Habitat Quality

Fauna habitat in the study area is considered to be of good quality, even though some areas have historically been subject to selective logging and other minor forms of disturbance, such as road building, road maintenance and impacts to aquatic habitat from historic mining upstream from the proposed Avebury Nickel Project. The area east of Comstock Creek is reserved as high quality wilderness (as indicated by Forestry Tasmania mapping), indicating its high significance for flora and fauna conservation in the region. Habitat in the study areas is similar, if not the same, to that of the wilderness area, and there is no physical or ecological movement barrier between the two areas.

Vegetation along the existing Allegiance access track off the Trial Harbour Road shows no signs of weed invasion, though the felling of trees and the road itself may present a movement barrier for some fauna species, such as small ground-dwelling mammals. However, animals such as the Tasmanian pademelon were seen to cross the access road freely.

The study area contains a mosaic of vegetation types of different age, fire regime history (buttongrass plains and heathland vegetation) and differing understorey densities. Other habitat features such as a high density of fallen trees, rotting logs and leaf litter indicate good habitat availability and diversity for a wide range of species.

5. Potential Impacts

Potential impacts to vegetation, flora and fauna are summarised below.

Vegetation and Habitat Loss - a total of about 12 ha of native vegetation will be cleared during the construction of Stage 1 of the Avebury Nickel Project, comprising the access road, portal and site facilities. Most clearing will take place among the rainforest vegetation.

Habitat Fragmentation - disruption to fauna movement across a fragmented habitat range. This may impact on ground-dwelling mammals that rely on ground cover for predator protection. The creation of increased 'edge effect' through the vegetation will result in changes to the fluxes of light, wind and temperature currently experience among the various vegetation communities. This can favour the establishment and spread of edge species (mainly exotic flora and fauna that thrive in disturbed fragmented environments, such as grassy weeds and birds such as noisy minors) that can displace native species and exacerbate the nature of disturbance to the forest environment already created through the construction of the access road.

Weeds - existing weed levels along Trial Harbour Road and throughout the study area are extremely low. Soil disturbance as a result of vegetation clearing and road and infrastructure building will provide an opportunity for the invasion of environmental weeds from surrounding regions, predominantly through the introduction of foreign soil and seed from construction vehicles and equipment.

Pathogens - *P. cinnamomi* may already exist in the area given the high annual rainfall, land use patterns (i.e., forestry) and distribution of the pathogen along the west coast (Woolley, pers. comm, 2003). It therefore has the opportunity to be introduced to the study area from other areas through soil carried in on construction vehicles, machinery and footwear. The area of buttongrass moorland/heath close to the Trial Harbour Road is susceptible to *P. cinnamomi* as it contains many grassy and sclerophyllous species susceptible to the fungus (Environment Australia, 1999). The status of myrtle wilt in the study area is unknown. Tree clearing activities that lead to tree stem and branch wounds have the potential to artificially elevate the incidence of myrtle wilt in myrtle beech (*Nothofagus cunninghamii*).

State significant species - the wedge-tailed eagle (*Aquila audux fleayi*) has the potential to be impacted. Suitable habitat (in the form of old growth rainforest) and nesting habitat for this species may be cleared for road and infrastructure development. Given the small amount of vegetation clearance, it seems unlikely to impact on the species, because: i) the area affected is a very small portion of a large area of surrounding suitable habitat, and ii) the range of individual birds is large. Their varied diet of fish, reptiles, birds and mammals, together with large home ranges ensures that localised effects to predator habitats do not effect their survival in the area.

Nationally significant species - impacts to nationally listed threatened species (as listed in Table 4.4) are likely to be minimal, and relate primarily to loss of suitable habitat, habitat fragmentation and disturbance to watercourses.

Traffic collisions - given the low number of trucks and 4WD vehicles that will be using the access road, the low frequency of traffic movement and the short duration of the Stage 1 development, it is not likely that collisions between fauna and traffic will be an issue.

Other potential impacts - other potential impacts that may occur as a result of Stage 1 development include fauna entrapment in the decline, collision with, and electrocution on, the powerline, and sedimentation of watercourses.

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Appendix 1

Flora and Fauna Records from the GTSpot

Appendix 1: Flora and Fauna Records from the GTSpot

The species in Table 1 come from searches performed on the Geo Temporal Species Point Observations Tasmania (GTSpot) database on the Tasmania Parks and Wildlife Service website (2003). It is important to note that this species listing is not comprehensive - they come from point locality recordings only, not quadrat searches. In many cases, there are multiple recordings for each species over time; this information has not been included in the table.

Table 1 Flora and fauna records from the GTSpot for the Avebury Nickel Project study area

SPECIES NAME	COMMON NAME
Fauna	
Acanthiza ewingii	Tasmanian thornbill
Acanthiza pusilla	Brown thornbill king island
Acanthorhynchus tenuirostris	Eastern spinebill
Acanthornis magnus	Scrubtit
Alauda arvensis	Common skylark
Anas superciliosa superciliosa	Pacific black duck
Anthus novaeseelandiae	Richards pipit
Aquila audax fleayi	Wedge-tailed eagle
Ardea novaehollandiae	White-faced heron
Ardeola ibis	Cattle egret
Artamus cyanopterus cyanopterus	Dusky woodswallow
Cacatua galerita galerita	Sulphur-crested cockatoo
Cacomantis flabelliformis prionurus	Fan-tailed cuckoo
Calamanthus fuliginosus	Striated calamanthus
Calidris ruficollis	Red-necked stint
Calyptorhynchus funereus xanthanotus	Yellow-tailed black cockatoo
Carduelis chloris	European greenfinch
Charadrius ruficapillus	Red-capped plover
Circus approximans gouldi	Swamp harrier
Colluricincla harmonica harmonica	Grey shrike-thrush
Columba livia	Feral pigeon
Coracina novaehollandiae	Black-faced cuckoo-shrike
Corvus tasmanicus tasmanicus	Forest raven
Coturnix ypsilophora ypsilophorus	Brown quail,swamp quail (ssp. of brown quail)
Cuculus pallidus	Pallid cuckoo
Dacelo novaeguineae novaeguineae	Laughing kookaburra

Table 1 Flora and fauna records from the GTSpot for the Avebury Nickel Project study area

SPECIES NAME	COMMON NAME
Fauna, ***cont'd***	
Daption capense	Cape petrel
Emblema bella	Beautiful firetail
Ephthianura albifrons	White-fronted chat
Eudyptula minor	Little penguin
Falco berigora tasmanica	Brown falcon (tasmanian),brown falcon
Fulmarus glacialoides	Southern fulmar
Gallinago hardwickii	Latham's snipe
Haematopus longirostris longirostris	Pied oystercatcher
Haliaeetus leucogaster	White-bellied sea-eagle
Halobaena caerulea	Blue petrel
Heteronympha merope salazar	
Hirundo neoxena	Welcome swallow
Hirundo nigricans nigricans	Tree martin
Larus novaehollandiae novaehollandiae	Silver gull
Larus pacificus pacificus	Pacific gull
Lichenostomus flavicollis	Yellow-throated honeyeater
Malurus cyaneus cyaneus	Superb fairy wren,blue wren
Melanodryas vittata	Dusky robin
Melithreptus validirostris	Strong-billed honeyeater
Morus serrator	Australasian gannet
Pachycephala olivacea	Olive whistler
Pachycephala pectoralis	Golden whistler
Pachyptila turtur subantarctica	Fairy prion southern sub-species
Pardalotus striatus striatus	Striated pardalote
Passer domesticus	House sparrow
Pelecanoides urinatrix urinatrix	Common diving-petrel
Petroica phoenicea	Flame robin
Pezoporus wallicus wallicus	Ground parrot
Phalacrocorax carbo novaehollandiae	Great cormorant
Phalacrocorax melanoleucos melanoleucos	Little pied cormorant
Phaps elegans	Brush bronzewing
Phylidonyris melanops crassirostris	Tawny-crowned honeyeater
Phylidonyris novaehollandiae	New holland honeyeater
Phylidonyris pyrrhoptera	Crescent honeyeater
Platycercus caledonicus	Green rosella
Puffinus tenuirostris	Short-tailed shearwater
Pygoscelis papua papua	Gentoo penguin

Table 1 Flora and fauna records from the GTSpot for the Avebury Nickel Project study area

SPECIES NAME	COMMON NAME
Fauna, *cont'd*	
Rhipidura fuliginosa albiscapa	Grey fantail
Sericornis humilis	White-browed scrub wren, Tasmanian scrub wren
Sterna bergii	Crested tern
Sterna caspia	Caspian tern
Sterna paradisaea	Arctic tern
Stipiturus malachurus littleri	Southern emu-wren
Strepera fuliginosa	Black currawong
Sturnus vulgaris	Common starling,starling
Thinornis rubricollis	Hooded plover
Turdus merula	Blackbird
Vanellus miles novaehollandiae	Masked lapwing
Zoothera lunulata	Bassian thrush,whites thrush
Zosterops lateralis lateralis	Silvereye
Flora	
Anodopetalum biglandulosum	Horizontal
Anopterus glandulosus	Native laurel
Atherosperma moschatum	Sassafras
Cenarrhenes nitida	Native plum, port arthur plum
Eucryphia lucida	Leatherwood
Grammitis billardierei	Finger-fern
Nothofagus cunninghamii	Myrtle, myrtle beech
Phyllocladus aspleniifolius	Celery top pine
Phymatosorus pustulatus	Kangaroo fern
Pittosporum bicolor	Cheesewood, tallow-wood
Rumohra adiantiformis	Leathery shield-fern, shield hare's-foot
Dillwynia glaberrima	Smooth parrot pea
Thelymitra flexuosa	Twisted sun orchid
Microtis unifolia	Common onion orchid
Prasophyllum australe	Austral leek orchid
Cryptostylis subulata	Large tongue orchid
Prasophyllum australe	Austral leek orchid

Appendix 2

Definition of Threatened Status for Flora and Fauna

Appendix 2. Definition of Threatened Status for Flora and Fauna

The following section defines the term ‘threatened’ according to Tasmanian and Commonwealth legislation. As the terms have different meaning at the state and Commonwealth levels, the species that are listed in the respective databases will not be the same.

A2.1 Commonwealth

The ‘Threatened’ status for the Commonwealth includes species listed as extinct in the wild, critically endangered, endangered or vulnerable under Part 13, Division 1, Subdivision A of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The EPBC Act 1999 references the International Union for Conservation of Nature and Natural Resources (IUCN) Red List Categories and Criteria (version 3.1, Feb 2000). The definition of these IUCN terms is provided below.

Extinct in the Wild

A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time:

(a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or

(b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.

Critically Endangered

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

(a) direct observation.

(b) an index of abundance appropriate to the taxon.

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat.

(d) actual or potential levels of exploitation.

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥80% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥80%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 100 km^2, and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at only a single location.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence.
(ii) area of occupancy.
(iii) area, extent and/or quality of habitat.
(iv) number of locations or subpopulations.
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence.
(ii) area of occupancy.
(iii) number of locations or subpopulations.
(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 10 km^2, and estimates indicating at least two of a-c (a-c being the same as for B1):

C. Population size estimated to number fewer than 250 mature individuals and either:

1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):

(a) Population structure in the form of one of the following:

(i) no subpopulation estimated to contain more than 50 mature individuals, OR

(ii) at least 90% of mature individuals in one subpopulation.

(b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).

Endangered

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

(a) direct observation.

(b) an index of abundance appropriate to the taxon.

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat.

(d) actual or potential levels of exploitation.

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥50%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥50% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 5000 km^2, and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at no more than five locations.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence.
(ii) area of occupancy.
(iii) area, extent and/or quality of habitat.
(iv) number of locations or subpopulations.
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence.
(ii) area of occupancy.
(iii) number of locations or subpopulations.
(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 500 km^2, and estimates indicating at least two of a-c (a-c being the same as for B1).

C. Population size estimated to number fewer than 2500 mature individuals and either:

1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):

(a) Population structure in the form of one of the following:
(i) no subpopulation estimated to contain more than 250 mature individuals, OR
(ii) at least 95% of mature individuals in one subpopulation.

(b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

Vulnerable

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

(a) direct observation.

(b) an index of abundance appropriate to the taxon.

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat.

(d) actual or potential levels of exploitation.

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 20,000 km^2, and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at no more than 10 locations.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence.
(ii) area of occupancy.
(iii) area, extent and/or quality of habitat.
(iv) number of locations or subpopulations.
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence.
(ii) area of occupancy.
(iii) number of locations or subpopulations.
(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 2000 km^2, and estimates indicating at least two of a-c (a-c being the same as for B1).

C. Population size estimated to number fewer than 10,000 mature individuals and either:

1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):

(a) Population structure in the form of one of the following:
(i) no subpopulation estimated to contain more than 1000 mature individuals, OR
(ii) all mature individuals are in one subpopulation.

(b) Extreme fluctuations in number of mature individuals.

D. Population very small or restricted in the form of either of the following:

1. Population size estimated to number fewer than 1000 mature individuals.

2. Population with a very restricted area of occupancy (typically less than 20 km^2) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

A2.2 Tasmania

The ‘Threatened’ status for Tasmanian native species includes those listed as extinct, endangered, vulnerable or rare under Schedules 3, 4 or 5 of the Tasmanian *Threatened Species protection Act 1995*. Those that are nominated and fit the criteria listed by the IUCN are protected in this Act. They are listed in four categories of decreasing seriousness:

Extinct: Those species presumed extinct.

Endangered: Those species in danger of extinction because long term survival is unlikely while the factors causing them to be endangered continue operating.

Vulnerable: Those species likely to become endangered while the factors causing them to become vulnerable continue operating.

Rare: Those species with a small population in Tasmania that are at risk.

The five categories or risk codes developed by the IUCN are listed in order of decreasing seriousness, and are summarised by the Department of Primary Industries, Water and Environment (DPIWE) as follows:

Extinct: Where a species has not definitely been located in the wild for the past 50 years. A well known Tasmanian example is the thylacine. The last recorded, proven sighting was in 1936. Since then there have been many reported sightings, often dozens a year. However none of the thylacine sightings has been confirmed, so it is presumed extinct and under the IUCN category can be listed as officially extinct.

Extinct In The Wild: This is when a species can not be found living in the wild despite exhaustive surveys, but is still known to exist in captivity. At present there are no species in this category in Tasmania.

Critically Endangered: In this case a species is in extreme danger of becoming extinct in the immediate future. Species are placed in this category if they:

- have an 80% decrease in population in the past ten years.
- occupy an area of less than 10 km^2 and are severely fragmented (populations isolated from each other) or are continuing to decline or fluctuate in numbers.
- number less than 250 mature individuals and are declining by 25% every 3 years.
- number less than 50 mature individuals.
- have a 50% probability of extinction within 5 years or 2 generations.

Endangered: A species at very high risk of becoming extinct in the near future. The criteria include:

- 50% decline in population in past ten years.
- occupy an area of less than 500 km^2.
- less than 2,500 mature individuals (20% decline, fragmented or fluctuating).
- less than 250 mature individuals.

- 20% probability of extinction in 20 years or 5 generations.

Vulnerable: A species is facing a high risk of extinction in the medium term future. The criteria include:

- 50% decline in population in the past 20 years or 5 generations.
- area of occupancy less than 2,000 km^2 plus two of these factors: continuing to decline, severely fragmented, only occur in 2 locations or suffer extreme fluctuations in figures.
- less than 10,000 mature individuals (continuing decline).
- less than 1000 mature individuals plus restricted locations or area occupied 10% probability of extinction within 100 years.

Appendix 4

Water Quality Characterisation

Allegiance Mining NL

Avebury Nickel Project

Water Quality Characterisation

June 2003

CR 938_5_v2

Allegiance Mining NL

Avebury Nickel Project

Water Quality Characterisation

June 2003
CR 938_5_v2

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1. Introduction

1.1 Background

Allegiance Mining NL (Allegiance) is intending to commence the Stage 1 development of the Avebury Nickel Project, near Zeehan, northwest Tasmania.

The estimated Avebury resource is 4,000,000 t at 1.5% Ni (about 60,000 t Ni). Allegiance proposes to develop the project in three stages. The success of Stage 1 development will determine whether Allegiance will proceed to Stages 2 and 3.

Stage 1 of the Avebury Nickel Project involves the development of a decline into the deposit where high grades (>2% Ni) are indicated. The decline will be about 1,000 m in length, 5 m wide and 5 m high. Approximately 100,000 t of waste rock will be excavated during development of the decline. The decline will allow Allegiance to conduct detailed resource and reserve definition drilling, in-situ examination of the mineralisation, bulk sampling of the mineralisation for metallurgical test work, and geotechnical studies to optimise the mine design.

Accompanying the first leg of the decline development will be the establishment of on-site and ancillary facilities including electricity, water tanks, workshop, office, ablutions, magazine, crib and diesel storage areas.

A 3-km access road will be constructed that runs south from Trial Harbour Road to the on-site facilities and then further south to the portal. Waste rock from the decline construction will be used in road construction (development waste will be geochemically characterised to confirm that this material is suitable for use as road base).

Two cross-cuts will be constructed at the bottom of the decline which will allow the extraction of approximately 150 t of mineralisation that will be transported off-site for metallurgical assessment.

Based on the geotechnical studies and metallurgical testwork resulting from Stage 1, a decision to go to full-scale production would see the project enter Stage 2 of development.

This report presents the results of a preliminary characterisation of water quality in waterbodies potentially impacted by the proposed project.

1.2 Objectives

The objectives of this study are to:

- Characterise the water quality of waterbodies potentially impacted by the proposed project.

- Compare the water quality with ambient water quality guidelines.

1.3 Assessment Framework

Assessment of water quality data is undertaken by referring to the protected environmental values (PEVs) associated with any particular waterbody (DPIWE, 2000). Once the PEVs have been identified, objectives can be established that will achieve the required level of protection. Objectives vary depending on the particular beneficial uses, with some uses requiring better water quality than others.

The PEVs for surface waters in the West Coast Municipal Area are presented in DPIWE (2000). The PEVs for Little Henty River and Hemp Creek are:

- Protection of modified (not pristine) aquatic ecosystems from which edible fish are harvested.
- Recreational water quality and aesthetics: primary contact[1], secondary contact[2] and aesthetic water quality.

Given that Comstock Creek is impacted by historical mining activity (DPIWE, 2000), the PEVs therefore are:

- Protection of modified (not pristine) aquatic ecosystems from which edible fish are not harvested.
- Recreational water quality and aesthetics: secondary contact and aesthetic water quality.

The protection of aquatic ecosystems generally requires more stringent water quality objectives than for the protection of recreational water quality and aesthetics. Therefore, for the purposes of characterisation of the water quality in the project area, the Australian water quality guidelines (ANZECC/ARMCANZ, 2000) trigger values (TVs) for the protection of slightly to moderately disturbed ecosystems have been used in this assessment. These generally attempt to protect of 95% of species from metal toxicity, although a 99% protection level has been adopted for Hg to allow for possible bioaccumulation and secondary poisoning effects.

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[1] Recreation involving bodily immersion/submersion where there is direct contact with water, and includes swimming diving, surfing and water skiing (DPIWE, 2000).

[2] Activities where there is some direct contact, but it is unlikely that water will be swallowed (e.g., paddling, boating and fishing) (DPIWE, 2000).

2. Methods

2.1 Sample Collection

Water quality samples were collected between 10 and 29 January 2003 at the following sites (Figure 1):

- Hemp Creek, downstream of the proposed decline portal. Hemp Creek drains to Little Henty River.
- Comstock Creek upstream of the confluence of Kynance Creek. Contiguous Creek and Kynance Creek drain to Comstock Creek which drains to Little Henty River upstream of Hemp Creek.
- The Little Henty River approximately 50 m downstream of the confluence of Hemp Creek.

Three water samples were collected at each site during low-flow conditions (approximately 6 L/s in Hemp Creek, 15 L/s in Comstock Creek, 8 L/s in Kynance Creek and 4,000 L/s in Little Henty River).

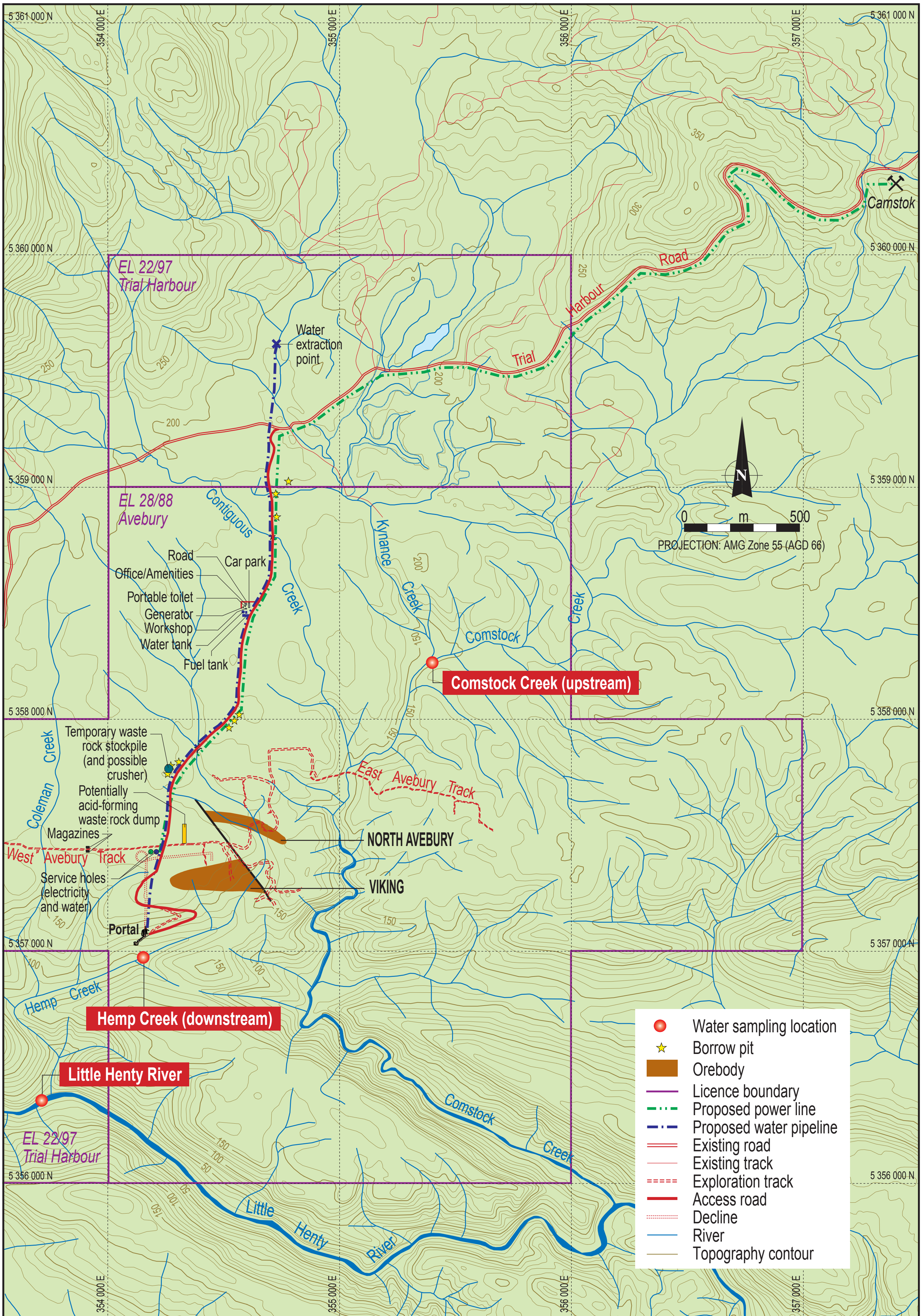
In addition, a sample of groundwater was collected on 21 March 2003 from the drill hole at the proposed decline portal.

2.2 Analyses

Water samples were analysed by Analytical Services Tasmania (AST), Sandy Bay, Tasmania. This is a NATA-accredited laboratory.

The following analytes were measured:

- General analytes:
  - pH
  - Conductivity (cond)
  - Turbidity (turb)
  - Total suspended solids (TSS)
  - Oil and grease (O&G)
- Nutrients:
  - Total nitrogen (TN)
  - Ammonia (NH_3)
  - Nitrate (NO_3)
  - Nitrite (NO_2)
  - Total phosphorus (TP)
  - Soluble reactive phosphorus (SRP)



NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Water sampling locations	Figure No: 1
	File No: 938_5_F001_HB	Avebury Nickel Project		

- Major ions and alkalinity[1]:
  - Sodium (Na)
  - Potassium (K)
  - Calcium (Ca)
  - Magnesium (Mg)
  - Chloride (Cl)
  - Sulfate (SO_4)
  - Total alkalinity
- Unfiltered (also referred to as 'total') and filtered (<0.45 µm, also referred to as 'dissolved') metals[2]:
  - Aluminium (Al)
  - Arsenic (As)
  - Cadmium (Cd)
  - Chromium (Cr)
  - Copper (Cu)
  - Iron (Fe)
  - Manganese (Mn)
  - Mercury (Hg)
  - Nickel (Ni)
  - Lead (Pb)
  - Selenium (Se)
  - Silver[3] (Ag)
  - Zinc (Zn)

The analytical methods employed by AST are summarised in Table 1.

2.3 Quality Assurance/Quality Control

2.3.1 Background

The validity of the water quality data was ensured by the implementation of a quality assurance/quality control (QA/QC) program. This was divided into two sections, the first of which concerned fieldwork, particularly sampling and sample treatment prior to delivery to the laboratory, while the second dealt with analytical aspects of the project.

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[1] Charges have been omitted for clarity.

[2] Including metalloids.

[3] NATA accreditation for AST does not cover Ag.

Table 1 Analytical Methods

AST method number	Analyte	Method
1001-Water	pH	APHA Method 4500-H
1002-Water	Conductivity	APHA Method 2510
1009-Water	Turbidity	APHA Method 2130B
1011-Water	Total suspended solids	0.45 µm Filtration
1101-Water	Alkalinity	APHA Method 2320/4500-CO2
1103-Water	Anions (Cl, SO_4)	APHA Method 4110C
1205-Water	Dissolved nutrients (NO_3, NO_2, NH_3, SRP)	APHA Method 4500
1206-Water	Total nutrients (TN, TP)	APHA Method 4500
1301-Water	Metals in water (Al, As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn)	APHA Method 3030/3120
1301a-Water	Metals in water (a) (Ag)*	APHA Method 3030/3120 *
1302-Water	Major cations in water (Na, K, Ca, Mg)	APHA Method 3030/3120
1305-Water	Mercury in water	APHA Method 3500-Hg
1307-Water	Selenium in water	APHA Method 3500-Se
1401-Water	Oil & grease	APHA Method 5520

* NATA accreditation does not cover the performance of this service.
APHA: American Public Health Association.

2.3.2 Sampling Quality Assurance Program

Due care was taken when sampling to minimise possible contamination from sample containers, personnel and extraneous sources. Precautions taken, and techniques used, included:

- The use of laboratory-prepared sample bottles.
- The use of disposable plastic gloves (not containing powder) when sampling.
- Taking samples in the actual sample bottle used to transport and store the sample prior to analysis.

2.3.3 Analytical Quality Assurance Program

The analytical QA/QC program included the following analyses:

- Field duplicates.
- Laboratory replicates.
- Bottle blank for metals.
- Laboratory blanks.
- Laboratory reference materials.

2.4 Historical Data

Water samples were collected from Comstock Creek by the Department of Primary Industries, Water and Environment (DPIWE), Tasmania in 1997 and 1999. Total and dissolved metal concentrations measured in these samples are reported in NSR (2000).

3. Results

3.1 General Analyses

The results of the general water quality analyses (pH, conductivity, turbidity, TSS and oil and grease) are presented in Table 2. The median values for each waterbody are included in Table 2 as well as ANZECC/ARMCANZ (2000) default trigger values for Southeastern Australia. Where possible, ANZECC/ARMCANZ (2000) values derived for Tasmania have been used.

The pH of Hemp Creek and Little Henty River are in the expected range. The low pH (median 3.8) in Comstock Creek suggests that acid rock drainage (ARD) is occurring upstream of the sampling site, as has been previously reported (DPIWE, 2000). The groundwater is pH 6.8 suggesting that no ARD is currently occurring from the proposed decline area.

The median conductivity of Hemp Creek (138 µS/cm) and Little Henty River (151 µS/cm) exceeds the default trigger value of 90 µS/cm (Table 2). The median conductivity in Comstock Creek (327µS/cm) is over twice that in the other two waterbodies. The groundwater conductivity (324 µS/cm) is twice the median conductivity of Hemp Creek.

Turbidity and TSS were low, as expected in upland streams in low-flow conditions. Oil and grease concentrations are at or below the reporting limit (<1 mg/L) in all samples with the exception of one sample from Hemp Creek (2 mg/L).

3.2 Nutrients

Nutrient concentrations (TN, NO_3/NO_2, NH_3, TP and SRP) are presented in Table 2. Nutrient concentrations are generally lower than the ANZECC/ ARMCANZ (2000) trigger values for upland rivers, although some values marginally exceed these trigger values.

3.3 Major ions and Alkalinity

Major ion concentrations (Na, K, Ca, Mg, Cl, SO_4 and HCO_3[1]), total alkalinity and water hardness are presented in Table 3.

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[1] Calculated from alkalinity assuming 100% contribution of HCO_3 at pH>6.5.

Table 2 Water quality - general parameters and nutrients

Lab.No.	Location	Date	Time	pH	Cond	Turb	TSS	O&G	TN	NO_3	NO_2	NH_3	TP	SRP
					µS/cm	NTU	mg/L		µg-N/L				µg-P/L	
40047	Hemp Creek	10/1/03	9:15	6.9	136	11	32	2	110	12	<2	3	<5	2
40167	Hemp Creek	17/1/03	14:00	6.7	138	7.0	6	<1	172	27	<2	4	9	4
40489	Hemp Creek	24/1/03	11:30	7.0	143	2.0	3	<1	134	32	<2	8	<5	3
40048	Comstock Creek	10/1/03	9:15	3.9	288	5.8	6	1	83	7	<2	6	<5	<2
40166	Comstock Creek	17/1/03	11:30	3.8	327	5.0	8	<1	106	11	<2	9	<5	<2
40488	Comstock Creek	24/1/03	10:00	3.8	358	7.8	7	<1	94	8	<2	11	<5	<2
40164	Little Henty River	15/1/03	13:00	6.9	130	1.8	6	<1	196	2	<2	4	<5	2
40487	Little Henty River	22/1/03	15:00	7.8	151	2.0	2	<1	226	<2	<2	7	16	8
40661	Little Henty River	29/1/03	14:00	7.3	160	1.6	<1	<1	169	2	<2	6	7	4
41915	Groundwater	21/3/03	14:00	6.8	324	-	4	-	-	-	-	-	-	-
Average (median)														
Hemp Creek				*6.9*	*138*	*7.0*	*6*	*<1*	*134*	*27*	*<2*	*4*	*<5*	*3*
Comstock Creek				*3.8*	*327*	*5.8*	*7*	*<1*	*94*	*8*	*<2*	*9*	*<5*	*<2*
Little Henty River				*7.3*	*151*	*1.8*	*2*	*<1*	*196*	*2*	*<2*	*6*	*7*	*4*
Default trigger values for Southeastern Australia (Tasmania)														
Upland Rivers				6.5-7.5‡	90	2-25	-	-	480	190†	-	13	13	5

* ANZECC/ARMCANZ (2000).
† NO_3+NO_2.
‡ For Tasmanian lakes and rivers which are humic-rich: 4.0 - 6.5.

Table 3 Water quality - major ions

Lab.No.	Location	Date	Time	Na	K	Ca	Mg	Cl	SO_4	HCO_3*	Total Alkalinity	Hardness
				Concentration (mg/L)							mg $CaCO_3$/L	
40047	Hemp Creek	10/1/03	9:15	16.0	1.00	2.35	3.46	30	3.5	11	9	20
40167	Hemp Creek	17/1/03	14:00	16.3	1.14	2.69	3.74	31	4.1	13	11	22
40489	Hemp Creek	24/1/03	11:30	16.1	1.16	2.81	3.84	31	4.1	15	12	23
40048	Comstock Creek	10/1/03	9:15	10.4	0.41	9.67	8.21	21	97	<1.2	<1	58
40166	Comstock Creek	17/1/03	11:30	11.4	0.47	13.1	10.6	21	130	<1.2	<1	76
40488	Comstock Creek	24/1/03	10:00	11.2	0.43	14.0	11.3	21	130	<1.2	<1	81
40164	Little Henty River	15/1/03	13:00	11.2	0.65	7.94	3.62	21	7.4	24	20	35
40487	Little Henty River	22/1/03	15:00	11.8	0.70	10.1	4.30	21	9.0	30	25	43
40661	Little Henty River	29/1/03	14:00	11.6	0.70	11.5	4.62	21	9.3	37	30	48
41985	Groundwater	21/3/03	14:00	22.6	1.98	19.8	13.7	42	9.3	111	91	106
Average (median)												
Hemp Creek				*16.1*	*1.14*	2.69	*3.74*	*31*	*4.1*	*13*	*11*	*22*
Comstock Creek				*11.2*	*0.43*	*13.1*	*10.6*	*21*	*130*	<1.2	*<1*	*76*
Little Henty River				*11.6*	*0.70*	*10.1*	*4.30*	*21*	*9.0*	*30*	*25*	*43*

* Calculated from alkalinity assuming 100% contribution of HCO_3 at pH>6.5.

In terms of median ion concentrations (mg/L), the cation dominances for the waterbodies are:

- Hemp Creek: Na > Mg ≅ Ca > K
- Comstock Creek: Ca ≅ Na ≅ Mg > K
- Little Henty River: Na ≅ Ca > Mg > K
- Groundwater: Na ≅ Ca>Mg>K

The anion cation dominances for the waterbodies are:

- Hemp Creek: Cl > HCO_3 > SO_4
- Comstock Creek: SO_4 > Cl > HCO_3
- Little Henty River: HCO_3 > Cl > SO_4
- Groundwater: HCO_3 > Cl > SO_4

This suggests that limestone is not a major feature in the Hemp Creek catchment, but that there is a greater proportion of limestone in the Little Henty River catchment as a whole. High SO_4 and low HCO_3 concentration/alkalinity in Comstock Creek (see Table 3) further indicate that the creek is affected by ARD.

The groundwater has an alkalinity of 91 mg $CaCO_3$/L, and therefore significant neutralising capacity.

The water in Hemp Creek (median hardness of 22 mg $CaCO_3$/L) and Little Henty River (median hardness of 43 mg $CaCO_3$/L) are classified as 'soft' (0 to 59 mg $CaCO_3$/L, ANZECC/ARMCANZ (2000)). The hardness of Comstock Creek (median hardness of 76 mg $CaCO_3$/L) is classified as 'moderate' (60 to 119 mg $CaCO_3$/L).

3.4 Metals

3.4.1 General

Unfiltered and filtered metal (Al, As, Cd, Cr, Cu, Hg, Fe, Mn, Ni, Pb, Se, Ag and Zn) concentrations are presented in Table 4. ANZECC/ARMCANZ (2000) water quality guidelines trigger values (TVs) for slightly-moderately disturbed ecosystems are also presented in Table 4.

The practical quantitation limit (PQL) for Cd and Ag is <1 μg/L. This is the PQL generally achieved by laboratories around Australia undertaking routine water quality measurements. The slightly-moderately disturbed ecosystems TVs for Ag

Table 4 Water quality - metals

Lab.No.	Location	Date	Time	Al	As	Cd	Cr	Cu	Fe	Mn	Hg	Ni	Pb	Se	Ag	Zn
				Concentration (µg/L)												
				Unfiltered												
40047	Hemp Creek	10/1/03	9:15	200	<5	<1	1	<1	368	8	<0.05	1	<5	<1	<1	2
40167	Hemp Creek	17/1/03	14:00	222	<5	<1	1	<1	411	-	<0.05	2	<5	<1	<1	6
40489	Hemp Creek	24/1/03	11:30	165	<5	<1	<1	<1	330	12	<0.05	1	<5	<1	<1	2
40048	Comstock Creek	10/1/03	9:15	1270	<5	4	<1	3	1110	2080	<0.05	30	79	<1	<1	5500
40166	Comstock Creek	17/1/03	11:30	1210	<5	4	<1	6	1090	-	<0.05	36	86	<1	<1	6010
40488	Comstock Creek	24/1/03	10:00	1470	<5	4	<1	5	1740	2650	<0.05	38	85	<1	<1	6930
40164	Little Henty River	15/1/03	13:00	144	<5	<1	<1	3	668	-	<0.05	3	9	<1	<1	181
40487	Little Henty River	22/1/03	15:00	124	<5	<1	<1	4	735	99	<0.05	3	9	<1	<1	205
40661	Little Henty River	29/1/03	14:00	77	<5	<1	<1	2	684	76	<0.05	2	<5	<1	<1	184
41918	Groundwater	21/3/03	14:00	50	<5	<1	<1	<1	3200	97	<0.05	<1	<5	<1	<1	8
				Filtered												
40047	Hemp Creek	10/1/03	9:15	174	<5	<1	1	<1	299	5	<0.05	2	<5	<1	<1	2
40167	Hemp Creek	17/1/03	14:00	147	<5	<1	<1	<1	287	-	<0.05	2	<5	<1	<1	4
40489	Hemp Creek	24/1/03	11:30	133	<5	<1	<1	<1	248	10	<0.05	1	<5	<1	<1	2
40048	Comstock Creek	10/1/03	9:15	1280	<5	4	<1	3	723	2060	<0.05	32	77	<1	<1	5540
40166	Comstock Creek	17/1/03	11:30	1180	<5	4	<1	5	462	-	<0.05	36	83	<1	<1	6000
40488	Comstock Creek	24/1/03	10:00	1480	<5	4	<1	5	993	2690	<0.05	38	87	<1	<1	7050
40164	Little Henty River	15/1/03	13:00	100	<5	<1	<1	3	507	-	<0.05	3	<5	<1	<1	148
40487	Little Henty River	22/1/03	15:00	100	<5	<1	<1	2	589	80	<0.05	3	6	<1	<1	185
40661	Little Henty River	29/1/03	14:00	58	<5	<1	<1	2	559	10	<0.05	<1	<5	<1	<1	154
Ambient freshwater water quality guidelines* Slightly-moderately disturbed ecosystems trigger value				55[†]	13[††]	0.2[H]	1[H,‡]	1.4[H]	ID	1900[C]	0.06[B]	11[H]	3.4[H]	5[B,‡‡]	0.05	8[H]

* ANZECC/ARMCANZ (2000). Based on a hardness of 30 mg $CaCO_3$/L. Notes on each of the water quality guideline trigger values are included in Attachment B.

and Cd are 0.05 µg/L and 0.2 µg/L [1] respectively. Therefore, it is not possible to determine if concentrations of Ag and Cd which are less than the PQL are also below the TVs.

The PQL for Pb is <5 µg/L. This is slightly higher than the TV for slightly-moderately disturbed ecosystems of 3.4 µg/L for water hardness of 30 mg/L $CaCO_3$, but lower than the TV of 6.5 µg/L for water harness of 50 mg/L $CaCO_3$.

Note that there is no TV for Fe provided in ANZECC/ARMCANZ (2000).

3.4.2 Hemp Creek

Unfiltered and filtered metal concentrations are generally low in Hemp Creek (see Table 4). The concentrations of As, Cr, Cu, Hg, Mn, Ni, Se and Zn are equal to or below TVs. The concentrations of Cd, Pb and Ag are below PQLs but, as discussed in Section 3.4.1, it is not possible to determine if they are below the TVs.

Both the unfiltered Al concentration (165 to 222 µg/L) and the filtered Al concentration (133 to 174 µg/L) exceeds the TV for waters pH>6.5 of 55 µg/L. It should be noted that elevated Al concentrations are common in the rivers of western Tasmania and that Al is most likely bound to organic matter in Hemp Creek and not readily bioavailable (Koehnken, 2001).

3.4.3 Comstock Creek

Present Study

Unfiltered and filtered Al, Cd, Cu, Fe, Mn, Ni, Pb and Zn concentrations are generally significantly higher in Comstock Creek than in Hemp Creek or Little Henty River. This is most likely the result of ARD which is also indicated by the low pH, higher conductivity, and high SO_4 concentration (see Section 3.3).

The filtered concentrations of Cd, Cu, Ni, Pb and Zn all exceed TVs. Filtered As, Cr and Se concentrations are below PQLs and TVs, while filtered Ag concentrations are below the PQL but it is not possible to assess if they are below the TV.

Filtered Zn concentrations exceed the hardness adjusted TVs by 339 to 396 times, while filtered Cd and Pb concentrations exceed the hardness adjusted TVs by 8 to 11 and 7 to 10 times respectively (Table 5). Filtered Cu and Ni concentrations are less than twice the TVs.

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[1] For harness of 30 mg/L $CaCO_3$.

Table 5 Exceedence of trigger values in Comstock Creek

Location	Date	Time	Hardness mg $CaCO_3$/L	Cd	Cu	Ni	Pb	Zn
				Concentration (µg/L) (TV)*				
Concentrations and TVs								
Comstock Creek	10/1/03	9:15	58	4 (0.4)	3 (2)	32 (19)	77 (8)	5540 (14)
Comstock Creek	17/1/03	11:30	76	4 (0.5)	5 (3)	36 (24)	83 (11)	6000 (18)
Comstock Creek	24/1/03	10:00	81	4 (0.5)	5 (3)	38 (26)	87 (12)	7050 (19)
Exceedence factor				**Exceedence factor**				
Comstock Creek	10/1/03	9:15	58	11	1.2	2	10	396
Comstock Creek	17/1/03	11:30	76	9	2	1.5	7	339
Comstock Creek	24/1/03	10:00	81	8	2	1.5	7	377

* Hardness-adjusted ANZECC/ARMCANZ (2000) trigger values for slightly-moderately disturbed ecosystems in brackets.

The ANZECC/ARMCANZ (2000) guidelines do not provide a TV for Al for waters with pH<6.5 as there is insufficient toxicity data available. However the guidelines note:

- Toxicity of Al to fish and invertebrates is increased at low (e.g., <5.5) and high pH (e.g., >9).
- Toxicity of Al is reduced by complexing with fluoride, citrate and humic substances.

ANZECC/ARMCANZ (2000) also note that at low pHs the toxic effects of the high H^+ concentration appear to be more important than the effects of low concentrations of aluminium.

The Al, Cd, Cu, Mn, Ni, Pb and Zn concentrations are similar in the unfiltered and filtered samples indicating that these metals are not particulate-bound.

Historical Data

Metal concentrations measured by DPIWE in Comstock Creek in 1997 and 1999 are presented in Table 6.

The historic concentrations of metals in Comstock Creek were similar to the concentrations measured in the present study (including high concentrations of Cd, Cu, Ni, Pb and Zn). It is not possible to draw any conclusions regarding temporal trends in water quality in Comstock Creek as the data does not include information on river flows at the time of sampling and the higher metal concentrations may be a result of different flows during sampling.

3.4.4 Little Henty River

Copper, Fe, Pb, Mn and Zn concentrations are generally higher in Little Henty River compared to Hemp Creek but lower than concentrations in Comstock Creek. The filtered concentrations of Al, Cu and Pb exceed hardness-adjusted TVs by less than two times. The filtered concentrations of Zn exceeds hardness-adjusted TVs by 13 to 17 times (see Table 7). Given the filtered Cd hardness-adjusted TVs are higher than the PQL, it is not known if concentrations exceed the TVs.

Given that the Little Henty River sampling site is approximately 3 km downstream of Comstock Creek, the high metal concentrations in Comstock Creek may be contributing to those in Little Henty River. In addition to Comstock Creek, there are many other historic mining areas of high metal concentrations and ARD in the catchment of the Little Henty River.

3.4.5 Groundwater

Unfiltered metal concentrations are low in the groundwater with the exception of elevated Fe concentration (3,200 µg/L).

Table 6 Historical water quality in Comstock Creek - metals

Location	Date	Al	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
		Concentration (µg/L)									
		Total									
Comstock Creek	22/10/97	2560	39	66	7	<5	59100	10800	147	380	33000
Comstock Creek	10/6/99	2190	19	23	<1	12	25100	4270	42	147	14900
Comstock Creek	10/8/99	370	1	<1	<1	9	1300	138	4	85	298
Comstock Creek	10/8/99	2110	20	26	<1	13	30700	4230	51	155	14900
		Dissolved									
Comstock Creek	22/10/97	-	-	-	-	-	-	-	-	-	-
Comstock Creek	10/6/99	1780	19	23	<1	10	351	4290	47	81	14700
Comstock Creek	10/8/99	287	<1	<1	1	11	681	129	3	52	284
Comstock Creek	10/8/99	1430	19	25	1	14	678	4220	51	80	14400
Ambient freshwater water quality guidelines*											
Slightly-moderately disturbed ecosystems tri		$55^{\dagger}$	0.2^{H}	ID	$1^{H,\ddagger}$	1.4^{H}	ID	1900^{C}	5^{H}	3.4^{H}	8^{H}

Data source: Department of Primary Industries, Water and Environment.

* ANZECC/ARMCANZ (2000). Based on a hardness of 30 mg $CaCO_3$/L. Notes on each of the water quality guideline trigger values are included in Attachment B.

Table 7 Exceedence of trigger values in Little Henty River

Location	Date	Time	Hardness	Al	Cd	Cu	Pb	Zn
			mg $CaCO_3$/L	Concentration (µg/L) (TV)*				
Concentrations and TVs*								
Little Henty River	15/1/03	13:00	35	100 (55)	<1 (0.2)	3 (2)	<5 (4)	148 (9)
Little Henty River	22/1/03	15:00	43	100 (55)	<1 (0.3)	2 (2)	6 (5)	185 (11)
Little Henty River	29/1/03	14:00	48	58 (55)	<1 (0.3)	2 (2)	<5 (6)	154 (12)
Exceedence factor				**Exceedence factor**				
Little Henty River	15/1/03	13:00	35	2	<5	2	<1.2	16
Little Henty River	22/1/03	15:00	43	2	<4	1.1	1.1	17
Little Henty River	29/1/03	14:00	48	1.1	<4	1.0	-	13

* Hardness-adjusted ANZECC/ARMCANZ (2000) trigger values for slightly-moderately disturbed ecosystems in brackets.

3.5 Quality Assurance/Quality Control

3.5.1 Criteria

Acceptance limits for duplicate samples, recovery of known additions and recovery from reference materials are provided by APHA (1992). The following APHA guidelines have been adopted in this report:

- Recoveries of metals and anions between 80% and 120% are considered to be acceptable.
- The results of the analyses of duplicate samples have been compared calculating the precision (P) as defined by APHA (1992):

  $P (\%) = [100 |(x1-x2)|/mean(x1, x2)]$

A precision of <25% is considered acceptable for low-level metal and anion duplicates (i.e., measured concentration is less than 20 times the detection limit).

3.5.2 Sampling Quality Assurance Program

The results of the analysis of blank (metals) and duplicate field samples are presented in Attachment C.

Metals concentrations in the blank sample are at or below the PQL with the exception of Al and Zn. The unfiltered and filtered concentrations of Al and Zn are significantly lower in the blanks than in the actual samples.

In replicate field samples, the precision (P) is greater than 25% for ammonia (28.6%) and filtered Ni (40.0%). In both cases the concentration is close to the detection limit and ammonia and filtered Ni results are acceptable.

On the basis of these results, the field sample QA/QC results are acceptable.

3.5.3 Analytical Quality Assurance Program

The results of the analytical QA/QC program are presented in Attachment B.

With few exceptions, the analytical QA/QC results are within the criteria outlined in Section 3.5.1 and the results are therefore acceptable.

4. Conclusions and Recommendations

4.1 Existing Water Quality

These data indicate:

- Hemp Creek is pH 6.7 to 7.0, Na and Cl dominated with low nutrient and metal concentrations which are considered typical of undisturbed upland streams in Tasmania. The median conductivity of Hemp Creek (138 µS/cm) exceeds the default ANZECC/ARMCANZ (2000) trigger value (TV) of 90 µS/cm.
- Comstock Creek is affected by acid rock drainage (ARD) within its catchment. This is indicated by low pH (median 3.8), high SO_4 concentration (median 130 mg/L), low alkalinity (<1 mg $CaCO_3$/L) and high metal concentrations. Occurrence of ARD in Comstock Creek has previously been documented (DPIWE, 2000).
- Based on ANZECC/ARMCANZ (2000) TVs for slightly to moderately disturbed ecosystems, the key contaminants in Comstock Creek are Zn followed by Cd and Pb. The low pH in Comstock Creek is also likely to be environmentally detrimental.
- Little Henty River (at the sampling site) is dominated by Na/Ca and HCO_3. It contains elevated metal concentrations, most likely as a result of ARD occurring in its catchment.
- Comparing to the potential receiving waters of Hemp Creek, groundwater from the proposed decline portal area may be characterised as follows:
  - pH of 6.8 is within the range measured in Hemp Creek.
  - Conductivity of 324 µg/cm is twice the median conductivity of Hemp Creek.
  - Unfiltered[1] As, Cd, Cu, Hg, Pb, Se and Ag concentrations are less than the practical quantitation limit (PQL) in the groundwater and Hemp Creek.
  - Unfiltered Al, Cr and Ni concentrations are the same or lower in the groundwater than Hemp Creek.
  - Concentrations of unfiltered Fe, Mn and Zn are higher in the groundwater than in Hemp Creek.

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[1] TSS = 4 mg/L.

- Comparing to the potential receiving waters of Comstock Creek, groundwater from the proposed decline portal area may be characterised as follows:
  - pH 6.9, higher than the range measured in Comstock Creek.
  - Conductivity of 324 µS/cm is in the range measured in Comstock Creek.
  - Unfiltered As, Cr, Hg, Pb, Se and Ag concentrations are less than the PQLs in the groundwater and Comstock Creek.
  - Unfiltered Al, Cd, Cu, Mn, Ni and Zn concentrations are lower in the groundwater than Comstock Creek.
  - The concentration of unfiltered Fe is higher in the groundwater than in Comstock Creek.

4.2 Recommendations

The following is recommended:

- Determine discharge for each of the water bodies, including development of flow-duration curves. This will allow the relative contribution of potential contaminants to the Little Henty River from Hemp Creek and Comstock Creek to be determined.
- Expand the existing database by ongoing sampling including the concentrations of potential contaminants during high flow conditions in each of the water bodies.

5. References

APHA. 1992. Standard Methods for the Examination of Water and Wastewater. 18th edition. American Public Health Association/American Water Works Association/Water Environment Federation. Washington.

ANZECC/ARMCANZ. 2000. Australia and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council/Agricultural and Resource Management Council of Australian and New Zealand.

DPIWE. 2000. Environmental Management Goals for Tasmanian Surface Waters. West Coast Municipal Area (Excluding the Gordon and Pieman River Catchments). Department of Primary Industries, Water and Environment. Tasmania. December.

Koehnken, L. 2001. Basslink Integrated Impact Assessment Statement, Potential Effects of Changes to Hydro Power Generation, Appendix 3: Gordon River Water Quality Assessment. Report prepared by Technical Advice on Water for Hydro Tasmania.

NSR. 2000. Avebury Nickel Project, Scoping Study – Environment. Report prepared by NSR Environmental Consultants Pty Ltd for Allegiance Mining NL. CR 938_1_v2. December.

Attachment A

Laboratory Reports

Please contact Luci David at NSR on 03-9882 3555 for a copy of laboratory reports.

Attachment B

Notes on Water Quality Guidelines

Notes on water quality guidelines (ANZECC/ARMCANZ, 2000):

† For pH>6.5, insufficient data to derive trigger value for pH<6.5.

†† For As (V), 24 µg/L for As (III).

H Chemicals for which algorithms have been provided in Table B1 to account for the effects of hardness. The values have been calculated using a hardness of 30 mg/L $CaCO_3$. These should be adjusted to the site-specific hardness.

‡ For Cr (VI), insufficient data to derive trigger value for Cr (III).

B Chemicals for which possible bioaccumulation and secondary poisoning effects should be considered.

C Figure may not protect key test species from chronic toxicity (this refers to experimental chronic figures or geometric mean for species).

‡‡ For Se (total).

ID Insufficient data to derive a reliable trigger value.

Table B1 Trigger values for slightly - moderately disturbed ecosystems

Hardness (mg $CaCO_3$/L)	Cd	Cr(VI)	Cu	Pb	Ni	Zn
	Hardness modified trigger value (µg/L)					
30	0.2	1.0	1.4	3.4	11.0	8.0
50	0.3	1.5	2.2	6.5	17.0	12.3
100	0.6	2.7	3.9	15.7	30.6	22.3
200	1.1	4.7	7.0	37.8	55.2	40.1

Attachment C

Field Sampling Quality Assurance Program Results

Table C1 Sampling quality assurance program results

Method	Analyte		Blank	Field duplicates (Little Henty, 15/1/2003 13:00:00)		
		Lab.No.:	40490	40164	40165	*P(%)*
1001-Water	pH		-	6.9	7.1	*2.9*
1002-Water	Conductivity	µS/cm	-	130	133	*2.3*
1009-Water	Turbidity	NTU	-	1.8	2.2	*20.0*
1011-Water	TSS	mg/L	-	6	6	*0.0*
1205-Water	Ammonia	mg-N/L	-	0.004	0.003	*28.6*
	Nitrate	mg-N/L	-	0.002	<0.002	*0.0*
	Nitrite	mg-N/L	-	<0.002	<0.002	*0.0*
	Phosphorus, Dissolved	mg-P/L	-	0.002	<0.002	*0.0*
1206-Water	Nitrogen, Total	mg-N/L	-	0.196	0.165	*17.2*
	Phosphorus, Total	mg-P/L	-	<0.005	<0.005	*0.0*
1401-Water	Oil & Grease	mg/L	-	<1	<1	*0.0*
1302-Water	Ca Dissolved	mg/L	-	7.94	7.88	*0.8*
	K Dissolved	mg/L	-	0.65	0.63	*3.1*
	Mg Dissolved	mg/L	-	3.62	3.63	*0.3*
	Na Dissolved	mg/L	-	11.2	11	*1.8*
1101-Water	Alkalinity Total	mg $CaCO_3$/L	-	20	20	*0.0*
1103-Water	Chloride	mg/L	-	21	21	*0.0*
	Sulphate	mg/L	-	7.4	7.1	*4.1*
1301-Water	Al Dissolved	µg/L	27	100	103	*3.0*
	Al Total	µg/L	25	144	152	*5.4*
	As Dissolved	µg/L	<5	<5	<5	*0.0*
	As Total	µg/L	<5	<5	<5	*0.0*
	Cd Dissolved	µg/L	<1	<1	<1	*0.0*
	Cd Total	µg/L	<1	<1	<1	*0.0*
	Cr Dissolved	µg/L	<1	<1	<1	*0.0*
	Cr Total	µg/L	<1	<1	<1	*0.0*
	Cu Dissolved	µg/L	1	3	3	*0.0*
	Cu Total	µg/L	1	3	3	*0.0*
	Fe Dissolved	µg/L	<20	507	544	*7.0*
	Fe Total	µg/L	<20	668	688	*2.9*
	Mn Dissolved	µg/L	<5	-	-	-
	Mn Total	µg/L	<5	-	-	-
	Ni Dissolved	µg/L	<1	3	2	*40.0*
	Ni Total	µg/L	<1	3	3	*0.0*
	Pb Dissolved	µg/L	<5	<5	6	*18.2*
	Pb Total	µg/L	<5	9	9	*0.0*
	Zn Dissolved	µg/L	4	148	147	*0.7*
	Zn Total	µg/L	4	181	182	*0.6*
1301a-Water	Ag Dissolved	µg/L	<1	<1	<1	*0.0*
	Ag Total	µg/L	<1	<1	<1	*0.0*
1305-Water	Hg Dissolved	µg/L	<0.05	<0.05	<0.05	*0.0*
	Hg Total	µg/L	<0.05	<0.05	<0.05	*0.0*
1307-Water	Se Dissolved	µg/L	<1	<1	<1	*0.0*
	Se Total	µg/L	<1	<1	<1	*0.0*

Appendix 5

Socio-economic Study Stage 1

Allegiance Mining NL

Avebury Nickel Project

Socio-economic Study Stage 1

May 2003

CR 938_3_v1

Allegiance Mining NL

Avebury Nickel Project

Socio-economic Study Stage 1

May 2003
938_3_v2

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1. Introduction

Allegiance Mining NL (Allegiance) intends to commence the Stage 1 development of the Avebury Nickel Project, near Zeehan, northwest Tasmania (Figure 1).

The estimated Avebury resource is 4,000,000 t at 1.5% Ni (about 60,000 t Ni). Allegiance proposes to develop the project in three stages. The success of Stage 1 development will determine whether Allegiance will proceed to Stages 2 and 3.

Stage 1 of the Avebury Nickel Project involves the development of a decline into the deposit where high grades (>2% Ni) are indicated. The decline will be about 1,000 m in length, 5 m wide and 5 m high. Approximately 75,000 t of waste rock will be excavated during development of the decline. The decline will allow Allegiance to conduct detailed resource and reserve definition drilling, in-situ examination of the mineralisation, bulk sampling of the mineralisation for metallurgical test work, and geotechnical studies to optimise the mine design.

Accompanying the first leg of the decline development will be the establishment of on-site and ancillary facilities including electricity, water tanks, workshop, office, ablutions, magazine, crib-room and diesel storage areas. This will occupy an area of about 12 ha. The second leg of the decline development will involve drilling a services hole down to the decline for air, water and power.

A 1.5-km access road will be constructed that runs south from Trial Harbour Road to the on-site facilities and then further south to join the access track to the portal. Disturbance associated with access road construction will total approximately 10 ha. Waste rock from the decline construction will be used in road construction (development waste will be geochemically characterised to confirm that this material is suitable for use as road base).

Two cross-cuts will be constructed at the bottom of the decline which will allow the extraction of approximately 150 t of mineralisation that will be transported off-site for metallurgical assessment. Removal of this material will involve about five trips by 10 yard (20 t) trucks along the Trial Harbour Road over a one week period at the end of the Stage 1 development.

Based on the geological and geotechnical studies and metallurgical testwork resulting from Stage 1, a decision to go to full-scale production would see the project enter Stage 2 of development. This involves extraction of ore from the underground mine and trucking the resource to an existing off-site mill for processing. To mitigate against potential road and traffic issues, rail transport will also be considered during this stage. The initial mining rate in Stage 2 (commencing 2004) is estimated as 300,000 tonnes per annum (tpa).

NSR Environmental Consultants Pty Ltd	Job No: 938	Allegiance Mining NL	Avebury Nickel Project location	Figure No: 1
	File No: 938_3_F001_HB	Avebury Nickel Project		

Stage 3 would see an increase in mining activity, resulting in the extraction of about 500,000 tpa of rock. Stage 3 would involve constructing an on-site mill, together with a tailing storage facility, thereby eliminating the need to transport ore off-site for processing. Construction for Stage 3 would commence in 2006 and will be scheduled so as to ensure continuity of production. On-site processing of ore is envisaged to continue for a minimum of six years beyond 2006.

1.1 Objectives

The objectives of this study are to:

- Describe the existing social context of the community of Zeehan and surrounding west coast region of Tasmania.
- Assess implications of Stage 1 mining activity for the local community.

1.2 Scope

The scope of the project is to:

- Characterise the existing population and identify relevant historical and current influences.
- Identify existing accommodation resources and community infrastructure and services, and quantify spare capacity.
- Identify the existing education and skill levels, employment and income levels of potentially affected populations.
- Identify local economies and standards of living of potentially affected populations.
- Determine potentially affected peoples' expectations for employment, training, business development, infrastructure and services both with and without the project.
- Recommend practical and achievable measures to enhance the positive and minimise the negative socio-economic effects of the project.

This study focuses on the township of Zeehan and surrounding west coast region of Tasmania.

1.3 Method

Information for this report was gathered from a variety of sources.

The West Coast Planning Scheme report and NSR (1997) provided most of the background information on the township of Zeehan.

Information about tourism and community attitudes towards the proposed mine was obtained through discussions with the local Council and personnel from the West Coast Heritage Authority.

Demographic information for Zeehan was obtained from the Australian Bureau of Statistics.

2. Social Context

2.1 Location

The Avebury Nickel Project is located 6 km west of the town of Zeehan, on Tasmania's west coast (Figure 1), within the West Coast Council municipality. Trial Harbour Road runs north of the proposed mining site, while the site is bounded by Kynance and Comstock creeks to the east and the Little Henty River to the south.

Other major towns located near Zeehan include Queenstown, Strahan and Rosebery. A major road network connects Zeehan to the above towns and the TasRail railway operates between Melba Flats (near Zeehan) and Burnie. The Abt Railway has reopened for tourism and connects Queenstown to Strahan.

2.2 Historic Influences[1]

The discovery of Huon Pine and coal reserves on the west coast of Tasmania in 1818 sparked the first wave of European inhabitants to this area.

A penal settlement, Sarah Island, was established for convicts so that their labour could be used to harvest Huon Pine. In 1834, the penal settlement was closed and the logging industry came to a halt. The high level of the exploitation of Huon Pine was not to be matched again.

The settlement was re-opened in 1846, when 200 convicts were sent to cut more pine. However, after one year, the settlement was finally abandoned. Over the next 30 years, several work parties of pioneers harvested Huon Pine along the Gordon River banks, and the King River.

In response to the mining boom in the 1880s the demand for timber in the region substantially increased. Access tracks were improved and pioneers could gain access to timber in areas that were previously too difficult to access. As it became more difficult to find suitable stands of timber, the industry gradually declined. Today, only a few remnant stands remain and cutting is strictly controlled.

The west coast mining industry played a significant role in the history and political economy of Tasmania, comprising of up to one third of the state's wealth. It continues to be the most important activity on the West Coast.

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[1] All historic information was sourced from WCC (2001a).

In the 1880s gold was discovered in the King River near where Queenstown is located today. This led to the discovery of Mt Lyell copper deposits and the establishment of the Mt Lyell Mining Company, which is still in operation.

The high rainfall, poor drainage and rugged terrain motivated the mining entrepreneurs to develop permanent railway lines. This became the main transport infrastructure for more than 80 years.

Many settlements were established in response to the mining boom, many of which no longer exist. Some of the major settlements that survived include Zeehan, Rosebery, Queenstown and Strahan.

The first mining operations in Zeehan occurred in 1884 and exploited silver, lead and zinc (Plate 1). By 1908, Zeehan was a bustling mining town with a population of 7000, making it the third largest town in the state. It had 27 hotels, a concert hall and theatre capable of holding 1,000 people, hospitals, churches, public buildings and established the School of Mines that is now a first class mining museum.

A lead smelter, which at one stage was the largest in Australia, was established at Zeehan and operated on and off until the 1920s. By 1910, the rich surface deposits of silver-lead ore were depleted and the population of Zeehan and economic activity declined steadily.

2.3 Current Influences

The township of Zeehan is still heavily reliant on the mining industry for its survival. There are three main mines in the area, namely the Henty Gold Mine, Mt Lyell Copper Mine and Renison Tin Mine. Since the initial development of these mines, improvements in technology, transport infrastructure, and changes to working arrangements, have reduced the demand for labour to operate these operations (WCC 2001a).

New industries based around tourism and recreation (four wheel driving, fishing, and walking) have developed the need for additional services. Structures, artefacts and buildings associated with the cultural heritage of the region also attract people to Zeehan (WCC 2001a).

Zeehan is also the administrative centre for the West Coast. It houses the Council administration and a number of Government agencies.

2.4 Population Characteristics

The population of Zeehan has significantly declined over the past 15 years (Table 1). This is consistent with the rest of the west coast region of Tasmania. Over this period, the region was severely affected by the impacts of the recession in the late 1980s, due to its narrow economic base and limited opportunity to develop alternatives.

Plate 1
Historic mining shafts in Zeehan

Plate 2
West Coast Pioneers' Memorial Museum

Plate 3
Campervans and trailers, touring the west coast, passing through Zeehan

Table 1 Population of Zeehan 1986 to 2001

Year	Population	Change No.	% Change over time
1986	1,610		
1991	1,132	-478	-29.7%
1996	1,116	-16	-1.4%
2001	892	-224	-20.1%

Source: WCC (2001a), ABS (2001).

From 1986 to 1991, the population declined by 29.7%. The population remained relatively stable between 1991 and 1996 then declined by 20.1% from 1996 to 2001 (WCC (2001a), ABS (2001)).

Specifically, the factors that have contributed to the population decline include:

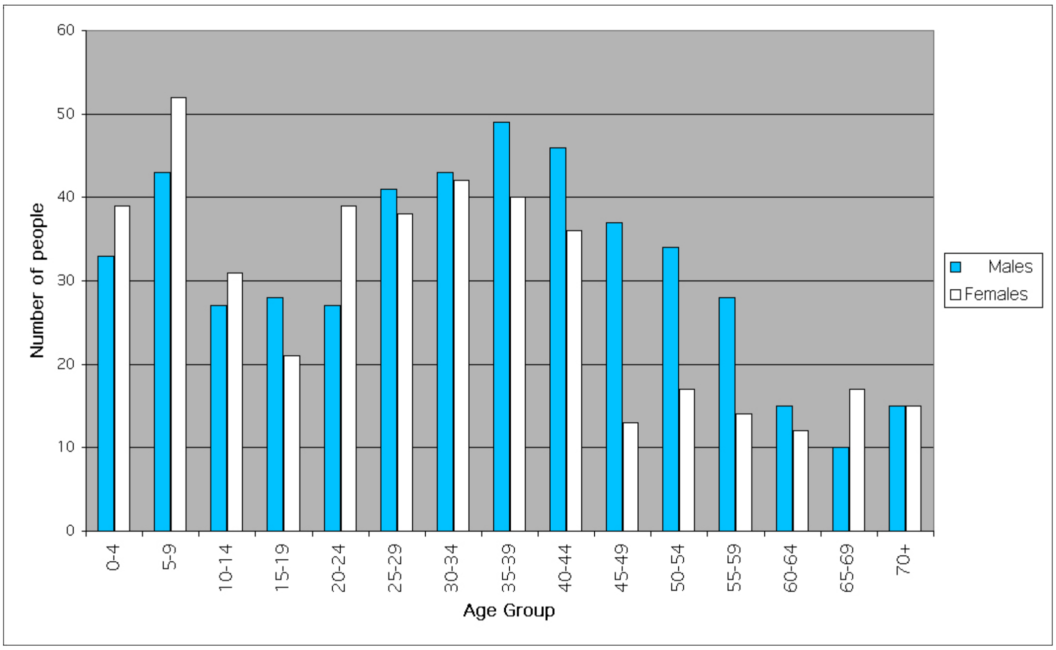
- Rationalisation and scaling down of mining operations, which has directly and indirectly reduced employment opportunities.
- Improvements in transport infrastructure. This has made it easier for people employed in the mining sector to live and commute from outside the region.
- Improved accessibility to many goods and services outside the region, due to changes in transport infrastructure, which has driven business away from the local community. West coast residents are able to travel to Burnie or Launceston for regular shopping trips and to access health, education and financial services.
- Construction workforces leaving the area after completion of the west coast hydro schemes in the early 1990s.
- Rationalisation of public services including a reduction in size and relocation. This has led to a drop in employment opportunities and loss of population (WCC 2001a).

If mining declines in the area, with few alternative employment options (Section 2.6), it is possible that many people will leave the west coast for the larger centres of Burnie and Launceston.

Figure 2 shows that a high proportion of the population is aged between 0-9 years and 30-40 years of age. This illustrates a predominantly family orientated population with a high number of dependents. The small number of elderly people in the population may indicate that people do not tend to retire to the area.

The gender ratio of the population favours males; 53% males versus 47% females.

Figure 2 Age and Sex of Zeehan Population 2001



Source: ABS (2001).

Trial Harbour is a small coastal settlement located approximately 5 km west of the project area. Trial Harbour has a small permanent population, of approximately 40, but during peak holiday seasons, the population increases up to 200 people (Wardlaw pers. com. 2003). The median age of the permanent population was estimated at 50 years in the 1996 population census for the Granville Harbour and Trial Harbour Collection District (Hydro Tasmania, 2003). This suggests that the permanent population mostly comprises retirees.

2.5 Ethnicity

The population of Zeehan is predominantly Anglo-Saxon. The 2001 census shows that 91% were Australian-born. A small percentage of the population (4%) were of Aboriginal decent and less than 1% were of Torres Strait Island descent (ABS, 2001).

The majority of people are affiliated with some kind of Christian religion (64%), most following either the Anglican or Catholic Church (ABS, 2001).

2.6 Employment

According to 2001 census data, 397 people were employed in Zeehan, representing 87.8% of the labour force[1]. This is similar to Tasmania in which 89.9% of the labour force was employed. Subsequently, Zeehan has a slightly

[1] Labour force is defined, for the population aged >15 years, as those currently employed (full- and part-time) plus those unemployed and looking for work.

higher unemployment rate than Tasmania with 12.2% of people looking for work compared with 10.1% for Tasmania (ABS, 2001, 2001a).

At present, unemployment figures are more volatile than before the recession in the late 1980s, due to the higher proportion of the workforce now being employed on a casual or contract basis. In 1981, 4% of Zeehan's population was unemployed. This increased to 15% by 1991, which coincided with the decline in the mining industry from 1986 to 1991 (NSR, 1997).

Employment distribution in Zeehan underlines the importance of the mining industry to the local economy, with 45% (163) of the workforce directly employed in the mining sector (Figure 3). The hospitality industry (i.e., accommodation, cafes and restaurants) is the second largest employer comprising of 11% (38) of Zeehan's workforce. This is followed by the construction industry (8% (28)).

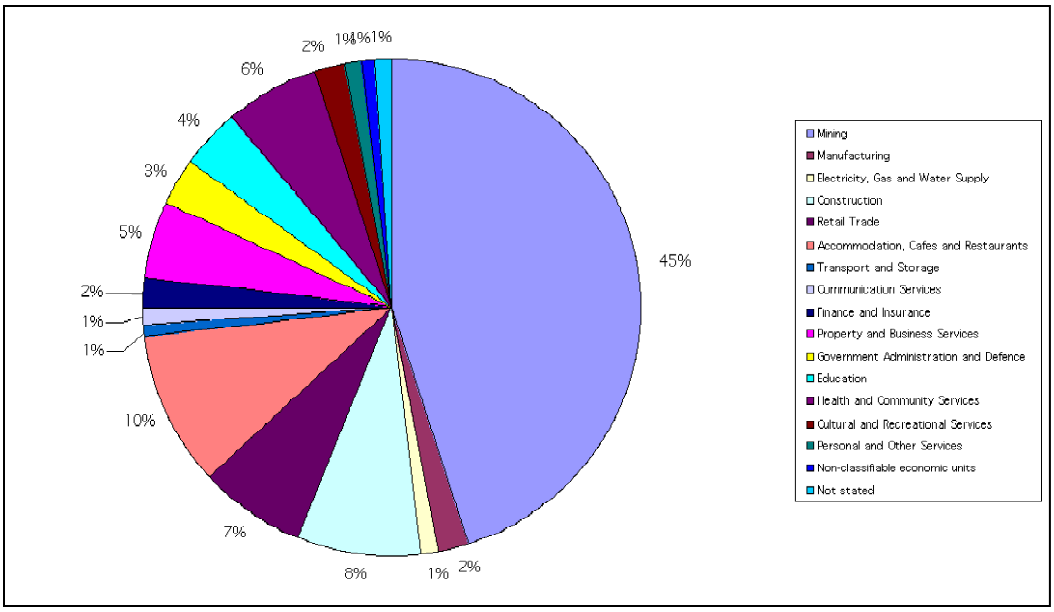
Typically, men in Zeehan are employed at the mines, primarily the Renison Mine. Some are employed at the Henty Mine, and fewer still at Mt Lyell. Women are engaged in services supporting the tourism industry (Beamsley pers. com. 2003).

The construction of the Heemskirk Wind Farm will provide further employment opportunity for local people. It is estimated that 150 people will be required for its construction which will take 6 to 12 months, starting as early as 2003 pending approval, final feasibility and design. More than 50% of personnel will be sourced from existing residents of the west coast area. Once in operation, a small maintenance crew will be required to service the wind farm over its 20 to 25 year lifetime. On-going road maintenance will employ local workers (Hydro Tasmania, 2003).

2.7 Education

In 2001, the Zeehan population was largely unqualified, with only 30% of people (over 15 years of age) having obtained a qualification beyond secondary schooling and 61% having no qualification (Table 2).

Figure 3 Distribution of employment at Zeehan 2001



Source: ABS (2001)

Table 2 Highest qualification level 2001 (15 years of age or more)

Qualification	**Males**	**Females**	**Total %**
Postgraduate Degree	6	0	0.9
Graduate Diploma and Graduate Certificate	3	3	0.9
Bachelor Degree	20	14	5.1
Advanced Diploma and Diploma	18	11	4.3
Certificate	92	34	18.9
Not stated	35	26	9.1
Not applicable	193	213	60.8
Total	**367**	**301**	**100**

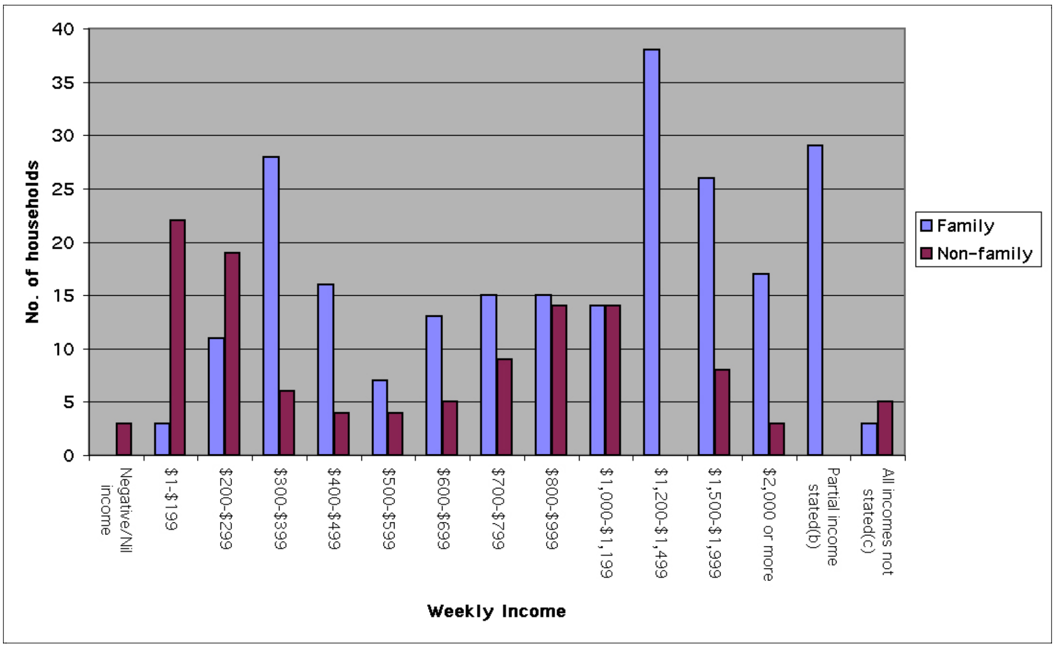
2.8 Income

The average weekly income per household in Zeehan varies depending on whether it is a family[1] or non-family household. The 2001 census revealed that family households, on average, have a higher weekly income than non-family households. The most common income for family households was $1,200 to $1,499 per week (ie. $62,400 to $77,948 per annum) compared with $1 to $199

[1] Family is defined by the ABS as a two or more persons, one of whom is at least 15 years of age, who are related by blood, marriage (registered or defacto), adoption, step or foster, and who are usually resident in the same household.

(ie. %52 to $10,348 per annum) for a non-family household (Figure 4) (ABS, 2001).

Figure 4 Weekly Household Income by Household Type in Zeehan 2001



Source: ABS (2001)

2.9 Accommodation

According to 2001 census data, there were 487 private dwellings in the township of Zeehan, 76% of which are separate houses. A total of 378 (78%) dwellings were occupied and 109 (22%) unoccupied. Of those private dwellings that were occupied, 47% were fully owned, 12% were being purchased and 31% were rented. The remaining 10% were under another tenure scheme such as rent-free or life tenure schemes (ABS, 2001).

Zeehan also has a range of temporary accommodation including Bed & Breakfasts, the Heemskirk Motor Inn (including budget accommodation that was formerly single mens quarters), the local caravan park, the Cecil Hotel and the Guest House.

Approximately 20 km west of Zeehan, the coastal settlement of Trial Harbour offers little in the way of accommodation. Housing is in high demand, as it is a popular place for holiday goers and weekenders. The shack is the most common form of dwelling. These used to be quite basic in terms of facilities but there appears to be a trend towards renovating them. There is also a designated area for camping managed by the Tasmanian Parks and Wildlife Service (Wardlaw pers. com. 2003).

2.10 Tourism

The town of Zeehan has approximately 90,000 to 100,000 visitors each year. One of the most popular attractions is the Pioneers' Memorial Museum (Plate 2) bringing in 25,000 visitors annually (Halton pers. com. 2003).

The tourist season runs from September through to April, with peak numbers occurring between January and March. Over the four month period from September 2002 to the end of December 2002, tourist numbers increased by 23% from 2001. This is thought to reflect the establishment of a daily ferry from Melbourne to Tasmania (Halton pers. com. 2003).

Tourists who visit Zeehan usually come from Melbourne on the ferries, and travel to Cradle Mountain, Strahan and Queenstown to visit the Gordon River and the newly re-opened Abt Wilderness Railway. The Gordon River Cruise is a major drawcard and 73% of all visitors to the west coast go on the cruise (WCC 2001a). According to a survey conducted by John Halton, Manager of the West Coast Heritage Authority, 23% of visitors to Zeehan go on Gordon River Cruises. Tourists who visit Zeehan normally complete a circuit around Tasmania taking in southern, eastern and the northern parts of the state (Plate 3) (Halton pers. com. 2003).

Tourists also visit Zeehan to pursue activities such as fishing, walking, and four wheel driving and stay in Zeehan when Strahan is fully booked (Beamsley pers. com. 2003).

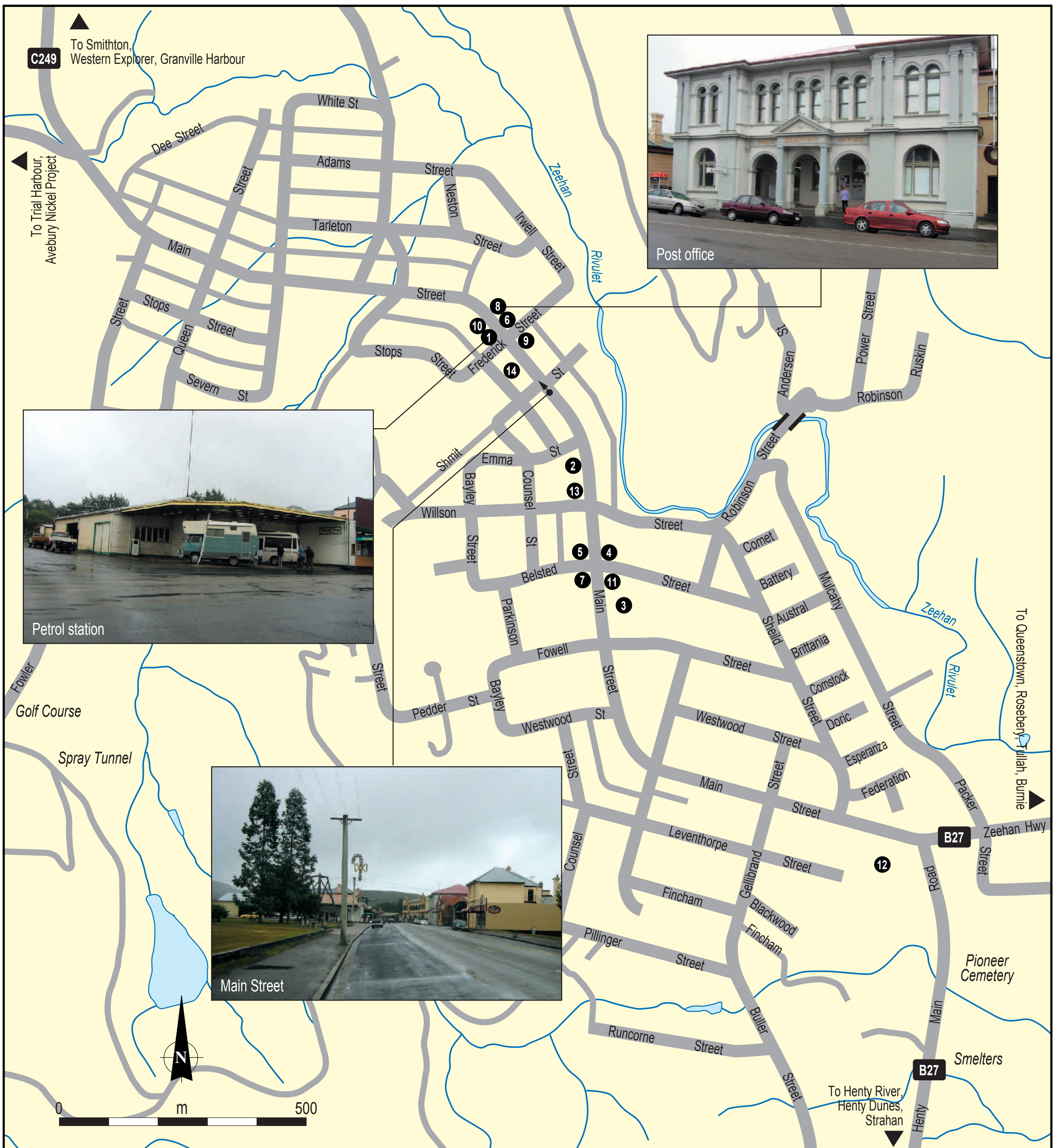
With its operational port, Trial Harbour is also a popular place for fishing. Trial Harbour attracts a substantial number of weekender and holiday visitors.

2.11 Community Facilities and Services

Zeehan is relatively self-sufficient in terms of day-to-day services and facilities. However, due to improved transport infrastructure, west coast residents tend to travel to Burnie or Launceston for regular shopping trips and to access health, education and financial services. Zeehan is the main administrative centre for the west coast. The town layout is illustrated in Figure 5 (WCC 2001a).

In January 2003[1], the following community services and facilities were recorded (Table 3).

[1] NSR reconnaissance trip.



Key

1 - Petrol station
2 - West Coast Council
3 - Primary school
4 - Police station
5 - Fire station
6 - West Coast Pioneers' Memorial Museum
7 - Medical centre
8 - Post office
9 - ANZ Bank
10 - Silver City Info/Tour
11 - Library
12 - Heemskirk Motor Hotel
13 - Cecil Hotel
14 - Howard Park

NSR Environmental Consultants Pty Ltd	Job No: 938 / File No: 938_3_F005_HB	Allegiance Mining NL / Avebury Nickel Project	Town layout of Zeehan	Figure No: 5

Table 3 Community Facilities and Services in Zeehan

Service/Facility type	**Facility/Service available in Zeehan**
Health	• Zeehan Nursing Service • Zeehan Medical Centre (General Practitioner provided) • Zeehan Neighbourhood Centre Incorporated
Childcare and Education	• Library • Zeehan Child Care Centre • Primary School
Shops and Commercial Services	• 2 Small supermarkets • 1 Newsagency • 2 Milkbars/takeaway shops • 2 Coffee shops • 1 Chemist • 2 hotels • ANZ Bank • 1 Craft Shop (run by volunteers) • 1 Secondhand shop
Local Police and Emergency Services	• Police station • Fire station
Local Industrial Services	• Airfield • Drillers • Welding • 2 Petrol stations
Recreational Facilities	• Swimming pool • Squash courts • Tennis courts • Sports oval • Golf course
Cultural/Entertainment Facilities	• Catholic church • St Luke Church • Lion club • RSL
Waste Disposal Facilities	• West Coast Council

Services provided in Burnie, Rosebery, and Queenstown are listed in Table 4. Trial Harbour does not have any commercial services or facilities. It has a recreational oval with a shed maintained by the Trial Harbour Progress Association. The community and the local fire fighters use the shed for meetings. There is also a history room that is run voluntarily by two of the permanent residents.

Table 4 Community Facilities and Services available outside of Zeehan

Service/Facility	Location service/facility available
High School	Rosebery, Queenstown
Shops and services not in Zeehan	Queenstown, Burnie
Specialist medical services such as Dentist, Optometrist	Queenstown, Burnie
Hospitals	Rosebery, Queenstown

Source: Keating (2003)

2.12 Urban Infrastructure

2.12.1 Electricity

The town of Zeehan is connected to the State electricity grid. Electricity generation in Tasmania is predominantly hydro-electric with back up provided by the oil- and gas-fired Bell Bay power station and the Basslink cable, that will connect the mainland grid to the George Town substation, when construction is completed in 2006.

The coastal settlement of Trial Harbour is not connected to the State electricity grid. Electricity is supplied through diesel-powered generators and wind energy (Wardlaw pers. com. 2003).

2.12.2 Water and Sewerage

Zeehan has a sewerage and water scheme that has a capacity to support up to 2,000 people. The sewage plant is located at the southern end of Zeehan and the water supply is sourced from Lake Fisher in Zeehan (Keating pers. com. 2003).

Trial Harbour has a rudimentary water supply and sullage system run by the Trial Harbour Progress Association. These services are only equipped to accommodate the current population (i.e., 40 people in Granville Harbour and Trial Harbour Collection District, 1996 census (Hydro Tasmania, 2003)) and do not have the capacity for expansion (Wardlaw pers. com. 2003).

2.12.3 Transport Network

Since the 1960s, there has been substantial investment in the local road network providing direct connections between Smithton, Devonport, Burnie, Launceston and Hobart and the west coast. The Murchison Highway and Trial Harbour Road will be the main routes used in Stage 1 of the development (WCC 2001a). The existing road between Trial Harbour and Zeehan is gravel (Wardlaw pers. com. 2003).

There are two railways on the west coast, the TasRail railway line connecting Melba Flats and Burnie and the Abt Wilderness railway line, which is a tourist railway that runs between Queenstown and Strahan. The TasRail railway line provides a connection for mines and processing works to the Port of Burnie.

There are three ports in operation on the west coast; Strahan, Trial Harbour and Granville Harbour. The latter two are limited to servicing the fishing industry. The Port of Strahan services the fishing and tourism industry.

There are licensed airfields in Zeehan, Strahan and Queenstown. None of these provide regular connections and they are used mostly for private and charter aircraft. The State Emergency Services occasionally use them for medical and fire fighting purposes. Parks and Wildlife Service and Forestry Tasmania and mineral exploration companies also use the airfields (WCC 2001a).

2.12.4 Telecommunication

Telephone and facsimile services are available in Zeehan and surrounding areas via the Telstra network. GMS and CDMA provide the mobile phone network.

There is one public telephone booth in Trial Harbour. Some of the residents are connected to the Telstra network.

2.13 Interests and Concerns of the Community

Currently, Zeehan depends very heavily on the nearby Renison tin mine, and to a lesser extent on tourism. Renison provides an additional benefit from being a year-round operation, whereas tourism is most evident in the January to March period only (see Section 2.10).

The well being of Zeehan is therefore currently very vulnerable to the economic fortunes of the Renison operation. Proposed development at Avebury and the Heemskirk Wind Farm would broaden the commercial base supporting Zeehan and dramatically diminish the town's high vulnerability to global economic factors.

The Avebury Nickel Project enjoys wide community support in Zeehan which is also very supportive of the minerals industry in general. This support was also demonstrated during a planning meeting held at the West Coast Council Chamber in Zeehan, 9 January 2003, which a number of Councillors attended. The Mayor of the West Coast Shire, Darryl Gerrity, speaking on behalf of the Councillors, stated that the Council was very supportive of the project and would assist in any way to ensure the project proceeds. This support extends to a significant number of Zeehan residents who own shares in Allegiance.

Kelly Keating from the West Coast Council, stated that the Zeehan community would like to see an increase in employment opportunities for the locals to ensure the future development of the area. Over the past 20 years, locals have experienced what happens when services and businesses are forced to close down due to a declining population. Zeehan residents would like to see the town expand to maintain the current available services and provide opportunity for new services and businesses. The opening of a new mine would help to facilitate this (WCC, 2001a).

In a recent newsletter from the Tasmanian West Coast Business Development Inc., (December 2002), the mine was identified as one of the two major projects proposed for Zeehan; the other being the Heemskirk Wind Farm. It was stated that at its peak, the Avebury Nickel Project would create enormous spin off benefits, such as increased demand for local goods and services and more business opportunities in the area. One such business opportunity proposed by Tour Guide, Debbie Beamsley of Silver City Info/Tours, is to conduct tours of the mine.

A high level of broader support for the Avebury Nickel Project was conveyed in the recent ABC Stateline program (14 March 2003) which highlighted the fact that should development of the Avebury Nickel Project progress to Stage 2 production, it will be the first new major mine development in Tasmania in 15 years. The program went on to highlight the substantial economic and employment benefits of the development to the west coast area.

The community of Zeehan hopes that Zeehan can become the central point and tourist 'hub' for the west coast. Zeehan is centrally located to Rosebery, Queenstown and Strahan and with its mining history and recreation opportunities has the potential to serve this purpose.

3. The Project and Its Potential Impacts

3.1 Project Information

The Stage 1 development of the Avebury Nickel Project will employ 20 to 25 people (including contractors) for decline development, drilling and support services. These employees will be sourced locally from Zeehan. If the project proceeds to Stage 2, 40 people will be employed and by Stage 3, up to 100 people would be employed.

Project infrastructure requirements will be provided on site, no additional facilities, i.e., housing, community services and facilities, will be required in Zeehan to support the workforce. Employees will commute to the project site daily.

Stage 1 construction is expected to commence in September 2003 and will be completed within approximately six months.

3.2 Economic Impacts

The Avebury Nickel Project will have a beneficial impact on the current industrial and economic base of the west coast region. The project will stabilise the economic and employment base, making the host community of Zeehan more prosperous and more resilient, and will assist to arrest population decline. Mining will also provide an economic boost to the area in the form of wages and increased support for existing local industries.

Currently the median individual income in Zeehan is $300 to $399 per week (ABS, 2001). Assuming that this is the median income for 52 weeks of the year, the median individual income is $15,000 to $20,748 per annum. Therefore, the working population earns a total of approximately $10 to $14 million per annum. The Avebury Nickel Project will inject an additional $2.5 million in wages into the community during the nine months required for Stage 1 development.

The majority (90%) of the $7.5 million total cost estimate for the Stage 1 development will be spent in Tasmania, particularly the local community.

If the Stage 1 development is successful it will lead to stages 2 and 3 development which will bring additional economic benefits to Zeehan and Tasmania.

3.3 Impacts on Services, Facilities and Infrastructure

3.3.1 Services and Facilities

The Avebury Nickel Project will have minimal impact upon services and facilities in Zeehan given that the workforce will be sourced locally and there will be no new demand.

There will be a requirement for local businesses such as drilling companies and mine support services to support the project that will help to strengthen their commercial viability.

3.3.2 Education

The Stage 1 Avebury Nickel Development will coincide with Stage 1 of the Heemskirk Wind Farm. Although Allegiance's employment policy is to, in the first instance, source employees locally from the west coast region wherever the appropriate skills and support facilities are available, if there is a need for people to relocate to Zeehan to fill positions at either the Avebury Nickel Project or the Heemskirk Wind Farm, there will be an associated increase to the local population. This will include families with education requirements.

One hundred and sixteen students currently attend the Zeehan Primary School. Previously the school catered for up to 260 students. Therefore, the school currently has the capacity to increase enrolments at all levels from kindergarten to grade 6 if, and as, required (Meares pers. comm. 2003) [1].

3.3.3 Electricity

Electricity requirements for the project will be met by extending the current mains power line from the state electricity grid along Trial Harbour Road and down to the site where a transformer and temporary sub-station will be installed. This will not require an upgrade to the existing service to Zeehan.

3.3.4 Water

Water requirements for the project, both potable and initial underground needs, will be met by extraction from Kynance Creek. It will not be necessary to utilise Zeehan's water scheme.

3.3.5 Transport

Road upgrading and maintenance has been identified as one of the major issues affecting the local community. Because of climatic conditions on the west coast, costs for road maintenance are expensive. One of the problems facing the West Coast Council administration, particularly with the declining permanent

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[1] Funding for teachers is allocated based on the number of students enrolled.

population, is generating sufficient revenue to maintain the existing road network in a condition suitable for trucks and tourist vehicles.

The traffic generated by Stage 1 of the project will include employee vehicles, fuel and supply trucks (on a regular basis) and up to five (20 t) truckloads will transport ore between Zeehan and the off-site processing facility, within a one week period at the end of Stage 1.

At present, the Trial Harbour Road is not sealed and is used by vehicles similar, to those described above, to transport people and supplies (including building supplies) to Trial Harbour. Traffic on the Trial Harbour Road has increased significantly in the past one to two years primarily in relation to increased tourism and surveys and services provisions for the Heemskirk Wind Farm (Newnham pers. comm. 2003). The proposed use of the road is considered to be similar to the existing use of the road and therefore upgrading and maintenance will not be required. Project scheduling will result in Stage 1 coinciding with the drier months of the year.

The existing transport network will adequately cater for the required transport needs.

3.4 General Impacts

In the west coast region of Tasmania, the prospect of full-time employment is largely restricted to the mining industry, especially in towns such as Queenstown, Rosebery and Zeehan. The Avebury Nickel Project will provide new employment opportunities and strengthen the industry on which Zeehan and many of the surrounding communities in the region were developed. Other employment opportunities, toursim-based, exist in places such as Strahan, but these are seasonal or largely part-time (Heiler, 2002).

Despite the benefits of employment, it has been suggested that certain work practices in the mining industry have adversely impacted the social wellbeing of the community. For example, a recent survey conducted by Heiler (2002) investigated the impact of extended and intensive work schedules on the health and safety of employees and on family life in the Tasmanian mining industry. Results were interpreted as suggesting that extended working hours and rotating shift work (especially night shifts) adversely impacted on health and safety, and the family life, of the employee.

However, the Avebury Nickel Project is a development that the local community welcomes. Employees will already be members of the community, therefore assimilation will not be an issue. Zeehan is also promoting its tourism potential and hopes that it can become a central point for tourists visiting the region. Increased economic activity in the area will strengthen the commercial viability of existing shops and services which will, in turn, benefit tourists. There is also the potential for the project to become a tourist attraction itself, especially if it proceeds to stages 2 and 3.

4. References

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Newnham, L. Project Manager, Allegiance. Planning meeting with West Coast Council. 9 January 2003.

Wardlaw, A. Council Manager, West Coast Council. Telephone conversation. 24 February 2003.

Appendix 6

Desktop Review of
Aboriginal Cultural Heritage Resources –
Allegiance Avebury Nickel Project - Stage 1

Report on a desktop review of Aboriginal cultural heritage resources:- Allegiance Avebury Nickel Project - Stage 1, west of Zeehan, in Tasmania.

by Steve Stanton

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February 2003

A report prepared for NSR Environmental Consultants Pty Ltd, 124 Camberwell Road, Hawthorn East, Victoria.

ABORIGINAL SITE LOCATION INFORMATION CONTAINED IN THIS REPORT IS CONFIDENTIAL AND NOT FOR PUBLIC DISSEMINATION

Table of contents

Figure 1:

- the location and extent of the study area,
- & the preliminary layout for the development.

Introduction

This report outlines the results of a desktop review of Aboriginal cultural heritage values for Stage 1 of the proposed Allegiance Avebury Nickel Project which is located 6 km west of the town of Zeehan, in Tasmania. The desktop review and other investigations are being conducted for NSR Environmental Consultants Pty Ltd (NSR) during preparation of the development proposal and environmental management plan (DPEMP) for the project. The objective of the review is to identify any issues in relation to Aboriginal cultural heritage resources and to ensure their future management meets the requirements of both the Aboriginal community and statutory regulations.

Stage 1 of the project involves the development of an access road, a decline and sill which will be utilised to further analyse the nickel deposit, and the establishment of on-site facilities and ancillary facilities including a workshop, ablutions block, and office. Should the project proceed, Stage 2 would involve the extraction of ore and its transport to an existing facility for processing. Stage 3 involves increased ore extraction and the potential development of on-site processing and storage facilities. Figure 1 shows the study area location and a preliminary layout for the development.

The desktop review was undertaken for NSR by Aboriginal Heritage Consultant, Steve Stanton, in order to ensure:-

- that any previously recorded Aboriginal cultural heritage resources which are located within the study area or potential locations for such resources to occur, are identified, to ensure that their future management needs are considered during Stage 1 of the project;
- that the Aboriginal community's heritage interests are protected by ensuring that Aboriginal values (e.g. traditional plant or landscape values) are maintained and that any Aboriginal cultural heritage resources within the study area are afforded culturally appropriate future management;
- and that the views, and any concerns which might be held by the Aboriginal community in relation to this project, are covered in consultations with the Tasmanian Aboriginal Land Council (TALC) as representatives of the Aboriginal community.

The results of the desktop review indicate that no Aboriginal sites have previously been identified and recorded within the study area, however, sites may be present as the area has not been subjected to a formal survey and assessment. All Aboriginal sites have significance for the Aboriginal community and are protected by various legislation (see legislative framework on page 7). As such, a thorough survey and assessment of those areas to be impacted should be completed prior to any disturbance of the existing landscape in order to identify any sites which may be present. It is also recommended that Allegiance maintains flexibility in the overall project design until such time as any Aboriginal values have been identified.

Study area

The study area formed part of the territory of the North West Tribe whose tribal lands extended from Table Cape to Cape Grim, and down the west coast to Macquarie Harbour (Ryan 1996). The proposed mining site consists of State Forest and is accessed via Trial Harbour Road which runs north of the site. The site is also bounded by Kynance and Comstock Creeks to the east, Hemp Creek to the west, and the Little Henty River to the south.

Maps of the study area indicate that while there are steep, rugged sections formed by valleys, there are also gently inclined areas adjacent to various watercourses which are tributaries of the Little Henty River. It appears that the area contains level benches, plains, and also potential marshy areas in the vicinity of watercourses. These terrain factors increase the potential of the study area to be the location for Aboriginal sites. Further information regarding the study area is not available at this stage of the project and can only be obtained during a systematic field survey carried out prior to any ground disturbing works taking place, should the project be regarded as viable and likely to proceed.

Assessment methods

Following initial consultation with the TALC, the Tasmanian Aboriginal Site Index (TASI) at the Department of Tourism, Parks, Heritage and the Arts (DTPHA) was inspected in order to determine if any Aboriginal sites had previously been recorded within, or immediately adjacent to, the study area. The TASI also provides an insight into site distribution patterns for the broader region. This research assists in developing an understanding of both the potential density of sites, and the nature and extent of sites which may be present in the area. These aspects of the TASI research were the key objectives of this desktop study.

Individual site index cards were inspected for a broad area extending well beyond the margins of the study area. Information including the TASI number, site type, grid reference, the name of the site recorder and the year of recording, was noted. This information was then used to enable a more detailed inspection of individual site recording forms relevant to particular sites. These forms contain more detailed information e.g. the extent and composition of sites and are also used as a guide to both regional reports and reports on any smaller, localised, impact mitigation assessments.

Information gained during the research component of the study formed the basis for predictions regarding:

a. the potential for certain sites types to occur in the study area, and,

b. the likely site distribution pattern (when combined with landscape considerations).

Results of the TASI review

Inspection of the TASI revealed that there are no previously recorded sites within the study area. The surrounding country contains evidence of Aboriginal cultural heritage resources in the form of stone artefact surface scatters and shell middens that are concentrated near the coast, to the west of the study area. In order of proximity, the closest previously identified sites to the study area consist of the following:-

- Stone artefact scatters (TASI 7763 & 7764) which were identified by Stanton (1997) during a survey of the Trial Harbour area in relation to the establishment of treatment ponds for septic waste. These sites are over 5 km to the west of the proposed mining site.
- Five artefact scatters and seven shell middens recorded and registered (TASI Nos. not available at the time of research) during a TALC project in the Trial Harbour area, and all located over 5 km from the proposed mining site.
- An artefact scatter (TASI 198) and rock engravings (TASI 33) both of which lie close to the high water mark at Trial Harbour.
- An artefact scatter (TASI 2353) located near the Little Henty River, some 6 kms to the south west.
- An artefact scatter (TASI 4102) located approx. 10 km inland (east) of the study area

While no regional assessment has been undertaken for the west coast of Tasmania, the results of assessments in other areas of the State provide a useful guide to previous Aboriginal use of the area and the likely patterns of site distribution in various landscapes. Dunnett's (1994) northern region survey included a sample survey of inland areas of north west Tasmania. The terrain which occurs within the proposed mining site environs is similar to some of the landscapes investigated during Dunnett's assessment. The results of his assessment, therefore, provide a useful guide in terms of predicting both the type and extent of potential sites within the study area.

Dunnett found that while the density of artefacts and sites varied, they can be found anywhere in the region. He also found a higher incidence of sites and artefacts in the western portion of the northern region. These sites occurred at locations between the coast and elevations of 900m asl, and were often associated with the availability of raw materials for stone artefact manufacture, or other resources. The results of studies in other areas of Tasmania (e.g. Kee 1990) suggest that artefact scatters are likely to occur on floodplains, terraces and undulating flats associated with rivers and smaller watercourses. Drier and well drained locations are more likely to contain sites, particularly where they afford good access to fresh water.

Sites are also likely to be found where there is an interface between forest environments and marshes or wetland areas. This is particularly relevant should marshy areas occur within the Avebury study area.

There are also non-predictable Aboriginal site locations, such as sites located where local conditions have now changed e.g. where vegetation types or treelines may have been different during previous climatic regimes, or prior to European modification of the landscape. Earlier landscapes, prior to climatic or human changes, may have been suitable for occupation by Aboriginal people or used for extraction of resources e.g. plant foods or stone for artefact manufacture.

Based upon TASI research it appears that there have been no previous localised impact mitigation studies carried out in the vicinity of the study area.

In summary, while prior studies have not defined site distribution patterns for the west coast region (which incorporates the study area), the results of studies in other regions of Tasmania suggest that there is potential for sites to be present within the study area. The terrain of the study area appears to contain landforms which studies in other regions have shown are suitable for Aboriginal occupation or resource extraction (e.g. benches adjacent to watercourses, plains and marshy areas). As such, a systematic survey of the entire study area is regarded as essential in order to identify any sites which are likely to be present, based upon predictive models for other areas of the State which contain similar terrain types.

There is also the possibility that sites are present based upon the premise that they may occur at random locations throughout the entire Tasmanian landscape. While past regional studies may act as a useful guide, a recent assessment by TALC has shown that sites may also occur in non-predictive locations. Using predictive models, TALC surveyed certain areas in north eastern Tasmania which were regarded as having “low site potential” based upon such models, and found a number of significant sites.

Aboriginal community consultation

There is a recognised need to inform and consult with the Tasmanian Aboriginal community on all matters concerning Aboriginal cultural heritage. The TALC, as Aboriginal community representatives, have established protocols and policies with various state government agencies, private developers, local governments and other parties, to ensure that the Aboriginal community's cultural heritage interests are maintained and protected. These mechanisms also assist in ensuring that matters pertaining to Aboriginal cultural heritage are dealt with in an expedient manner, and that developments conform to legislation such as the *Aboriginal Relics Act* 1975.

The results of this desktop study were discussed with the Project Section of TALC in order to provide a mechanism for the inclusion of any Aboriginal community concerns or directions regarding the project. This process provides an opportunity for securing Aboriginal community input into the future management of any Aboriginal cultural resources, should they be identified in the study area. The recommendations contained in this report were developed in conjunction with the TALC based on these discussions.

All land has extremely high cultural significance for individual Aboriginal people and for the Aboriginal community collectively. The completion of this desktop study is regarded by the TALC as a preliminary stage of the project assessment. TALC regard as imperative the need for a thorough investigation of the area (refer to Recommendation no. 1.) to be completed prior to the commencement of any works which will disturb the existing landscape of the study area. Until such time as potential Aboriginal sites and landscape values (e.g. traditional plants) in the study area have been identified, culturally appropriate management recommendations for such resources cannot be developed.

The project proponents will attempt to mitigate any impacts to Aboriginal sites or landscape values which may be present within the study area. It should be noted, however, that all land has significance when considered in an Aboriginal cultural context. As such, any development upon, or other disturbance of land, is contrary to principal Aboriginal beliefs regarding the land, its values, and its inherent cultural significance, both to individual Aboriginal people and the Aboriginal community collectively

As per established protocols, copies of this report have been delivered to the Project Section of the TALC, and to the Manager of the Aboriginal Heritage Section at DTPHA in Hobart.

Legislative framework

Aboriginal sites are afforded legal protection under various State and Federal statutes - the key elements of pertinent legislation are summarised below. The summary is intended as a guide only and should be confirmed with the administering agency (DTPHA) and, where necessary, specialist legal opinion. In terms of this assessment, the main legislation relating to Aboriginal cultural heritage values in Tasmania is the *Aboriginal Relics Act* 1975. This Act is the primary legislation which governs the treatment of Aboriginal cultural heritage (any place, site or object made or created by, or bearing the signs of the activities of, the original inhabitants of Australia or descendants of such inhabitants in or before 1876) in Tasmania.

The Act is administered by DTPHA and its main provisions are:

- all relics are protected under the Act and it is illegal to 'destroy, damage, deface, conceal, or otherwise interfere with a relic' without a permit;
- it is illegal to 'cause an excavation to be made or any other work to be carried out on Crown land for the purpose of searching for a relic' without a permit;
- it is illegal to 'sell or offer for sale a relic', or 'to cause or permit a relic to be taken out of Tasmania without a permit';
- persons who own or who have knowledge of a relic shall inform the Parks and Wildlife Service of this, and provide information about the location of the relic(s);
- and the ability to declare sites and objects as 'protected' sites or objects which are required to be managed by the Parks and Wildlife Service.

Although the *Aboriginal Relics Act* 1975 is managed by DTPHA, for matters relating to Aboriginal cultural heritage, the protocol is to liaise primarily with the Tasmanian Aboriginal community through TALC. Through DTPHA policy, TALC acts as the primary adviser in relation to the *Aboriginal Relics Act* 1975, endorses Aboriginal cultural heritage research and reports, and approves access to the TASI database managed by DTPHA.

The development of culturally appropriate management structures for Aboriginal heritage values is dependant upon the undertaking of a thorough assessment of the entire study area. This process enables management issues to be considered which may in turn assist the proponents, both in complying with legislative constraints and avoiding delays which may arise if Aboriginal values are not considered during the planning and feasibility phases of the project.

Recommendations

The following recommendations are based upon directions received from the Aboriginal community, through TALC, and accord with Section 14 (1) of the *Aboriginal Relics Act* 1975;

- Except as otherwise provided in this Act, no person shall, otherwise than in accordance with the terms of a permit granted by the Minister on the recommendation of the Director - (a) destroy, damage, deface, conceal, or otherwise interfere with a relic.

Accordingly, it is recommended that:

1 . The project proponents should commission a systematic survey and assessment of the study area (also taking into account potential impacts for Stages 2 & 3) prior to any disturbance of the existing landscape and prior to finalisation of the layout/footprint for the project. There may also be a need for monitoring by an Aboriginal Heritage Officer during initial ground disturbing/vegetation reduction works, in those areas offering poor ground surface visibility at the time of survey, and which may be considered to have good site potential.

2 . The project proponents should maintain a measure of flexibility in terms of the project design until such time as all potential Aboriginal values within the study area have been identified.

Further advice regarding the need for investigation of Aboriginal cultural heritage resources in relation to the proposed Allegiance Avebury Nickel Project may be obtained from the Manager, Aboriginal Heritage Section at DTPHA in Hobart (03 6233 3927).

References

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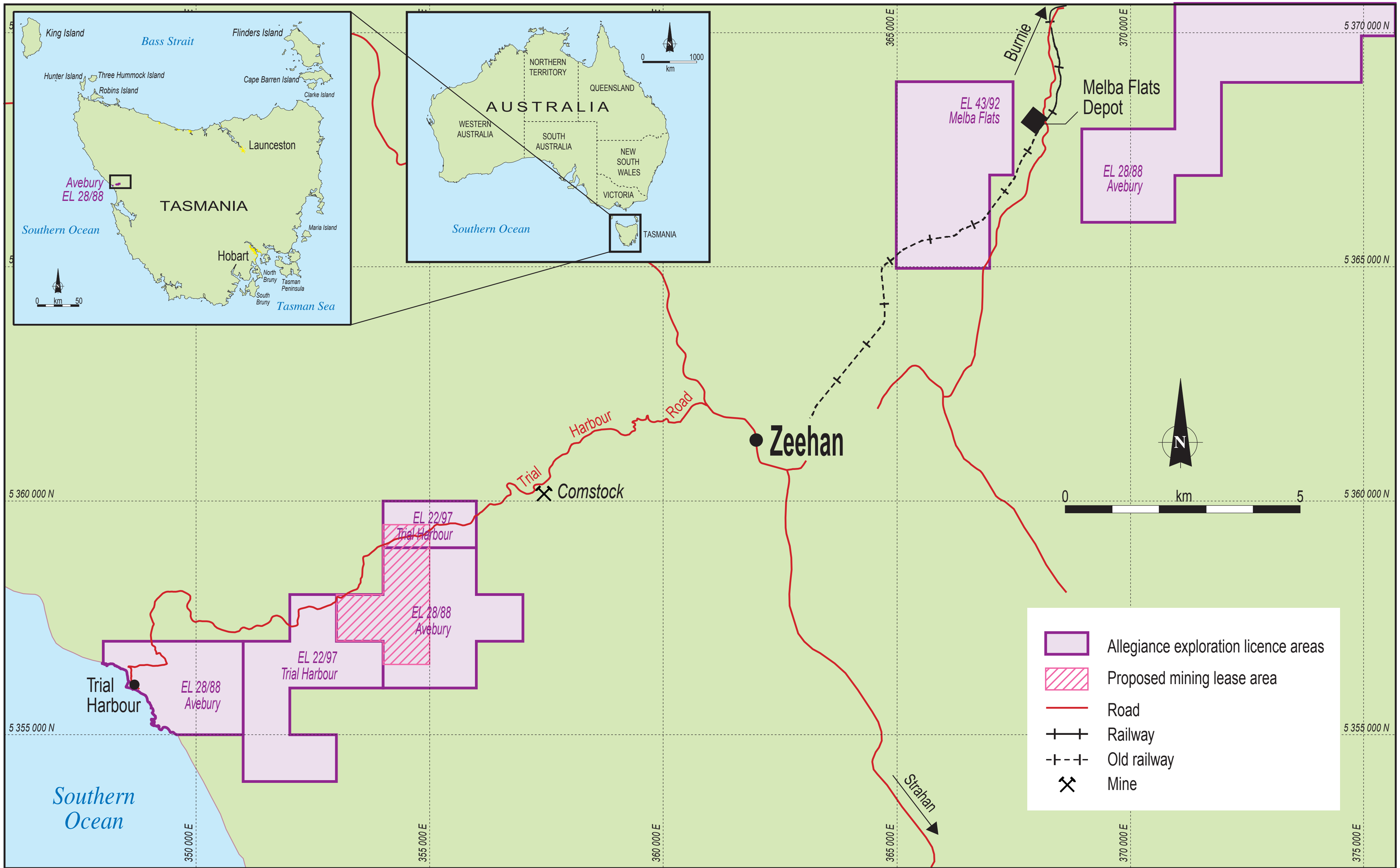

NSR Environmental Consultants Pty Ltd

Job No: 938

File No: 938_2_F1.02_HB

Allegiance Mining NL

Avebury Nickel Project

Allegiance exploration licence areas

Figure No: **1.2**

Appendix 7

Allegiance Avebury Nickel Project – Stage 1
Historic Heritage Study

ALLEGIANCE AVEBURY NICKEL PROJECT STAGE 1

HISTORIC HERITAGE STUDY

FINAL REPORT

Prepared by

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for

NSR Environmental Consultants Pty Ltd

March 2003

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CONTENTS

1 EXECUTIVE SUMMARY

1.1 Introduction

This historic heritage assessment is a desktop study commissioned by NSR Environmental Consultants Pty Ltd to determine the existence and extent of any historic material on the proposed site of the Allegiance Avebury Nickel Project Stage 1 development near Zeehan on Tasmania s west coast, and to provide advice on mitigating potential impacts to that material.

The study area is located in a region of intensive late nineteenth century mineral activity which was crucial to the economic development of the colony. It was first traversed in c1876 with a blazed track marked in 1882 followed by a cart track in 1885. The cart track was upgraded soon after and was on the same alignment as the modern Trial Harbour Road. Miners Rights were granted in the study area in the late nineteenth century (probably in c1880-81), several Mining Leases in 1905-1912 and other leases from 1969 to 1991. Available documentary evidence does not indicate whether any of these rights and leases were worked. Some forestry activity occurred on the edges of the study area in the mid twentieth century.

1.2 Heritage Sensitivity

Any remnant historic features from the period 1876-1912 in the region are potentially of historic heritage significance and able to inform present and future generations about the early history of prospecting, mining activity and road building in the region and state. The Trial Harbour Road is an important historic communications corridor able to contribute to an understanding of nineteenth century road building techniques in remote areas with adverse climatic conditions and the operation of a major remote nineteenth century mining field. While mining activity levels appear to have been generally low within the study area there are two areas of historic heritage sensitivity which require prudent and sympathetic management. These areas are:

- A corridor along the Trial Harbour Road. This corridor should extend 20m either side of the gravel road formation.
- The site of miners rights, mining leases and forestry activity in the north west quarter of the study area. Evidence of mid-twentieth century forestry activity is known to be extant adjacent to this area of sensitivity.

1.3 Recommendations

It is noted that the proposed development is unlikely to impact heritage values in the study area apart from the following two locations of potential heritage sensitivity:

- The point where the development access road and water pipeline crosses the Trial Harbour Road.

- The site of possible infrastructure requirements for Stage 3 of the project located in the north western corner of the study.

The following recommendations address heritage sensitivity within the study area. They remain identical for all three stages of the proposed development.

Recommendation 1	An historical archaeologist experienced in undertaking field surveys should be engaged to carry out an archaeological survey of a corridor 20m either side of the road formation of Trial Harbour Road at the site of any works to be carried out at or adjacent to the road.
Recommendation 2	An historical archaeologist experienced in undertaking field surveys should be engaged to carry out an archaeological field survey of any site of proposed works within the north west quarter of the study area identified as sensitive in this report prior to the commencement of the works. In particular the sites of any infrastructure requirements for future stages of the project which fall within the north west quarter of the study area should be surveyed prior to construction.
Recommendation 3	In the event that items of potential historic interest are discovered during the term of the Avebury Nickel Project in areas not identified as sensitive in this report the precautionary principal should apply and Mineral Resources Tasmania (Greg Dickens, tel: 6233 8374), the Forest Practices Board (Denise Gaughwin, tel: 6233 7966) and the Tasmanian Heritage Office (tel: 6233 2037) should be contacted for further advice.

2 INTRODUCTION

2.1 The Study

This historic heritage assessment is a desktop study commissioned by NSR Environmental Consultants Pty Ltd to determine the existence and extent of any historic material on the proposed site of the Allegiance Avebury Nickel Project Stage 1 development near Zeehan on Tasmania s west coast, and to provide advice on mitigating potential impacts to that material. The study brief required:

- a targeted historic overview
- a check and report on all appropriate historical registers to identify known sites of historical heritage significance within the study area and broader area
- analysis and interpretation of research results with consideration for management and mitigation issues relating to Stage 1 development
- mapping sites of known significance
- a sensitivity plan and advice on what, if anything, would be required next in terms of requirements for Stage 1 construction
- identification of specific requirements associated with Stages 2 and 3 development, and
- a brief report outlining the above information.

2.2 Study Area

The Avebury Nickel Project is located 6 km west of the town of Zeehan, on Tasmania s west coast. Trial Harbour Road runs north of the proposed mining site, while the site is bounded by Kynance and Comstock creeks to the east, Hemp Creek to the west and the Little Henty River to the south. See Figure 1 for study area.

2.3 Authorship

This report was prepared by Ian Terry, Historian, Heritage and Interpretation Consultant.

2.4 Method

The study uses heritage assessment methodology as established in J.S. Kerr s *The Conservation Plan* and the *Burra Charter 1999*. Historical research included examination of relevant indexes at the Archives Office of Tasmania, the State Library of Tasmania, the Tasmanian Heritage Office (in the Department of Tourism, Parks, Heritage and the Arts) and Forestry Tasmania. Relevant maps and plans were viewed with particular emphasis placed on maps of historic mining leases held by Mineral Resources Tasmania to identify potential historic mines within the study area. The significance assessment uses the criteria set down in Section 16 of the *Historic Cultural Heritage Act 1995*.

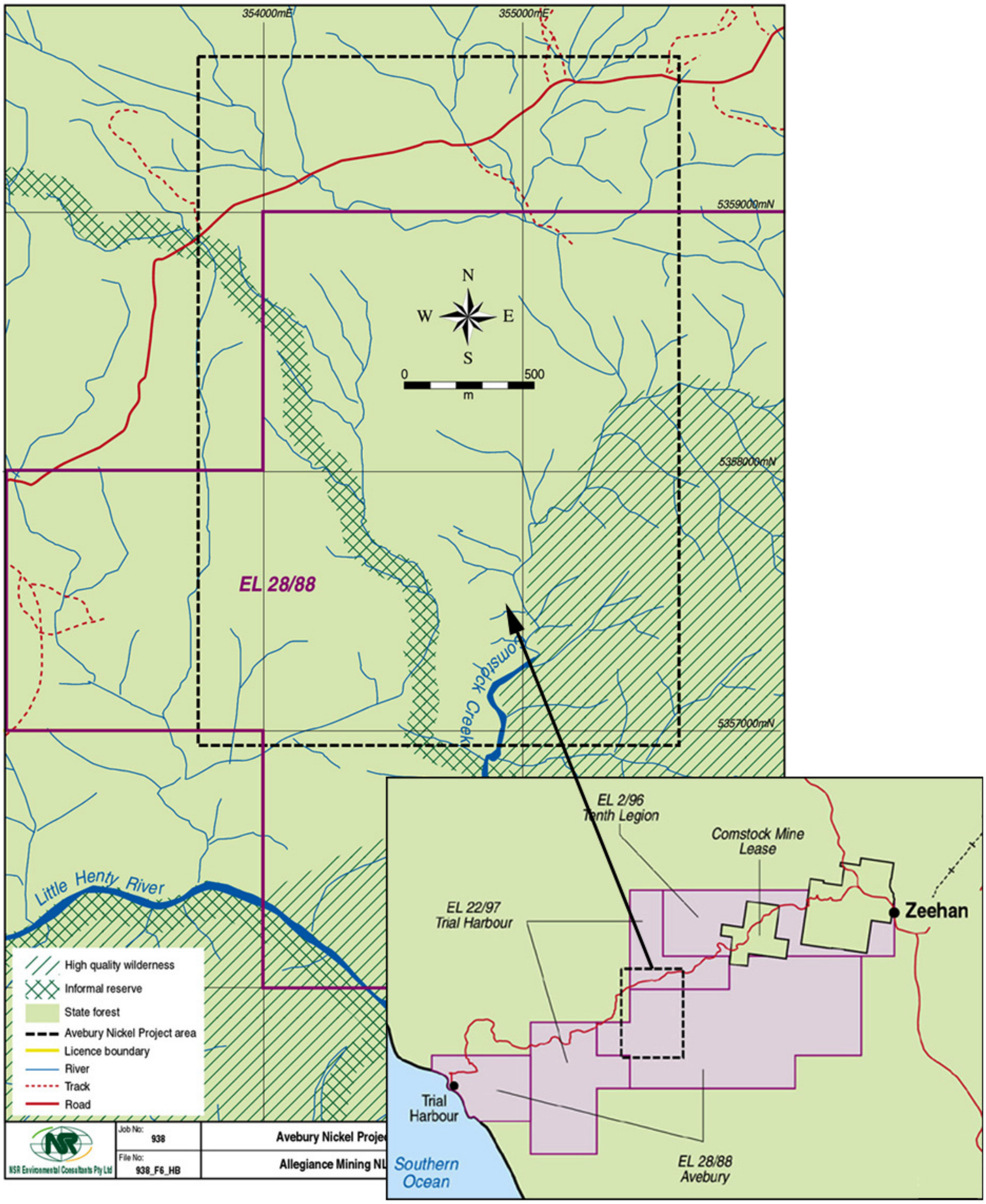

Figure 1. Study area (mapping provided by NSR Environmental Consultants Pty Ltd).

2.5 Current Listings

There are no current local government, state government or national estate heritage listings for historic sites within the study area. Although the Tasmanian Historic Places Index (THPI), maintained by the Tasmanian Heritage Office and Forestry Tasmania s Conserve Database indicate that the historic Swansea Mine was located on the eastern boundary of the study area, further investigation revealed that the grid reference provided in these databases was incorrect and that the Swansea Mine was in fact located several kilometres east of the study area.[1] Forestry Tasmania s Conserve Database indicates that Howard s Logging Ramp is located adjacent to the western boundary of the study area.

2.6 Limitations and Disclaimer

This report is a desktop study of the study area and uses known primary and secondary sources relating to the study area. It does not consider Aboriginal heritage issues. The results, assessments and judgements contained in this report are constrained by the available historic documentation. Whilst every effort has been made to gain insight to known and/or potential heritage issues within the Allegiance Avebury Nickel Project Stage 1 study area, the author cannot be held accountable for errors or omissions arising from such constraining factors.

2.7 Acknowledgments

Many people have contributed to this study. In particular I would like to acknowledge:

¥ Staff of the Archives Office of Tasmania.
¥ Staff of the Tasmaniana Library, State Library of Tasmania.
¥ Andrew Todd, Angie McGowan and Jo Lyngcoln of the Tasmanian Heritage Office.
¥ G reg Dickens, Technical Officer and historic mining heritage expert at Mineral Resources Tasmania.
¥ Penny Wells and Allison Woolley of Conservation Planning, Forestry Tasmania.
¥ Denise Gaughwin, Senior Archaeologist, Forest Practices Board.
¥ David Parham of Austral Archaeology.
¥ Anne McConnell, Heritage Consultant and Quaternary Geoscientist.

2.8 Abbreviations

AOT	Archives Office of Tasmania
MRT	Mineral Resources Tasmania
THO	Tasmanian Heritage Office
THPI	Tasmanian Historic Places Index

[1] The THPI record for the Swansea Mine is 7914:021. The mine, however, was located east of the study area Greg Dickens, pers comm (face to face interview), 30 January 2003.

3 HISTORIC CONTEXT

Following the discovery of tin at Mt Bischoff in December 1871 other regions of Tasmania s west coast were prospected through the 1870s. After surveyor, Charles Sprent cut a track from the Pieman River to the Heemskirk region in early 1876 the Merediths, Donellys and Moores secured mining leases in the Pieman-North Heemskirk region.[2] By the end of the decade some fifty companies had taken out leases on the Heemskirk field.[3]

In 1880-81 attention moved further south to South Heemskirk which extended close to the north-western corner of the study area. Although this field yielded little wealth, it saw the west coast region s first attempts at systematic mining.[4] The working of the north and south Heemskirk fields led to extensive prospecting in the immediate region culminating in Frank Long s discovery of rich silver ores at Zeehan in 1882.[5] Prospectors surveyed the Little Henty River, which flows close to the southern boundary of the study area, as early as 1877.

Sprent recommended a systematic grid of tracks to provide access throughout the west coast region. In 1882 the Overseer of Roads to Trial Harbour, John Clay, recommended the cutting of access tracks between the Heemskirk and West Coast Ranges. Tenders were called for two tracks and let to R.H. Carlisle, a Heemskirk mine manager. The tracks, marked by blazing trees, started at the Mt Agnew huts close to the current Trial Harbour Road.[6]

Carlisle s track was superseded in 1885 by a lower level bridle track cut by Frank Long and Joe Harman. The current road, which generally follows the alignment of the 1885 track, was constructed by the government between 1886 and 1888. A difficult track over which all early mining equipment to Zeehan had to be conveyed it was initially constructed of corduroy over swampy ground and damaged carts with broken axles were a common sight along its length.[7]

Although the study area was almost certainly prospected between 1877 and 1905 few mining leases have been taken out in the study area (see Figures 2 & 3). Leases secured include:

- A tin mining lease of 40 acres taken out in the area by Charles Brumby of Zeehan in August 1905 and voided between 1906 and 1912.[8] A survey plan of the lease reveals two previous miners rights of approximately 2 acres each in the eastern part of Brumby s lease. No more information is known about these miners rights.[9]

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[2] Binks, 1989, p. 207.
[3] Scripps, p. 55.
[4] Binks, 1988, p. 30.
[5] Binks, 1989, p. 207.
[6] Binks, 1988, pp. 33-4.
[7] Binks, 1988, pp. 82, 115.
[8] MRT Mining Lease 1501M.
[9] MRT Montagu 71/28; Greg Dickens, pers comm, 30 January 2003.

- A tin mining lease of 20 acres north of Brumby s lease by Robert Horsburgh and Edward Healey dated 5 December 1905 and voided between September 1906 and December 1909.[10] A survey of the lease shows a public works track in the south western corner of the lease running up approximately halfway along the western boundary.[11]
- 40 and 20 acre tin mining leases obtained by Michael Curtin on 7 May 1908 and voided in December 1909.[12]
- A 10 acre general mining lease taken out by Timothy Buckley on 26 November 1907 and voided between August 1908 and December 1909.[13]

These leases were all very shortlived and were probably only very lightly worked if at all. The tin sought was alluvial in nature and any activity that may have occurred probably left few substantial remnants.[14]

A water right along Colemans Creek was secured by Bernard and Kenneth Cooney and Raymond O Connor in October 1969. It was forfeited in October 1976. The right covered five acres crossing the Trial Harbour Road on the western edge of the study area.[15]

Later, other leases were taken out over the 1905-1912 leases in 1982 and 1986. However these leases were either not worked or expired within three to six years. Any mining activity undertaken was likely to have been at a very small scale and the leases are considered to be very unlikely to contain material of heritage significance related to mining in the 1980s.[16]

Several other leases were taken out in the north eastern corner of the study area between 1975 and 1991. Given the almost contemporary nature of the leases they were not examined further and are considered to be unlikely to contain historically significant remnants related to the period of their working.

Forestry has been a significant industry throughout the west coast region north of Macquarie Harbour in the twentieth century.[17] R. Howard operated several sawmills in the region between the 1940s and the 1960s. A log landing used by Howard and his contractors is located 40m east of the Trial Harbour Road adjacent to the study area (see figure 4 for location). The landing is constructed of earth and logs and indicates the presence of logging activity in the immediate locality.[18]

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[10] MRT Mining Lease 1869M.
[11] MRT Montagu 71/37.
[12] MRT Mining Lease 3717M and 3718M.
[13] MRT Mining Lease 3470M.
[14] Greg Dickens, pers comm.
[15] MRT 147M/69.
[16] MRT 3M/82, 8M/86; Greg Dickens, pers comm.
[17] Scripps, pp. 65-67.
[18] Scripps, p. 75; Site 7914.016 in Forestry Tasmania s Conserve Database. Updated material provided to author by Denise Gaughwin of the Forest Practices Board on 25 March 2003.

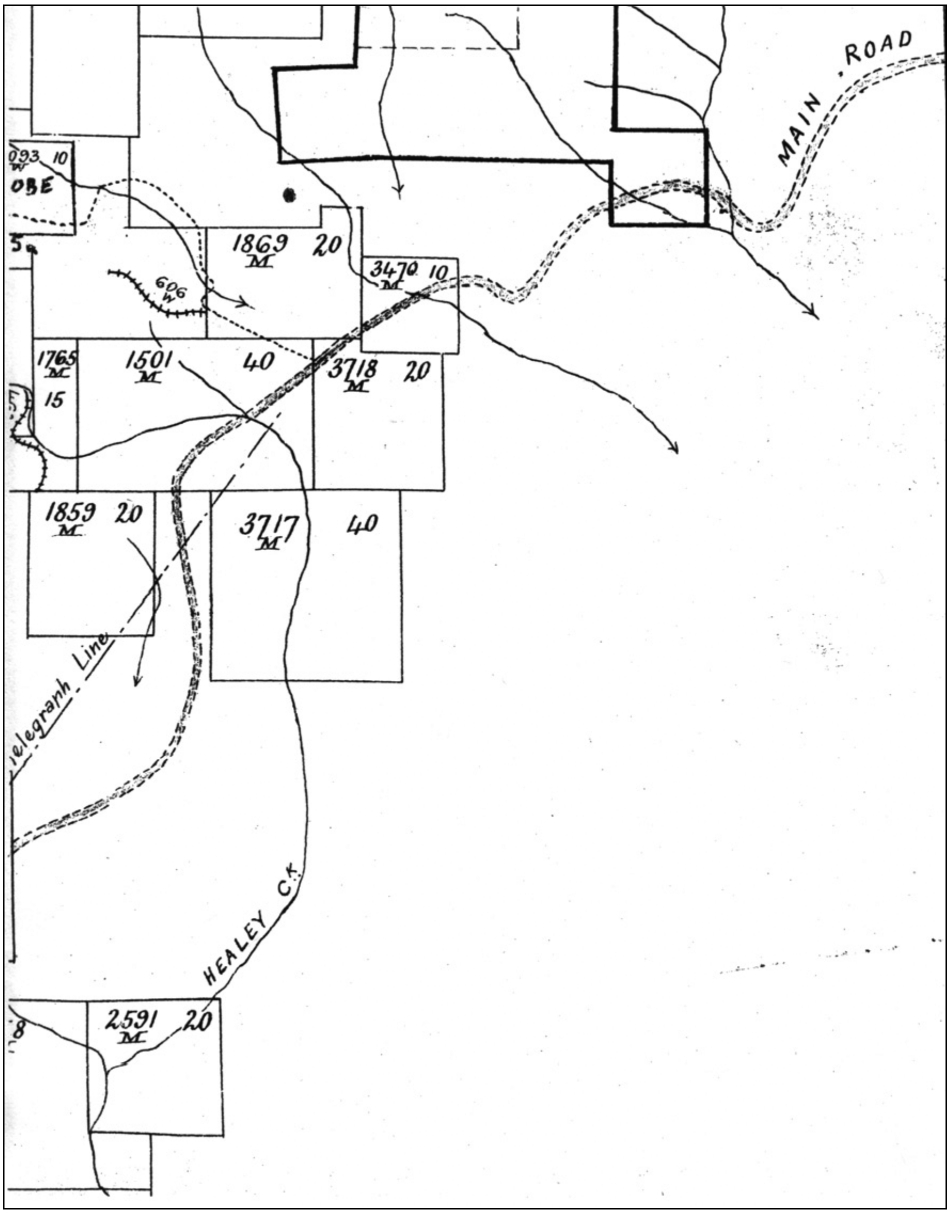

Figure 2. Early twentieth century chart showing mining leases in and around study area. Healey Creek is now Colemans Creek. See Figure 3 for mining lease locations within the study area (MRT MIN 229).

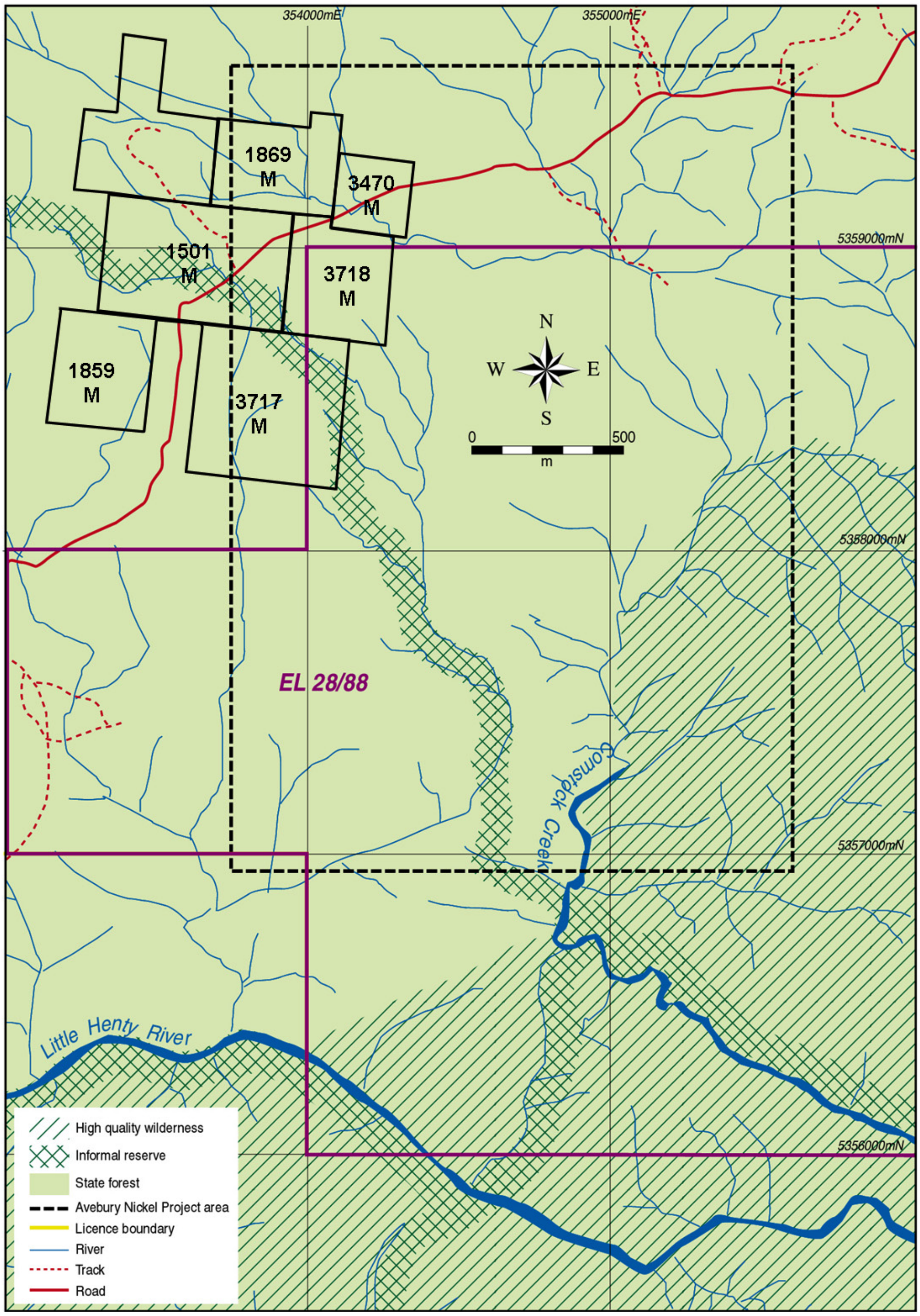

Figure 3. Study area showing approximate location of boundaries of early twentieth century mining leases.

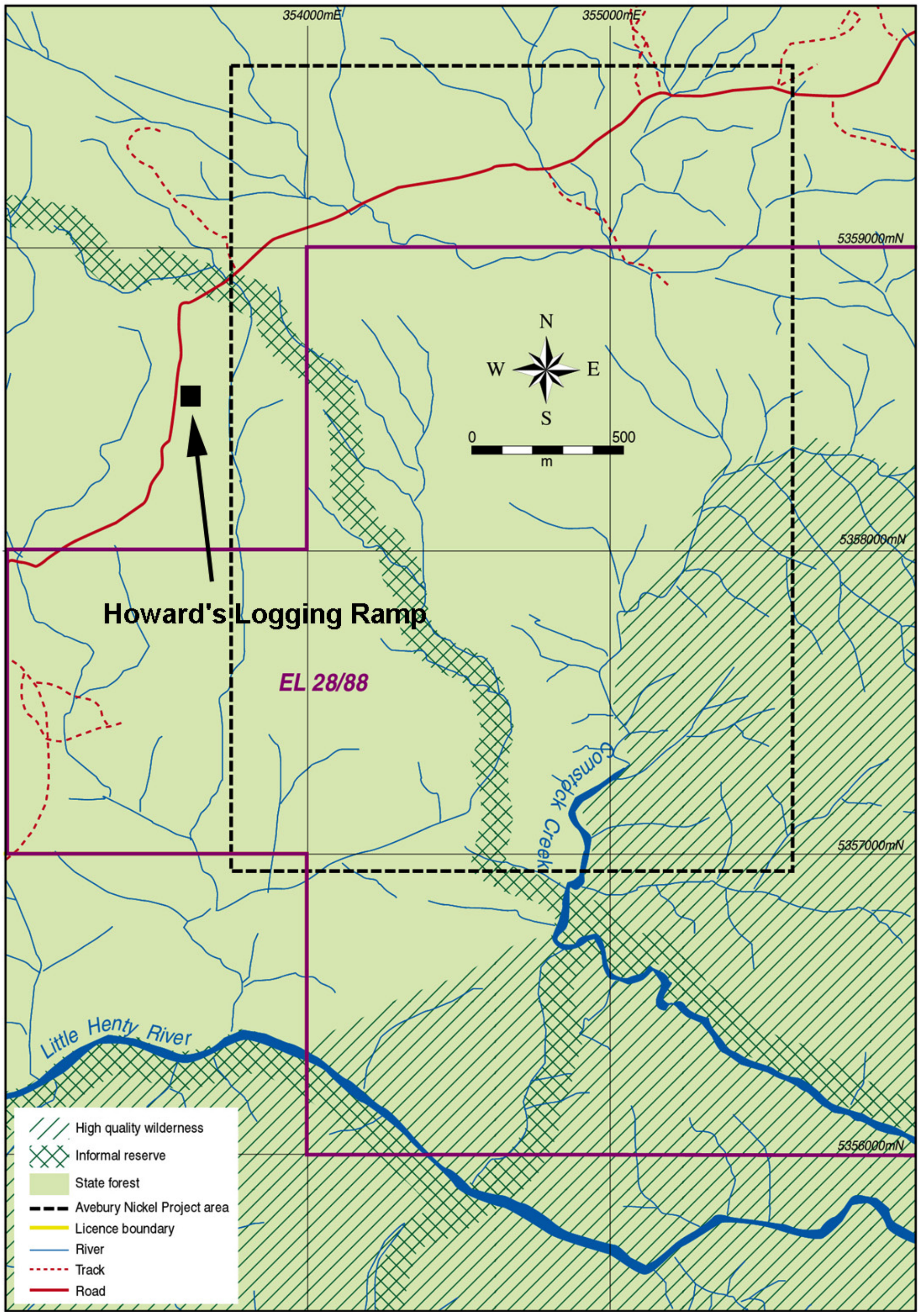

Figure 4. Approximate location of Howard s logging ramp (to within 100m of site). Site location drawn from Forestry Tasmania Conserve Database. The grid reference for the site is given as 353600 358500.

4 SIGNIFICANCE ASSESSMENT

4.1 Introduction

This significance assessment has been prepared following an analysis and assessment of the various aspects of cultural significance within the study area and the wider region. It has been formulated with regard to the Burra Charter 1999 and the criteria set down in Section 16 of the *Historic Cultural Heritage Act 1995.* The assessment procedure:

- allows comparison with other places,
- places sites in an historical context, and
- identifies key areas of value.

Significance can be embodied in:

- the actual fabric of a place,
- the setting and context of a place,
- the fitout and items within a place,
- the use and history of a place, and
- the records of users and the memories and responses which are made to a place by its direct and associated users.

4.2 Significance Criteria

The criteria used in the following Statement of Significance are those set down in the *Historic Cultural Heritage Act 1995*. These criteria require that to be eligible for inclusion in the Tasmanian Heritage Register the place must:

(a) be important in demonstrating the evolution or pattern of Tasmania's history;
(b) demonstrate rare, uncommon or endangered aspects of Tasmania's heritage;
(c) have potential to yield information that will contribute to an understanding of Tasmania's history;
(d) be important as a representative in demonstrating the characteristic of a broader class of cultural places;
(e) be important in demonstrating a high degree of creative or technical achievement;
(f) have strong or special meaning for any group or community because of social, cultural or spiritual associations;
(g) have a special association with the life or work of a person, a group or organisation that was important in Tasmania's history.

4.3 Previous Assessments

There have been no previous heritage assessments of mining related sites within the study area. Howard s Logging Ramp was assessed by Scripps in 1990.[19] As noted in s2.5 no sites within the study area are currently included in local, state or

[19] Scripps, p. 75

national heritage registers. The following assessment has been made after a careful analysis of the available documentary evidence and represents the professional opinion of the consultant.

4.4 Discussion & Statements of Significance

4.4.1 Trial Harbour Road

The Trial Harbour Road which passes through the north of the study area was one of the first roads to be constructed in the region. It was critical to the early development of the central west coast s first successful mining field located at Zeehan and so was essential to Tasmania s economic development in the late nineteenth century. All mining equipment to Zeehan was initially carried along this road until the construction of the Zeehan-Strahan railway in the early 1890s. The road may contain evidence of early road construction techniques including culverts, bridges, retaining walls and the like. It may also contain remnants of wrecked nineteenth century vehicles and/or mining equipment.

Significance

The Trial Harbour Road has state significance as the first road route to the important late nineteenth century mining town of Zeehan. It demonstrates late colonial governmental responses to providing transportation links to a remote mining town which was critical to the development of the colony s late nineteenth century economy. It also demonstrates the responses of late nineteenth century road builders to difficult environmental and topographic constraints. The road is important as it demonstrates the difficulty of transporting heavy mining equipment in a remote location in the late nineteenth century and may be able to demonstrate late nineteenth century road building technologies and techniques.

Significance is likely to be restricted to the road s alignment, infrastructure such as culverts and bridges, and damaged vehicles and/or machinery on its margins. Due to ongoing and periodic maintenance and reconstruction activities the road surface itself is unlikely to contain significant fabric.

4.4.2 Early 20th Century Mining Leases

It is unknown whether any mining or prospecting activities occurred on the miner s rights granted in the late nineteenth century or in the mining leases granted in the early twentieth century in the north western quarter of the study area. Any activity that did occur is likely to have been low level. It may have left evidence of shallow shafts, costeans, small scale mining equipment and some domestic remnants such as basic hut remains and/or garbage dumps.

Significance

The late nineteenth miners rights and early twentieth century mining leases may have some local significance as they may be able to contribute to our understanding of early twentieth century prospecting and subsistence mining activity in a remote area.

4.4.3 Howard s Logging Ramp

Some forestry activity occurred in the area in the mid twentieth century. The extent of this activity is unknown. Howard s Logging Ramp (more accurately called a log landing) demonstrates that logging occurred in or adjacent to the study area and may indicate the presence of other associated sites (such as roading, abandoned equipment or machinery, etc) nearby. Although such log landings are common throughout the state and Scripps assessed it as having low significance the site should be investigated prior to any development which may impact on its integrity.[20]

Significance

Howard s Logging Ramp demonstrates mid-twentieth century timber extraction and log loading practices. As such log landings are common in twentieth century logging areas this landing has been assessed as having low significance.

[20] Denise Gaughwin, pers comm, 25 March 2003.

5 HERITAGE SENSITIVITY

The study area is located in a region of intensive late nineteenth century mineral activity which was crucial to the economic development of the colony. As such any remnant historic features from the period 1877-1912 in the region are potentially of historic heritage significance able to inform present and future generations about the early history of prospecting and mining activity in the region and state. While mining activity levels appear to have been generally low within the study area two areas of historic heritage sensitivity requiring prudent and sympathetic management have been identified.[21] These areas (see Figure 5) are:

- A corridor along the Trial Harbour Road. This corridor should extend 20m either side of the gravel road formation.
- The north west quarter of the study area. Howard s Logging Ramp is also located adjacent to this area of sensitivity.

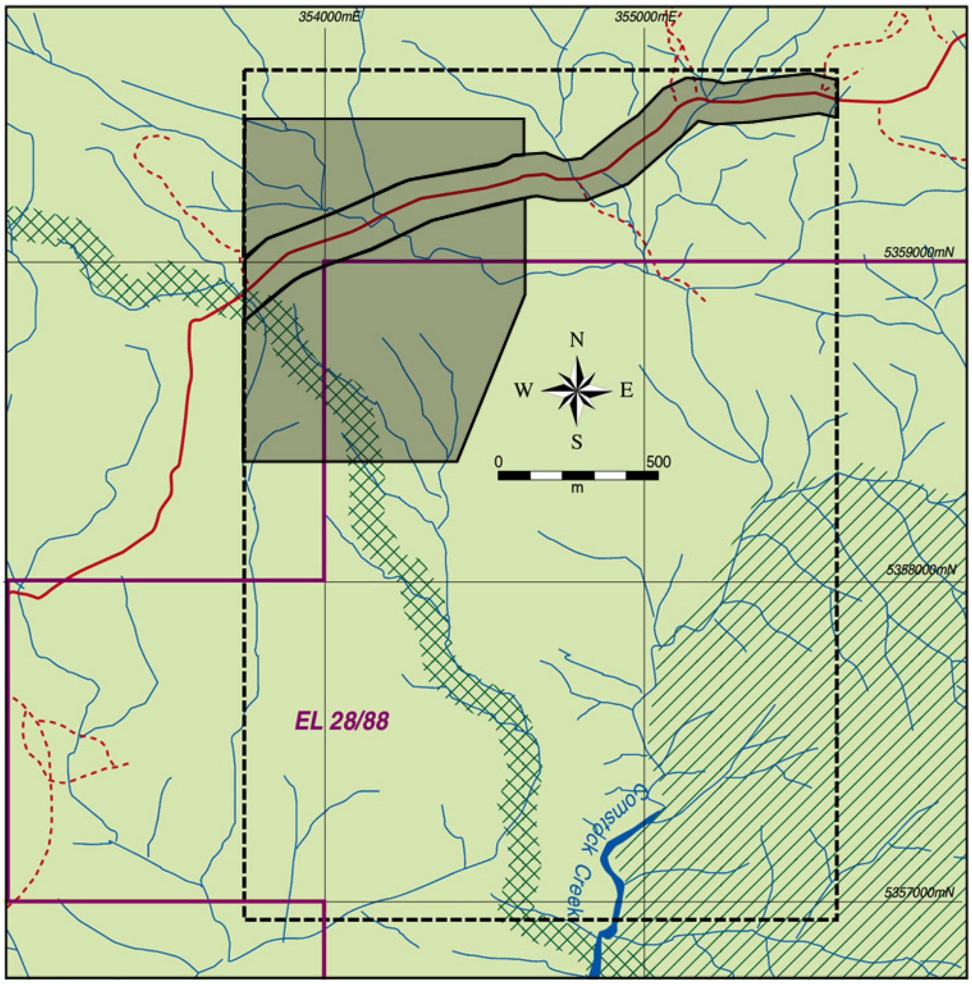

Figure 5. Areas of heritage sensitivity (shaded) within the study area.

[21] See Section 4.

6 RECOMMENDATIONS

It is noted that the proposed development is unlikely to impact heritage values in the study area apart from the following two locations of potential heritage sensitivity (see Figure 4):

- The point where the development access road and water pipeline crosses the Trial Harbour Road.
- The site of possible infrastructure requirements for Stage 3 of the project located in the north western corner of the study.

The following recommendations address the identified heritage sensitivity within the study area. They remain identical for all three stages of the proposed development.

Recommendation 1	An historical archaeologist experienced in undertaking field surveys should be engaged to carry out an archaeological survey of a corridor 20m either side of the gravel road formation of Trial Harbour Road at the site of any works to be carried out at or adjacent to the road.
Recommendation 2	An historical archaeologist experienced in undertaking field surveys should be engaged to carry out an archaeological field survey of any site of proposed works within the north west quarter of the study area identified as sensitive in this report prior to the commencement of the works. In particular the sites of any infrastructure requirements for future stages of the project which fall within the north west quarter of the study area should be surveyed prior to construction.
Recommendation 3	In the event that items of potential historic interest are discovered during the term of the Avebury Nickel Project in areas not identified as sensitive in this report the precautionary principal should apply and Mineral Resources Tasmania (Greg Dickens, tel: 6233 8374), the Forest Practices Board (Denise Gaughwin, tel: 6233 7966) and the Tasmanian Heritage Office (tel: 6233 2037) should be contacted for further advice.

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Appendix 8

Assessment of the Acid Forming Potential of Rock to be Mined during Construction of the Viking Decline

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NSR Environmental Consultants Pty Ltd

April 2003

Document No. 2039/597

Allegiance Mining NL

Avebury Nickel Project

ASSESSMENT OF THE ACID FORMING POTENTIAL OF ROCK TO BE MINED DURING CONSTRUCTION OF THE VIKING DECLINE

Contents

Tables

Figures

1.0 Introduction

Environmental Geochemistry International Pty Ltd (EGi) was commissioned by NSR Environmental Consultants Pty Ltd to carry out a geochemical assessment of 15 drill core samples representing material to be mined during construction of the Viking Decline at the Avebury Nickel Project being developed by Allegiance Mining NL.

Approximately 100,000 t of waste rock will be excavated during development of the decline and associated cross-cuts. This material, if suitable, will be used in the construction of an access road to the site and as fill around the proposed plant area.

The main purpose of the testing was to determine if the waste rock is likely to exhibit any potential to acidify and generate acid rock drainage (ARD) when exposed to atmospheric conditions. The multi-element composition was also examinined to identify any metal enrichments that may be of environmental concern.

This report presents a description of the test program undertaken by EGi and the results obtained. The implications for use of waste rock from decline development as road base are also presented.

2.0 Sample Descriptions

The geochemical program involved testing of 15 drill core samples. The intervals of drill core were selected by Newnham Exploration and Mining Services in consultation with EGi. The samples represented the main lithological units along the proposed path of the Viking decline. The drill core intervals and lithological descriptions are given in Table 1.

Table 1. Sample descriptions - Avebury Nickel Project

Hole	Interval (m)	Lithology
A043	13.3 - 48.0	Siltstone
A043	48.0 - 72.1	Mafic Agglomerate
A043	126.4 - 153.4	Mafic Agglomerate
A043	153.4 - 186.0	Hornfel
A043	192.2 - 250.0	Hornfel
A043	250.0 - 300.0	Hornfel
A016	145.0 - 165.0	Hornfel
A014	161.4 - 180.0	Hornfel
A038	210.0 - 231.0	Hornfel
A001	208.4 - 223.9	Hornfel
A039	265.5 - 285.0	Hornfel
A007	240.0 - 251.0	Hornfel
A034	198.0 - 208.0	Hornfel
A034	226.3 - 235.3	Hornfel
A034	251.0 - 257.5	Hornfel & Sulphide Band

The majority of the samples were Hornfel (*i.e.* 12 samples), which is the dominant lithological unit within which the decline will occur. There were also two samples representing Mafic Agglomerate and one sample representing Siltstone.

The samples were distributed spatially along the decline path as follows:

- South-North Leg 6 Samples
- West-East Leg 4 Samples
- East-West Leg 1 Sample
- Upper Cross-cut 1 Samples
- Lower Cross-cut 3 Samples

3.0 Geochemical Test Program

3.1 Sample Preparation

Each sample typically comprised between 2 to 5 kg of drill core segments. The samples were initially crushed to nominal 4 mm. A 200 g subsample of the crushed material was then riffle split and pulverized to less than 75 micron. All sample assays were carried out on pulverised material.

3.2 Test Program

The acid forming potential of each sample was assessed. This involved determination of the following suite of parameters:

- Total sulphur
- Acid neutralising capacity (ANC)
- Maximum potential acidity (MPA)
- ANC/MPA ratio
- Net acid producing potential (NAPP)
- Net acid generation (NAG).
- NAG pH

In addition, a selection of samples were tested for:

- Acid buffer characteristic curve (ABCC)
- Kinetic NAG
- Multi-element composition

Sample preparation and total sulphur assays were carried out by Sydney Environmental Laboratory. Multi-element analyses were carried out by Genalysis Laboratory Services in Perth. All other assays were carried out by EGi's in-house laboratory.

3.3 Procedures

The acid-base account and NAG testing involved a series of static laboratory procedures that evaluated the balance between acid generation processes (oxidation of sulphide minerals) and acid neutralising processes (dissolution of alkaline carbonates, displacement of exchangeable bases, and weathering of silicates).

The key parameters which describe the acid forming characteristics of a sample are referred to as the maximum potential acidity (MPA), the acid neutralising capacity (ANC), net acid producing potential (NAPP), and net acid generation (NAG). The methods used to determine these parameters were as follows:

- Total sulphur - Determined by the Leco high temperature combustion method.

- MPA - The maximum amount of acid that could be generated from the contained sulphur assuming it all occurs as reactive pyrite. MPA was calculated from the total sulphur content using the following formula:

  $$\text{MPA (kg } H_2SO_4\text{/t)} = \text{(Total \%S)} \times 30.6$$

- ANC - The amount of acid consumed by a sample under moderately acidic (pH < 1) conditions. ANC was determined by the Modified Sobek method. This method involves the addition of a known amount of standardised hydrochloric acid (HCl) to an accurately weighed sample, allowing the sample time to react (with heating), then back-titrating the mixture with standardised sodium hydroxide (NaOH) to determine the amount of unreacted HCl. The amount of acid consumed by reaction with the sample is then calculated and expressed in the same units as the MPA, that is kg H_2SO_4/t.

- NAPP - The net amount of acid that could be produced by a sample after allowance for ANC. The NAPP was calculated from the MPA and ANC results as follows:

  $$\text{NAPP (kg } H_2SO_4\text{/t)} = \text{MPA - ANC}$$

  If the MPA is less than the ANC then the NAPP is negative, which indicates that the sample may have sufficient ANC to prevent acid generation. Conversely, if the MPA exceeds the ANC then the NAPP is positive, and the material may be acid generating.

- ANC/MPA Ratio - Provides an indication of the relative margin of safety (or lack thereof) with respect to the acid forming potential of a sample. It was calculated from the ANC and MPA results as follows:

  $$\text{Ratio} = \text{ANC / MPA}$$

  The ANC/MPA ratio is another way of looking at the acid base account. A ratio of 1 is equivalent to a NAPP of zero. If the ratio is less than 1, then the NAPP must be positive and there is a strong possibility the sample is acid generating. A ratio greater than 1 corresponds with a negative NAPP. Various ANC/MPA values are reported in the literature for indicating safe values for prevention of acid generation. These values typically range from 1 to 3. As a general rule, a ANC/MPA ratio of 2 or more generally signifies that there is a high probability that the material will remain circum-neutral in pH and thereby should not be problematic with respect to acid rock drainage.

- The Net acid generation (NAG) test was also used in association with the NAPP prediction to classify the acid generating potential of each sample. Unlike the somewhat theoretical NAPP approach, the NAG test directly evaluates the net acid generating potential without estimating the acid potential and the acid neutralising capacity separately. During a NAG test, both acid generation and acid neutralisation reactions can occur simultaneously; therefore the end result represents the net amount of acid generated by the sample. The method involves the addition of 250 mL of 15% hydrogen peroxide to 2.5 gm of sample. The peroxide is allowed to react with the sample overnight and the following day the sample is gently heated to accelerate the oxidation of any remaining sulphides, then vigorously boiled for several minutes to decompose residual peroxide. The pH and acidity of the NAG liquor are measured after cooling. The amount of acid generated by the solids is expressed in the same units as NAPP, that is kg H_2SO_4/t.

3.4 ARD Classification Criteria

The acid forming potential of each sample was classified on the basis of the acid-base and NAG test results into one of the following categories:

- Non-acid forming (NAF),
- Potentially acid forming (PAF), and
- Uncertain

The classification criteria for each material type are described below.

Non-acid forming (NAF) Material

NAF material may, or may not, have a significant sulphur content but the availability of carbonate minerals and ANC within the material is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulphide minerals. As such, material classified as NAF is considered unlikely to be a source of acidic drainage. The criteria used to define NAF material were a negative NAPP and a NAGpH greater than 4.5.

Potentially acid forming (PAF) Material

PAF material always has a significant sulphur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material. This means there is a high risk that such a material, although pH circum-neutral when freshly mined, could oxidise and generate acidic drainage if exposed to atmospheric conditions. The criteria used to define PAF material were a positive NAPP and a NAGpH less than, or equal to 4.5.

Uncertain

An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results (*i.e.* when the NAPP is positive and NAGpH > 4.5, or when the NAPP is negative and NAGpH ≤ 4.5). Uncertain samples are generally given a tentative classification that is shown in brackets *e.g.* UC(PAF).

4.0 Results

4.1 Acid Forming Characteristics

The acid-base and NAG test results for the 15 samples are given in Table 2. The data are also presented graphically in Figure 1 as an Acid-Base plot and in Figure 2 as an ARD Classification plot.

ARD classifications were assigned to each sample based on the acid-base and NAG test results. The distribution of samples between the various ARD classifications was as follows:

- Nine samples were classified as non-acid forming (NAF)
- Two samples were classified as potentially acid forming (PAF)
- Four samples could not be definitively categorised with respect to acid forming potential on the basis of the data currently available and were therefore classified as "uncertain".

Non-Acid Forming Samples

The NAF samples can be generally described as having low sulphur content (0.03 to 0.22 %S) and low to moderate ANC (8 to 25 kg H_2SO_4/t). The NAF samples included:

- One Siltstone sample representing the start of the South-North leg
- Two Hornfel samples representing the end third of the South-North leg
- Four Hornfel samples representing the West-East leg
- One Hornfel sample representing the Upper Cross-cut
- One Hornfel sample in the Lower Cross-cut

Potentially Acid Forming Samples

The two PAF samples contained significantly more sulphur than any of the other samples in the test group. One sample contained 0.98 %S and the other 1.18 %S. The PAF samples included an interval of Mafic Agglomerate approximately mid-way along the South-North leg of the decline. This sample was from a section of core logged by Newnham Exploration and Mining Services as having a visible sulphide content of approximately 1% comprising mainly sparse pyrrhotite (disseminated and stringers). The other PAF sample was Hornfel from the Lower Cross-cut. It was logged as having sulphide bands (1-5%).

Uncertain Classifications

The four uncertain samples all had NAPP values that were slightly negative, indicating an excess of neutralisation capacity and suggesting the samples may be NAF. However, the NAGpH values were more acidic than the pH 4.5 criterion used to distinguish NAF from PAF materials. This suggests that some of the acid neutralisation capacity may not have been reactive enough to buffer all of the acid that was generated under NAG test conditions. The four samples appear in the lower, left hand quadrate of the ARD classification plot given in Figure 2.

Table 2: Acid forming characteristics of drill core samples - Avebury Nickel Project.

AREA	HOLE	INTERVAL (m)	LITHOLOGICAL UNIT	LOGGED TOTAL SULPHIDE	ACID-BASE ANALYSIS					NAG TEST		ARD Classification
					Total %S	MPA	ANC	ANC/MPA	NAPP	NAGpH	NAG	
SOUTH-NORTH LEG	A043	13.3 - 48.0	Siltstone	0%	0.08	2	8	3	-6	5.4	0	NAF
	A043	48.0 - 72.1	Mafic Agglomerate	trace	0.21	6	8	1.2	-2	4.2	<1	UC (PAF-lc)
	A043	126.4 - 153.4	Mafic Agglomerate	1%	0.98	30	12	0.4	18	3.0	6	PAF
	A043	153.4 - 186.0	Hornfel	2%	0.55	17	21	1.2	-4	3.6	2	UC (PAF-lc)
	A043	192.2 - 250.0	Hornfel	<<1%	0.12	4	24	7	-20	7.1	0	NAF
	A043	250.0 - 300.0	Hornfel	<<1%	0.10	3	23	8	-20	6.9	0	NAF
WEST-EAST LEG	A016	145.0 - 165.0	Hornfel	1%	0.06	2	12	7	-10	7.1	0	NAF
	A014	161.4 - 180.0	Hornfel	trace to 1%	0.22	7	12	1.8	-5	4.6	0	NAF
	A038	210.0 - 231.0	Hornfel	1%	0.17	5	12	2.3	-7	5.4	0	NAF
	A001	208.4 - 223.9	Hornfel	trace	0.03	1	23	25	-22	7.4	0	NAF
EAST-WEST LEG	A039	265.5 - 285.0	Hornfel	1%	0.44	13	14	1.1	-1	4.2	<1	UC (PAF-lc)
UPPER CROSS-CUT	A007	240.0 - 251.0	Hornfel	trace	0.10	3	16	5	-13	7.6	0	NAF
LOWER CROSS-CUT	A034	198.0 - 208.0	Hornfel	5%	0.34	10	23	2.2	-13	4.3	<1	UC (PAF-lc)
	A034	226.3 - 235.3	Hornfel	<1%	0.03	1	25	27	-24	7.8	0	NAF
	A034	251.0 - 257.5	Hornfel & Sulphide Band	1 to 5%	1.15	35	15	0.4	20	2.9	9	PAF

KEY

MPA = Maximum Potential Acidity (kgH_2SO_4/t)
ANC = Acid Neutralising Capacity (kgH_2SO_4/t)
NAPP = Net Acid Producing Potential (kgH_2SO_4/t)

NAGpH = pH of NAG liquor
NAG = Net Acid Generation capacity to pH 4.5 (kgH_2SO_4/t)

NAF = Non-Acid Forming
PAF = Potentially Acid Forming
PAF-lc = PAF but low capacity
UC = Uncertain Classification
(expected classification in brackets)

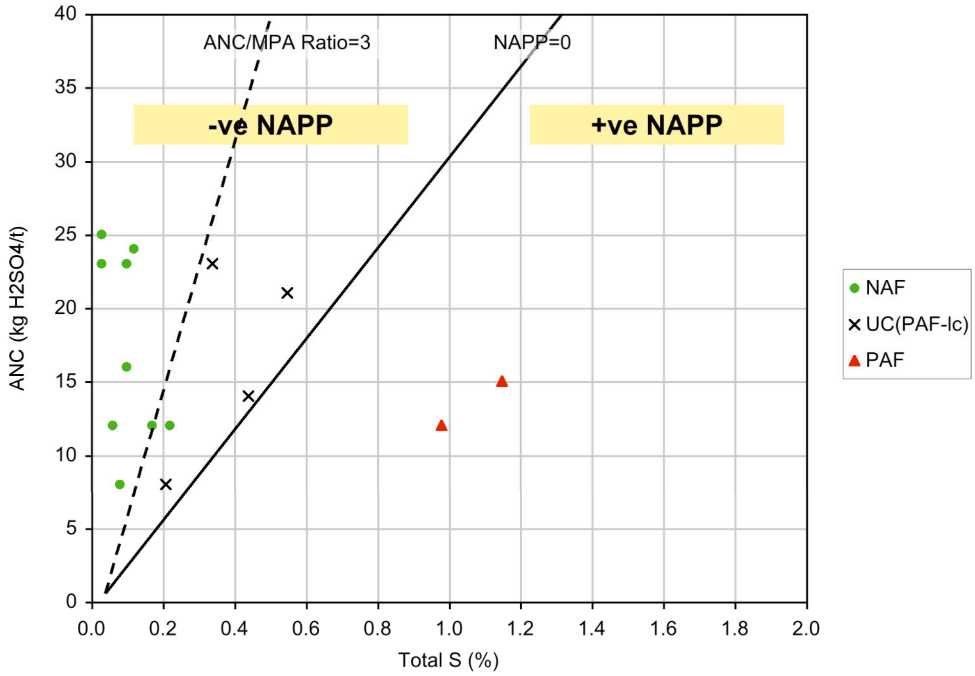

Figure 1: Acid-base account plot

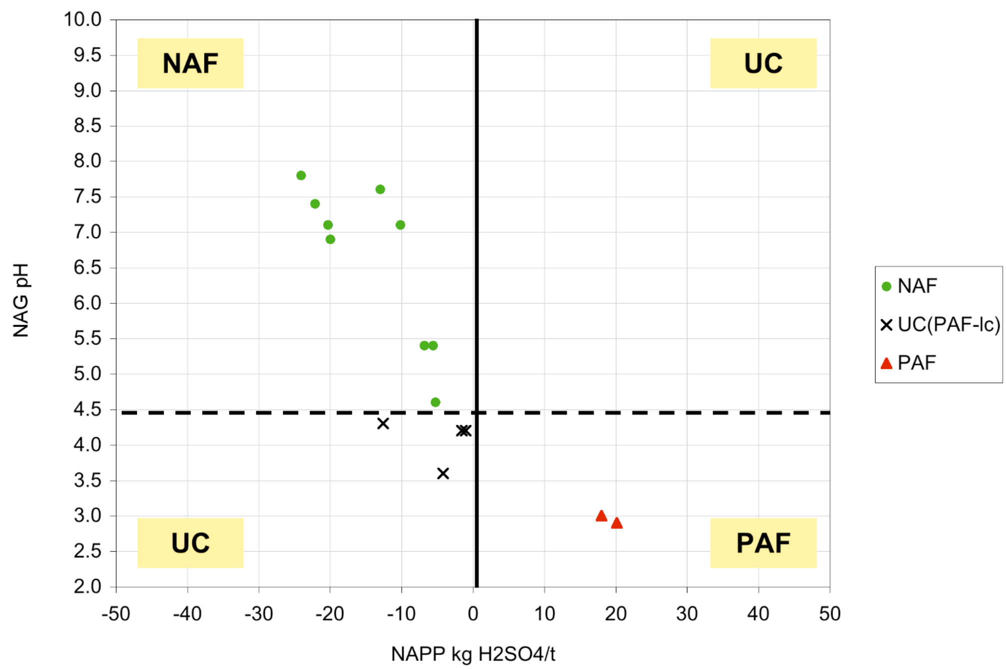

Figure 2: ARD classification plot

Uncertain samples are considered borderline with respect to acid generation. Based on the information currently available, the four samples have been tentatively classified as "Uncertain but possibly lower-capacity PAF material". This classification indicates the material may acidify, but in such an event the total acidity of the ARD produced would be expected to be relatively low.

4.2 Acid Buffer Characteristics

Figure 3 shows the acid buffer characteristics (ABCC) of one of the uncertain samples. The ABCC provides an indication of the readily-available buffer capacity within a sample which typically results from carbonates such as calcite and dolomite. The selected sample was Hornfel from approximately mid-way along the South-North leg. It had a mid-range sulphur content of 0.55 %S and a NAPP of -4 kg H_2SO_4/t.

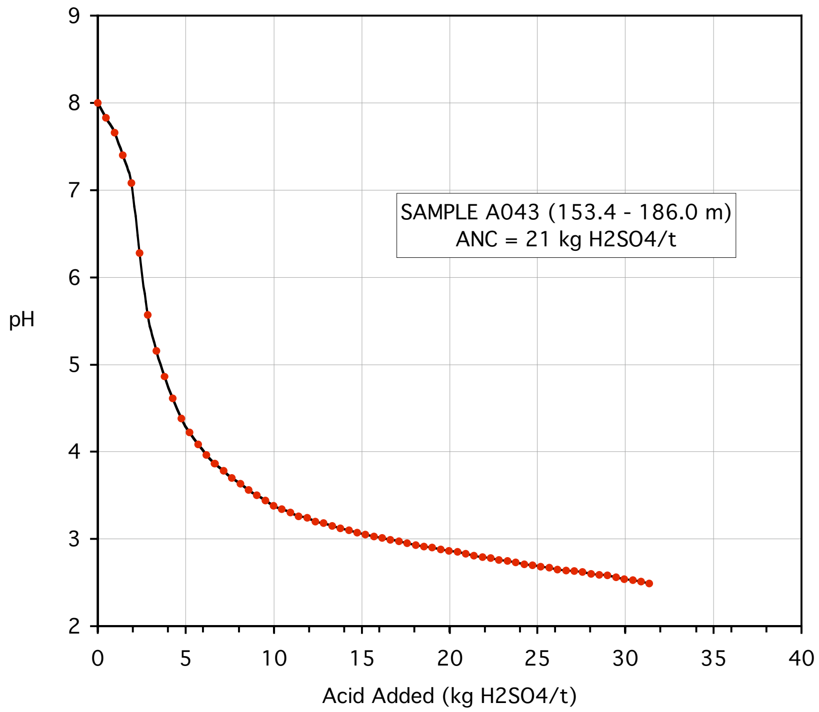

Figure 3. Acid buffer characteristic curve

The ABCC indicates very little acid was required to acidify the sample to less than pH 4. The acid input required was only 6 kg H_2SO_4/t, which is about one-third of the reported ANC. The results confirm that some of buffer potential in this Hornfel sample was not readily available, and this also probably explains why some other NAPP negative samples acidified to around pH 4 under NAG test conditions.

It should be noted that the kinetics of dissolution of less-soluble ANC may be adequate to neutralise acid at the generation rates typically encountered under field conditions, and may therefore contribute to pH control in the longer term. Real time, kinetic leach column tests will be required to confirm this.

4.3 Kinetic NAG Test

A kinetic NAG test was run on sample A034 (252.0 - 257.5 m), which was one of the two samples classified as PAF and had the highest sulphur content for the group of samples tested. The results of the kinetic NG test are given in Figure 4.

The pH profile confirms some buffering during the initial 60 minutes of the NAG test reaction. This buffering is indicated by a small plateau region where the pH deviates above the expected trend line (shown as dotted line in Figure 4). The subsequent acidification of the sample was accompanied by a rise in the temperature of the NAG liquor.

The results of the kinetic NAG test confirm that the material is likely to be acid generating if exposed in the field to atmospheric conditions, but the initial pH buffering provided by the ANC could delay the onset of acid conditions. The extent of this lag is difficult to predict with certainty, but a period of several months, possibly longer, would be expected.

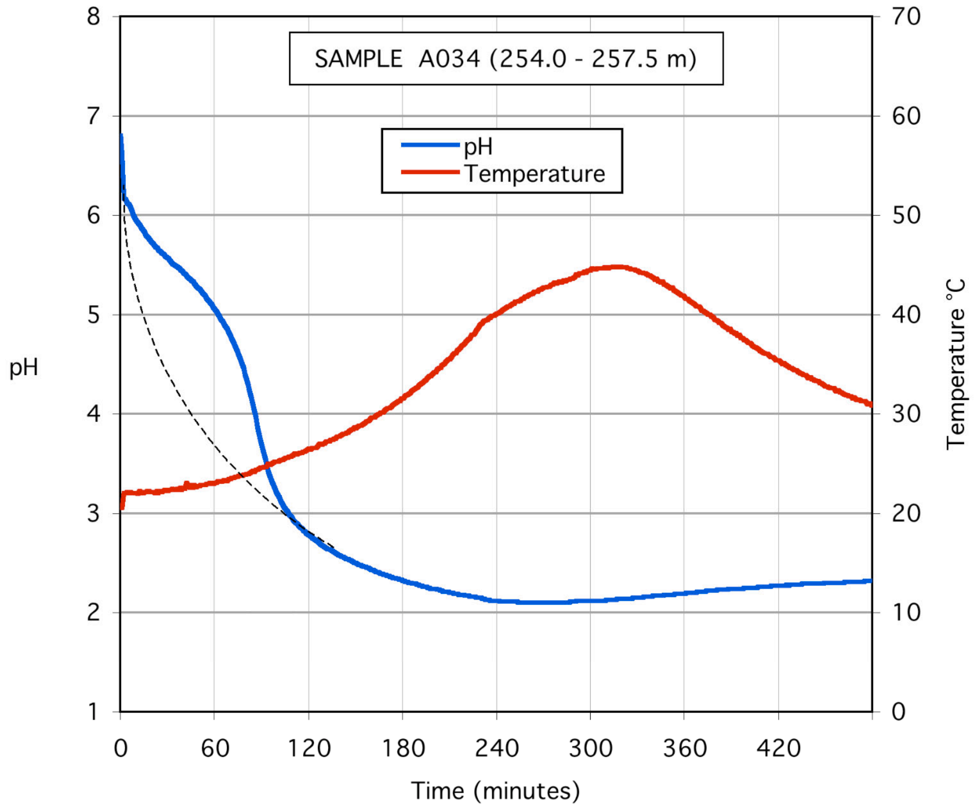

Figure 4. Kinetic NAG test

4.4 Multi-Element Composition

Multi-element scans were run on the two highest sulphur PAF samples, one mid-range sulphur sample, and one low sulphur NAF sample. The compositions of the four samples are given in Table 2. Geochemical Abundance Indices (GAI)[1] for each sample are also given in Table 2. The GAI provides an indication of the extent of elemental enrichment relative to average crustal abundance data. As a general rule, a GAI of 3 or greater signifies enrichment to a concentration that could be of environmental concern and may warrant further examination (*e.g.* batch or column leach testing) to assess potential elemental solubility and mobility under field conditions.

There were no enrichments of significance (*i.e.* GAI 3 or more) in the low sulphur, NAF sample. The other three samples were significantly enriched with sulphur, arsenic, bismuth and antimony. One of the three samples was also enriched with molybdenum. The significance of the sulphur in respect to acid generation has been discussed above. Of the other enrichments, arsenic is the one of most environmental importance.

[1] The Geochemical Abundance Index (GAI) compares the actual concentration of an element in a sample with the crustal abundance for that element. GAI is expressed on a log 2 scale which includes 7 integer increments (0 through to 6, respectively). A GAI of 0 indicates the element is present at a concentration similar to, or less than, average crustal abundance and a GAI of 6 indicates approximately a 100-fold, or greater, enrichment above average crustal abundance. Average crustal abundance data is taken from Bowen, H.J.M. (1979). Environmental Chemistry of the Elements. Academic Press, New York, p36-37. and Berkman, D.A. and Ryall, W.R. (1976). Field Geologists' Manual. The Australian Institute of Mining and Metallurgy, Parkville Victoria, p44-45.

Table 3: Multi-element composition of drill core samples - Avebury Nickel Project.

Element	Detection Limit	Concentration (mg/kg except where shown)				#Average Crustal Abundance	Geochemical Abundance Indices			
		A014 161.4 to 180.0 m	A039 265.5 to 285.0 m	A043 126.4 to 153.4 m	A034 251.0 to 257.5 m		A014 161.4 to 180.0 m	A039 265.5 to 285.0 m	A043 126.4 to 153.4 m	A034 251.0 to 257.5 m
Al	20	7.7%	6.4%	5.0%	6.9%	8.2%	0	0	0	0
Ca	10	2.4%	8.9%	5.5%	8.2%	4.0%	0	1	0	0
Fe	0.01%	8.1%	6.9%	8.1%	8.2%	4.1%	0	0	0	0
K	20	1.9%	1.0%	1.2%	0.8%	2.1%	0	0	0	0
Mg	20	3.2%	5.0%	3.2%	4.6%	2.3%	0	1	0	0
Na	20	1.8%	1.6%	1.3%	1.7%	2.3%	0	0	0	0
S	10	0.22%	0.4%	1.0%	1.2%	0.0%	**2**	**3**	**4**	**5**
Si	0.10%	26%	23%	28%	23%	28%	0	0	0	0
Ag	0.1	0.1	0.1	0.1	0.2	0.07	0	0	0	1
As	1	7.5	38	77	74	1.5	2	**4**	**5**	**5**
Ba	0.1	355	150	768	136	500	0	0	0	0
Be	0.1	1.8	1.8	1.4	1.9	2.6	0	0	0	0
Bi	0.01	0.25	1.0	2.9	25	0.05	2	**4**	**5**	**6**
Cd	0.1	0.15	0.1	0.1	0.2	0.11	0	0	0	0
Ce	0.01	63	57	62	70	68	0	0	0	0
Co	0.1	27	169	38	85	20	0	2	0	1
Cr	2	145	243	458	319	100	0	1	2	1
Cu	1	92	120	87	210	50	0	1	0	1
F	50	747	458	512	632	950	0	0	0	0
Hg	0.01	0.01	0.01	0.01	0.01	0.05	0	0	0	0
Mn	1	1468	1268	1521	1350	950	0	0	0	0
Mo	0.1	1	14	4.3	4.7	1.5	0	**3**	1	1
Ni	1	89	244	165	210	80	0	1	0	1
P	20	1177	1240	723	1177	1000	0	0	0	0
Pb	2	25	17	18	9	14	0	0	0	0
Sb	0.05	1.4	5.8	6.4	5.9	0.2	2	**4**	**4**	**4**
Se	0.01	0.19	0.24	0.26	0.39	0.05	1	2	2	2
Sn	0.1	2.7	6.3	12.4	10.9	2.2	0	1	2	2
Sr	0.05	97	240	132	251	370	0	0	0	0
Tl	0.02	1.07	0.77	0.49	0.61	0.6	0	0	0	0
V	2	186	193	149	208	160	0	0	0	0
Zn	1	147	63	88	99	75	0	0	0	0

#Average crustal abundance from Bowen H.J.M.(1979) Environmental Chemistry of the Elements.

5.0 Summary

Fifteen drill core samples representing rock that will be mined during development of the Viking decline were assessed for acid forming potential. Most of the samples were Hornfel, which is the dominant lithological unit within which the decline will occur. Acid-base and NAG test results were used to classify samples with respect to acid forming potential. The main findings were as follows:

- The samples were generally characterised by low to moderate ANC and variable sulphur content.
- The majority of samples had low sulphur contents (<0.2 %S) and were classified as NAF.
- Two PAF samples were identified, both having high sulphur contents (0.98 and 1.15 %S). One sample was from mid-way along the South-North leg and the other was from the Lower Cross-cut.
- Four samples could not be definitively classified. The acid forming potentials of these samples were tentatively assessed as "Uncertain but most likely PAF-low capacity".
- Arsenic appears to be significantly enriched in samples with moderate to high sulphur contents.

Based on the results of the geochemical assessment, the following preliminary guidelines are proposed in relation to the use of waste rock from decline development in road construction:

- SUITABLE - NAF ROCK

  Road construction should initially be limited to material with a sulphur content no greater than about 0.2 %S. (*i.e.* material logged as containing trace sulphide only).

- MARGINAL

  The results of this study suggest that some waste rock containing 0.2 to 0.5 %S could be lower capacity PAF material and as such would not be suitable for use as road base. Therefore, it is recommended that marginal material is not used in road construction unless some form of geochemical testing (*e.g.* NAPP and/or NAG) is initially carried out to clarify the acid forming potential. It may be possible to blend smaller amounts of marginal material with NAF rock to produce a mix that is geochemically acceptable for use as road base. The feasibility of this option will depend on the mining schedule and the relative amounts of marginal and NAF Rock available for blending at any given time. However, in the absence of any confirmation testing, it is recommended that marginal material is regarded as unsuitable for road base and managed accordingly.

- UNSUITABLE - PAF ROCK

  The results of this study suggest that material containing more than 0.5 %S could result in adverse impacts from acidic drainage if used for road construction. Therefore, it is recommended that such material is identified at time of mining and, to the extent possible, excluded from use as road base.

Management of PAF Waste Rock

A management program for PAF waste rock mined during the construction of the Viking decline will need to encompass ARD control strategies to ensure that such material does not become a long-term liability.

One option may be to return PAF material underground as backfill. In this case, PAF rock should be temporarily stockpiled at the surface within a bunded area to control surface drainage until such time that it can be returned underground. The potential for acid generation whilst temporarily stockpiled can be reduced by addition of crushed limestone to the waste rock. The aim of such an addition would be to provide sufficient ANC to extend the lag period for acid conditions to develop beyond the expected stockpiling period. An addition of crushed limestone of around 5 to 10 kg per tonne of PAF rock should increase the lag by at least six months.

If mine development precludes use of PAF waste rock as underground backfill, it should be placed in an engineered facility that will limit the potential for sulphide oxidation and ensure minimal long-term risk to the environment from ARD. It is expected that such a facility would need to be lined (*e.g.* membrane of compacted clay) to restrict seepage into the underlying strata. A cover layer would also need to be placed over the PAF rock to reduce leaching by rainfall and to limit diffusion of atmospheric oxygen down into the sulphidic rock.

The design specifications for such a storage facility are beyond the scope of this study, however there are a number of geochemical control measures that should be incorporated into the design to minimise both the short and long-term risks of ARD generation. For example, PAF rock should preferably be placed in small lifts and compacted to reduce permeability, then encapsulated by clay that is compacted to the specification of an oxidation control layer (*i.e.* Ksat less than 10^{-8} m/s and a degree of saturation of more than 0.85). Depending on the size of the facility, intermediate clay sealing layers may also be required to reduce the potential for ARD during the construction period. Such layers would also improve the overall geochemical and hydrogeological security of the facility in the longer term. An outer layer of loose competent NAF rock will also be required for erosion control and protection of the compacted clay cover layer. This outer layer will need to be of sufficient depth to provide for long term, sustainable plant growth and prevent plant root damage of the underlying oxidation control layer. A model such as SoilCover can be used to predict the effectiveness of any cover or barrier layers and to refine the thickness and permeability requirements for outer cover layers.